G3 Vector Signal Generator

Model AP5042A

Introduction

This data sheet provides key features and specifications for the G3 vector signal generator AP5042A.

KEYSIGHT

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Definitions and Conditions

Specifications represent warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature 23 °C, unless otherwise stated, and after a 45-minute warm-up period. The specifications include measurement uncertainty. Data represented in this document are specifications unless otherwise noted.

Nominal (nom) values indicate the expected mean or average performance, or an attribute whose performance is by design, such as the 50-ohm connector. This data is not warranted and is measured at room temperature (approximately 23 °C).

Measured (meas) describes an attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 23 °C).

Frequency

Frequency Option	CW frequency range	Settable CW frequency range	RF output connector
AP5042A-504	100kHz to 4 GHz	100kHz to 4.15 GHz	SMA (f)
AP5042A-506	100kHz to 6 GHz	100kHz to 6.6 GHz	SMA (f)
AP5042A-512	100kHz to 12 GHz	100kHz to 12 GHz	SMA (f)
AP5042A-520	100kHz to 20 GHz	100kHz to 20 GHz	SMA (f)
AP5042A-540	100kHz to 40 GHz	100kHz to 43.5 GHz	3.5mm (f)

Frequency resolution

CW	0.001 Hz

Phase adjustment

Phase offset range	0 ° to 360°
Phase offset resolution	0.1 °

Frequency switching modes

F1	Normal mode (phase reset)
F2	Phase coherent switching (opt. PHS)
F3	Phase calibratable mode (opt. PCM)

Frequency Reference

Frequency accuracy		Option LN1	Option LN2
Initial accuracy (nom)		± 10 ppb	
Aging rate (nom) [1]	First year	<± 500 ppb	<± 20 ppb
	Per day	<± 5 ppb	<± 0.5 ppb
Temperature effects (nom)	Full temperature range	<± 100 ppb	<± 20 ppb
Warm up	5 minutes +23 °C, with respect to 1 hour (nom)	<±100 ppb	

External reference input	
Mode	Phase lock to external reference
Frequency	10 MHz
Input power (nom)	-5 dBm to +10 dBm
Impedance (nom)	50 Ω
Lock range (nom)	± 1.5 ppm ± 0.3 ppm (opt. LN2)
Connector	BNC (f)

Flexible reference input (Option 1ER)	
Mode	Phase lock to external reference
Frequency	5 MHz to 250 MHz
Frequency resolution	1 MHz
Input power (nom)	-5 dBm to +10 dBm
Impedance (nom)	50 Ω
Lock range (nom)	± 1.5 ppm

Reference output	
Frequency	10 MHz, 100 MHz
Power (meas)	> 0 dBm, 50 Ω load
Connector	BNC (f)

1 After 30 days of continuous operation

High performance reference input (Option SNC)

Mode	Bypass of internal reference
Frequency	6 GHz
Input power (nom)	0 dBm to +10 dBm
Impedance (nom)	50 Ω
Connector	SMA (f)

High performance reference output (Option SNC)

Frequency	6 GHz
Power (meas)	> 3 dBm, 50 Ω load
Connector	SMA (f)

Sweep mode (frequency and power)

Operating mode	Linear step sweep (equally spaced frequency or amplitude)
Amplitude range	A3
Sweep shape	Sawtooth
Dwell time settable	500 µs to 30 s 8 ns to 30 s (opt. UNZ)
Delay time settable:	200 ns to 30s 8 ns to 30s (opt. UNZ)
Dwell/delay time resolution	8 ns
Number of points:	2 to 9'999 (SCPI: 2 to 2^{32} -1)
Sweep count:	Infinite or 1 to 9'999 (SCPI: 1 to 2^{32} -1)
Triggering	See chapter Trigger
Trigger type	Continuous (full sweep)
Continuous Mode	Free run, trigger and run

Power

Output parameters

Leveling modes	A1 – ALC ON and hold ON A2 – ALC OFF A3 – ALC OFF (agile mode)	leveling on parameter change or on command, active modulations will be interrupted
Resolution (nom)	0.01 dB (A1, A2) 0.5 dB (A3)	
Attenuator Type	Opt. 1E2 for 504 Opt. 2E2 for 506, 512, 520 Opt. 3E2 for 540	Electronic
	Opt. 1E1	Mechanic
Output impedance (nom)	50 Ω	
Maximum reverse power (nom)	0.5 W, 5 VDC	

Settable range

Levelling mode	Standard	Opt. 1E2	Opt. 2E2	Opt. 3E2	Opt. 1E1
A1, A2	-20 to +25 dBm	-55 to +25 dBm	-80 to +25 dBm	-80 to +25 dBm	-120 to +25 dBm
A3	-20 to + 15 dBm	-55 to +15 dBm	-80 to +15 dBm	-80 to +15 dBm	-20 to +15 dBm

Maximum output power in CW, A1 (meas)

Frequency	Standard	Opt. 1E2	Opt. 2E2	Opt. 3E2	Opt. 1E1
100 kHz to 10 MHz	+10 dBm	+8 dBm	+8 dBm	+8 dBm	+10 dBm
10 MHz to 100 MHz	+15 dBm	+14 dBm	+14 dBm	+14 dBm	+15 dBm
100 MHz to 2.5 GHz	+21 dBm	+20 dBm	+19 dBm	+19 dBm	+20 dBm
2.5 GHz to 4 GHz	+20 dBm	+18 dBm	+17 dBm	+16 dBm	+20 dBm
4 GHz to 4.9 GHz	+15 dBm	-	+13 dBm	+12 dBm	+14 dBm
4.9 GHz to 10 GHz	+22 dBm	-	+16 dBm	+15 dBm	+20 dBm
10 GHz to 20 GHz	+22 dBm	-	+12 dBm	+14 dBm	+18 dBm
20 GHz to 26 GHz	+18 dBm	-	-	+10 dBm	+16dBm
26 GHz to 40 GHz	+15 dBm	-	-	+5 dBm	+12 dBm

Absolute level accuracy in CW, A1 (meas)

Frequency	-20 to +15dBm Standard	-55 to <-20 dBm Opt. 1E2	-80 to <-20 dBm Opt. 2E2	-80 to <-20 dBm Opt. 3E2	-120 to <-20 dBm Opt. 1E1
100k to 10 MHz	±1.0 dB[2]	±2 dB	±2 dB	±2 dB	±2 dB
10 MHz to 4 GHz	±0.5 dB	±2 dB	±2 dB	±2 dB	±2 dB
4 GHz to 20 GHz	±0.5 dB	-	±2 dB	±2 dB	±2 dB
20 GHz to 40 GHz	±1.0 dB	-	-	±2 dB	±2 dB

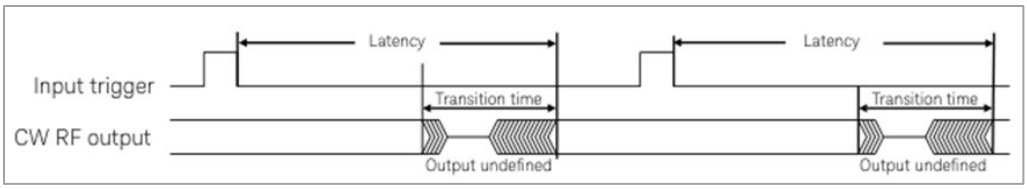
2 -20 dBm to +10 dBm

Absolute level accuracy in CW, A3 (meas)

Frequency	-20 to +15dBm Standard	-55 to <-20 dBm Opt. 1E2	-80 to <-20 dBm Opt. 2E2	-80 to <-20 dBm Opt. 3E2
100k to 10 MHz	±1.0 dB[3]	±3 dB	±3 dB	±3 dB
10 MHz to 4 GHz	±1.0 dB	±3 dB	±3 dB	±3 dB
4 GHz to 20 GHz	±1.5 dB	-	±3 dB	±3 dB
20 GHz to 40 GHz	±2.0 dB	-	-	±3 dB

3 -20 dBm to +10 dBm

Switching Speed



Latency and RF transition time for frequency changes (F1-F3) and amplitude changes (A1, A2) (meas)[4]

CW operation	< 10 ms
I/Q modulation active	< 10 ms

RF transition time for frequency changes (F1-F3) and amplitude changes (A3) (meas)[5]

Configuration	Opt. 504	Opt. 506, 512, 520	Opt. 540
Standard	2.0 µs	2.3 µs	5.1 µs
Opt. 1E2, 2E2, 3E2	2.0 µs	2.7 µs	5.3 µs
Opt. PHS	2.5 µs	3.5 µs	5.9 µs
Opt. 1E2, 2E2, 3E2 and Opt. PHS	3.0 µs	3.9 µs	6.2 µs

Latency for frequency changes (F1-F3) and amplitude changes (A3) (meas)[6]

Configuration	Opt. 504	Opt. 506, 512, 520	Opt. 540
Standard	0.5 ms	0.5 ms	0.5 ms
Opt. UNZ	2.6 µs	3.1 µs	5.9 µs
Opt. UNZ and Opt. 1E2, 2E2, 3E2	3.0 µs	3.9 µs	6.5 µs
Opt. UNZ and Opt. PHS	3.5 µs	4.7 µs	7.1 µs
Opt. UNZ and Opt. 1E2, 2E2, 3E2 and Opt. PHS	4.0 µs	5.1 µs	7.4 µs

4 Defined from receipt of SCPI command to next valid RF signal (phase settled to 0.2 rad, amplitude within 1dB of final value
5 Defined from valid RF signal to next valid RF signal (phase settled to 0.2 rad, amplitude within 1dB of final value). The RF signal will be blanked during transition.
6 Defined from received trigger command to RF invalid.

Phase Noise

Absolute SSB phase noise (CW) at +10 dBm or maximum output power in dBc/Hz, (meas) (Option LN1)

Frequency	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz	100 MHz
100 MHz	-107	-137	-148	-151	-151	-151	-151	-
1 GHz	-87	-117	-133	-141	-148	-153	-157	-157
2 GHz	-80	-111	-128	-135	-142	-149	-152	-152
4 GHz	-74	-106	-122	-130	-136	-144	-151	-152
6 GHz	-78	-95	-104	-113	-118	-118	-116	-142
10 GHz	-66	-92	-104	-113	-118	-118	-117	-144
20 GHz	-60	-91	-105	-114	-119	-119	-117	-147
40 GHz	-54	-84	-105	-114	-119	-119	-118	-143

Spectral Purity

Harmonics (CW), at 0 dBm (meas)

Frequency range	A1 or A2	A3
100 kHz to 10 MHz	-20 dBc	-
10 MHz to 4 GHz	-40 dBc	-
4 GHz to 4.9 GHz	-40 dBc	-
4.9 GHz to 6 GHz	-30 dBc	-
6 GHz to 12 GHz	-30 dBc	-
12 GHz to 20 GHz	-30 dBc	-
20 GHz to 40 GHz	-30 dBc	-

Non-harmonics (CW), > 10 kHz to 500 MHz offset, at 0 dBm (meas)

Frequency range	A1 or A2	A3
100 kHz to 10 MHz	-	-
10 MHz to 4 GHz	-65 dBc	-65 dBc
4 GHz to 4.9 GHz	-55 dBc	-55 dBc
4.9 GHz to 6 GHz	-50 dBc	-40 dBc
6 GHz to 12 GHz	-50 dBc	-40 dBc
12 GHz to 20 GHz	-50 dBc	-50 dBc
20 GHz to 40 GHz	-45 dBc	-45 dBc

Pulse Modulation (Option PME, PMR)

Pulse modulation

	I/Q (base band) modulator	RF modulator
On/off ratio (meas)	90 dB	40 dB
Rise/fall times (meas)	5 ns	5 ns
Video feed-through (meas) at PRF=500kHz, 0dBm 50% duty cycle	-70 dB at 1 GHz -50 dB at 20 GHz	-
RF delay to video (meas)	400 to 1000 ns	10 ns
Pulse overshoot (meas)	±1 dB	±1 dB
External pulse jitter (nom)	± 8ns	±10 ps
External pulse delay (meas)	20 ns	
External pulse input	MF1 IN, MF2 IN	

Internal pulse generator

	Opt. PME	Opt. PMR
Pulse period	192 ns to 10 s	16 ns to 10 s
Pulse width	96 ns to 10 s	8 ns to 10 s
Resolution	8 ns	
Triggering	See chapter Trigger	
Trigger type	Continuous (full sweep)	
Continuous mode	Free run, trigger and run	

Vector Modulation

Internal /Q baseband generator adjustments

Internal I/Q adjustments	None
Internal real-time complex digital I/Q filters	None

Carrier leakage

None (digital I/Q modulation)

Frequency response over modulation bandwidth (meas)

Center frequency	Amplitude
300 MHz 4.9 GHz	±3 dB
4.9 GHz to 20 GHz	±3.5 dB
20 GHz to 40 GHz	±4 dB

Internal Baseband Generator

This feature can only be configured over SCPI and the PC software, except for Opt. 431, UNT, 403.

Internal baseband generator

I/Q file resolution	16 bits
Waveform granularity	1 sample
Frequency offset	± half maximum bandwidth
Sample rate resolution	1 Hz
RF (I + Q) bandwidth and sample rate (nom)	400 MHz
Sample rate	1 Hz to 500 MHz

Arbitrary waveform memory

Maximum arbitrary waveform playback memory	Without marker	512 MSa
	With marker signals active	334 MSa

Waveform transfer rates, no markers, unencrypted (meas)

GUI to base band generator (LAN)	5 Mbit/s or 156 kSa/s

Waveform segments

Segment length minimum[7]	96 246, with markers signals active
Segment length maximum	See Maximum arbitrary waveform playback memory
Segment length quantum	See Waveform granularity
Maximum number of segments	65 k
Segment changeover mode	Seamless, immediate
Switching speed (meas)[8]	2 µs

Waveform sequences

Maximum number of sequences	1
Maximum number of segments per sequences[9]	2048
Maximum number of repetitions	10 M

7 Shorter Waveforms will be automatically extended by cyclically repeating the waveform.
8 Waveforms are pre-loaded, at 500 MHz sample rate, immediate segment changeover with opt. FCP interface.
9 All uploaded segments must have the same playback rate and the same marker configuration.

Waveform triggers

Type	Continuous
Continuous modes	Free run, trigger and run
Other parameters	See chapter Trigger

Markers[10]

Number of markers	4	
Marker (nom)	**Sample rate ≤ 125 MHz**	**Sample rate > 125 MHz**
Duration minimum value	1 sample	4 samples
Maximum duration variation	± 1 sample	± 8 ns
Maximum additional jitter	± 1 sample	± 8 ns

AWGN (Option 403)

Type	Real-time
Modes of operation	Digitally added to signals
Distribution density	Gaussian, statistical, $\mu = 0$, $\sigma^2 = 1$ (separate for I and Q)
Crest factor (nom)	≤ 21 dB
Periodicity	> 7×10^{44} s
Carrier-to-noise ratio (nom)	-60 dB to +90 dB
Carrier-to-noise ratio resolution (nom)	0.01 dB
Carrier-to-noise ratio formats	C/N
Noise bandwidth	0.8 of the actual set baseband generator sample rate

Custom digital modulation (Option 431)

Modulation	QAM (8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096)
Symbol rate	1 sps to 200 Msps
Filter type	cosine, root cosine, gaussian, rectangular, dirac, rectangular asymmetric
Filter parameter range	0.05 to 3
Pattern length	1 to 65535
Oversampling	1 to 32
Data	Random

10 Markers are defined during the waveform generation process and cannot be modified afterwards.

I/Q based analog modulation (Option UNT)

Amplitude modulation	
Waveform	Sine
AM-rate	0.1 Hz to 100 MHz
AM depth	0 to 100 %
Frequency modulation	
Waveform	Sine
FM-rate	0.1 Hz to 100 MHz
FM depth	0 Hz to 200 MHz (peak)
Phase modulation	
Waveform	Sine
ΦM-rate	0.1 Hz to 100 MHz
ΦM depth	0 to 100 rad

Simultaneous modulation

	AM	FM	ΦM	Pulse	Waveform I/Q	AWGN
AM	+	-	-	+	-	+
FM	-	+	-	+	-	+
ΦM	-	-	+	+	-	+
Pulse	+	+	+	+	+	+
Arbitrary I/Q	-	-	+	+	+	+
AWGN	+	+	+	+	+	+
+ = compatible		**– = incompatible**				

Trigger

Trigger input

Sources	Immediate, external, bus (GPIB, LAN, USB), global trigger, synchronous trigger between channels Synchronous trigger (Opt. SNC)
External input connector	MF1 IN, MF2 IN
External delay time	0 to 8.5 s
External delay resolution	2 ns
Additional external trigger latency (meas)	100 ns
External latency jitter	±2 ns
External slope	Rising, falling

Trigger output

Trigger output connector	MF1 OUT, MF2 OUT
Trigger output polarity	Normal, inverted
Trigger output delay time	0 to 2 µs
Trigger output delay resolution	2 ns
Trigger output pulse width	8 ns to 16 µs
Trigger output pulse width resolution	8 ns

External Multi-Function Inputs and Outputs (MF)

Digital inputs (MFI1 IN, MF2 IN)

Connector type	SMB (m)
Input impedance (nom)	10 k Ω DC and 50 Ω AC
Input voltage range (nom)	0 to 3.3 V
Input damage level	≤ –0.5 V and ≥ +5.5 V
Threshold voltage (nom)	0.9 V

Digital outputs (MFI1 OUT, MF2 OUT)

Connector type	SMB (m)
Output impedance (nom)	50 Ω
Output voltage range (nom)	0 to 3.3 V
Input damage level	≤ –0.5 V and ≥ +5.5 V

External Analog Inputs (Option EXT)

Analog inputs (I IN, Q IN)

Connector type	SMB (m)
Input impedance (nom)	50 Ω
Input voltage range (nom)	-0.5 V to +0.5 V
Input damage level	< -2 V and > +2 V
Analog bandwidth (meas)	50 MHz
Operation modes	Analog I/Q modulation, External AM, FM modulation (Option UNT)
Additional features	Individual digital gain and DC offset adjustment, overrange detection

Fast Control Port (Option FCP)

For fast, time critical settings and data streaming the G3 Vector Signal Generator can be controlled over an optional external fast control port. The FCP system can only be configured over SCPI and the PC software.

Fast control port	
Interface	18 bits parallel LVDS receiver with 100 Ω termination
Operation modes	I/Q data streaming, waveform segment ID streaming
Connector type	36-pin mini-D, MDR

I/Q data streaming over FCP	
I/Q sample rate	125 or 250 MHz
Data format	data (16 bits), clock, valid signal

Waveform segment ID streaming over FCP	
Sample rate	250 MHz
Data format	data (16 bits), valid signal

SD Card (Option 006)

Removable solid-state memory (micro-SD card) from rear panel. SD card is not included.
Used only for non-volatile I/Q waveform files (.QID, .QIM).[11]

SD card	
Supported SD	Up to 2 GB with FAT 12 or FAT 16
Supported SDHC	Up to 32 GB with FAT 32

11 Not hot plug capable (must be inserted before Instrument is powered on)

Remote Programming

Remote programming

Interfaces	LAN 1000BaseT LAN interface USB Version 2.0 GPIB IEEE-488.2,1987 with listen and talk (Option GPB)
Control language	SCPI Version 1999.0

Software AP504XA VSG GUI - hardware requirements

CPU architecture	X64
Memory	2 GB
Storage	380 MB
Recommended display resolution	Full HD 1920x1080
Ports	Ethernet or USB
Supported OS:	Windows 10 or newer

General Specifications

Physical specifications

Weight		< 22.5 kg
Dimensions	Height	88 mm
	Width	444 mm
	Length incl. connectors	594 mm

Power requirements

Number of channels	Frequency option	Power requirements	Average power consumption (meas)
1 (opt. 001)	Opt. 504 Opt. 506, 512, 520 ,540	100-240 VAC, 50/60 H 350 W Max	60 W 80W
2 (opt. 002)	Opt. 504 Opt. 506, 512, 520 ,540		100 W 140 W
3 (opt. 003)	Opt. 504 Opt. 506, 512, 520 ,540		140 W 180 W
4 (opt. 004)	Opt. 504 Opt. 506, 512, 520 ,540		180 W 220 W

Environmental specifications

Operating ambient temperature range	0 to +45 °C
Storage ambient temperature range	-40 to +70 °C
Operating and storage altitude	up to 15,000 feet/4600 m
Indoor use	For indoor use only
Humidity	Relative humidity range: 20 to 85%RH
Operating ambient temperature range	0 to +45 °C

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.

Safety

Safety complies to applicable safety regulation IEC/EN 61010-1.
This product complies with directive 2011/65/EU.
CE notice EMC complies to EMC regulations and directives for emission and immunity to interference (EN 61326-1 Industrial, EN/IEC 61326-2-1).

Recommended calibration cycle

2 years