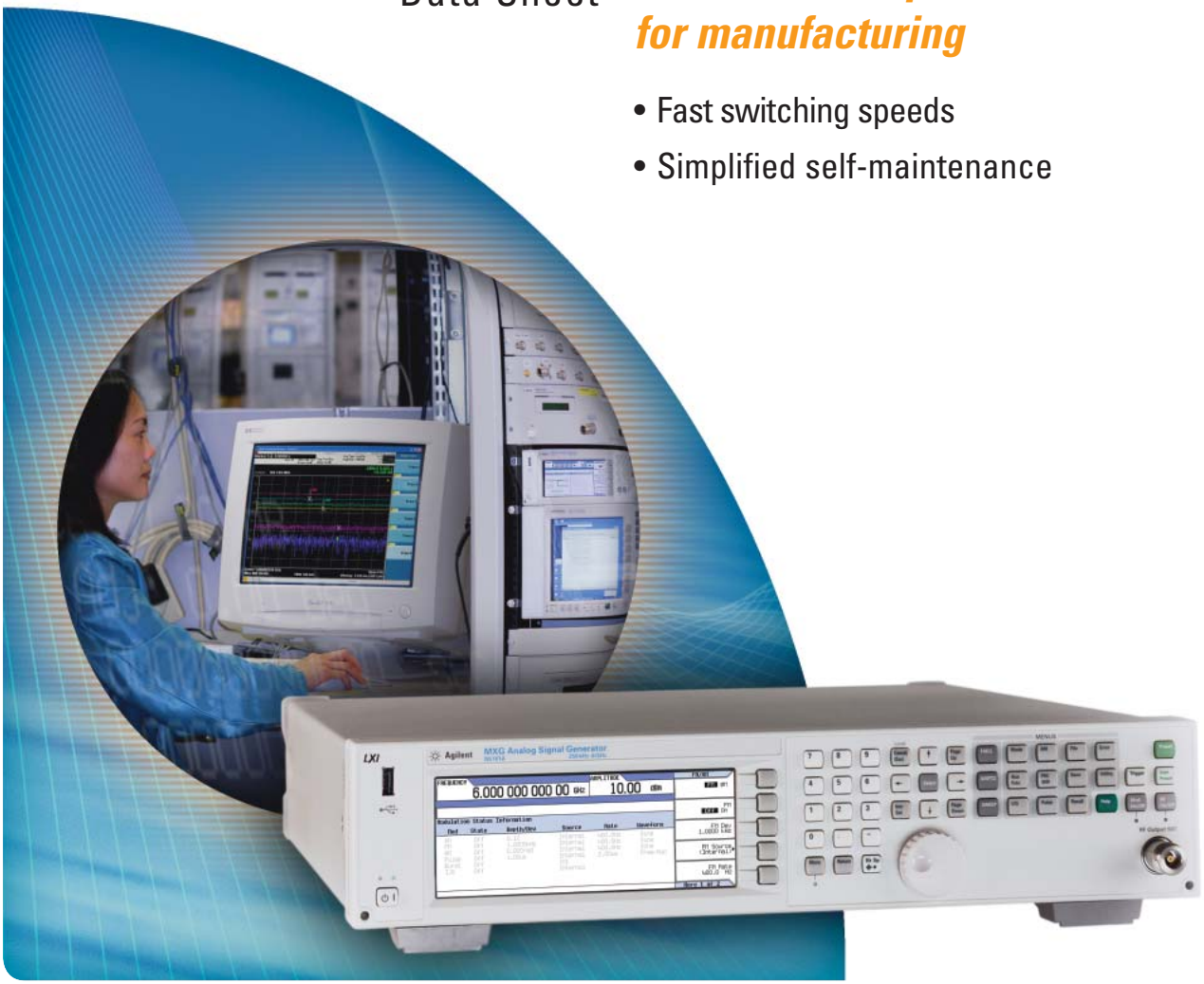
Agilent N5181A MXG Analog Signal Generator

Data Sheet

Performance optimized for manufacturing

- Fast switching speeds
- Simplified self-maintenance



Agilent Technologies

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Definitions

Specification (spec): Represents warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 0 to 55 °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.

Typical (typ): Represents characteristic performance, which 80% of the instruments manufactured will meet. This data is not warranted, does not include measurement uncertainty, and is valid only at room temperature (approximately 25 °C).

Nominal (nom): The expected mean or average performance, or an attribute whose performance is by design, such as the 50 Ω connector. This data is not warranted and is measured at room temperature (approximately 25 °C).

Measured (meas): 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 25 °C).

Note: All graphs contain measured data from several units at room temperature unless otherwise noted.

Frequency

Range

Option 501	250 kHz to 1 GHz
Option 503	250 kHz to 3 GHz
Option 506	250 kHz to 6 GHz

Minimum frequency 100 kHz [1]

Resolution 0.01 Hz

Phase offset Adjustable in nominal 0.01° increments

Frequency bands [2]

Band	*Frequency range*	*N*
1	100 kHz to < 250 MHz	0.5
2	250 to < 375 MHz	0.125
3	375 to < 750 MHz	0.25
4	750 to < 1500 MHz	0.5
5	1500 to < 3000.001 MHz	1
6	3000.001 to 6000 MHz	2

Switching speed [3, 4]

Type	*Standard*	*Option UNZ*
SCPI mode	≤ 5 ms (typ)	≤ 1.15 ms
List/Step sweep mode	≤ 5 ms (typ)	≤ 900 µs

Accuracy

± aging rate
± temperature effects
± line voltage effects

Internal time base reference oscillator aging rate ≤ ± 5 ppm/10 yrs, < ± 1 ppm/yr

Temperature effects ± 1 ppm (0 to 55 °C)

Line voltage effects ± 0.1 ppm (nom)

Line voltage range 5% to –10% (nom)

Reference output

Frequency	10 MHz
Amplitude	≥ +4 dBm (nom) into 50 Ω load

1. Performance below 250 kHz is unspecified.
2. N is a factor used to help define certain specifications within the document.
3. Time from receipt of SCPI command or trigger signal to within 0.1 ppm of final frequency or within 100 Hz, whichever is greater, and amplitude settled to within 0.2 dB.
4. Additional time may be required for the amplitude to settle within 0.2 dB when switching to or from frequencies < 500 kHz or amplitudes > +5 dBm

External reference input

Input frequency	*Standard*	*Option 1ER*
	10 MHz	1 to 50 MHz (in multiples of 0.1 Hz)
Lock range	± 1 ppm	
Amplitude	> –3.5 to 20 dBm (nom)	
Impedance	50 Ω (nom)	

Digital sweep modes

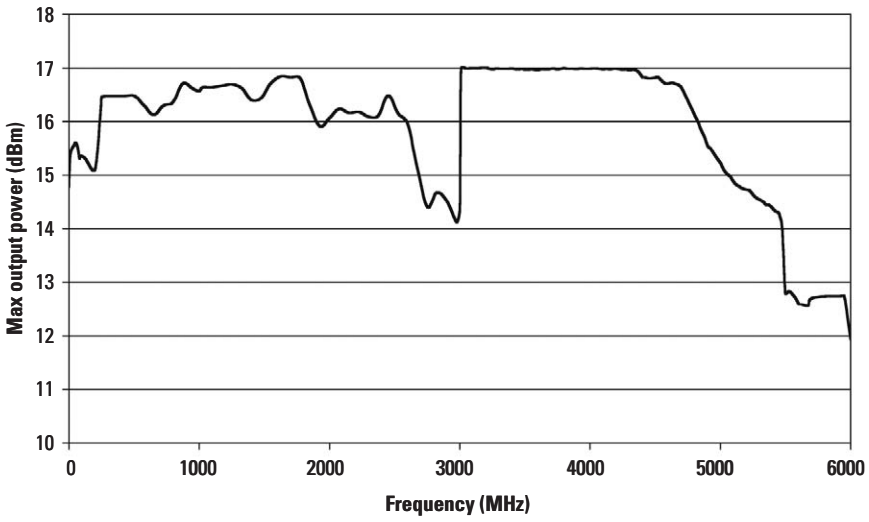
Operating modes	Step sweep (equally or logarithmically spaced frequency steps) List sweep (arbitrary list of frequency steps) Can also simultaneously sweep amplitude. See amplitude section for more detail.
Sweep range	Within instrument frequency range
Dwell time	100 µs to 100 s
Number of points	2 to 65535 (step sweep) 1 to 1601 (list sweep)
Step change	Linear or logarithmic
Triggering	Free run, trigger key, external, timer, bus (GPIB, LAN, USB)

Amplitude

Output power

Range [1]	***Standard***	***Option 1EQ*** [2]
250 kHz to 2.5 GHz	–110 to +13 dBm	–127 to +13 dBm
> 2.5 to 3.0 GHz	–110 to +10 dBm	–127 to +10 dBm
> 3.0 to 4.5 GHz	–110 to +13 dBm	–127 to +13 dBm
> 4.5 to 5.8 GHz	–110 to +10 dBm	–127 to +10 dBm
> 5.8 to 6 GHz	–110 to +7 dBm	–127 to +7 dBm

Maximum available output power



1. Quoted specifications between 20 and 30 °C. Maximum output power typically decreases by 0.2 dB/ °C for temperatures outside this range.
2. Settable to –144 dBm with option 1EQ, but unspecified below –127 dBm.

Resolution 0.02 dB (nom)

Step attenuator 0 to 130 dB in 5 dB steps, electronic type

Connector 50 Ω (nom)

SWR

≤ 1.4 GHz	1.7:1 (typ)
> 1.4 GHz to 4 GHz	2.3:1 (typ)
> 4.0 GHz to 5.0 GHz	2.4:1 (typ)
> 5.0 GHz to 6.0 GHz	2:2:1 (typ)

Maximum reverse power

Max DC voltage	50 VDC (nom)
250 kHz to 6 GHz	2 W (nom)

Switching speed [1]

Type	*Standard*	*Option UNZ*
SCPI mode	≤ 5 ms (typ)	≤ 750 µs
List/Step sweep mode	≤ 5 ms (typ)	≤ 500 µs

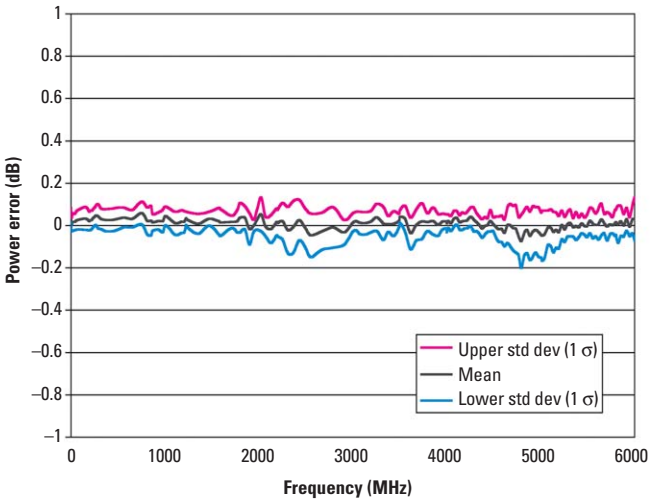
Absolute level accuracy [2] [ALC on]

	Standard		*Option 1EQ*
	+7 to –60 dBm	< –60 to –110 dBm	< –110 to –127 dBm
250 kHz to 1 MHz	±0.6 dB	±0.7 dB	±1.7 dB
> 1 MHz to 1 GHz	±0.6 dB	±0.7 dB	±1.0 dB
> 1 to 3 GHz	±0.7 dB	±0.9 dB	±1.4 dB
> 3 to 4 GHz	±0.8 dB	±0.9 dB	±1.0 dB
> 4 to 6 GHz	±0.8 dB	±1.1 dB	±1.3 dB

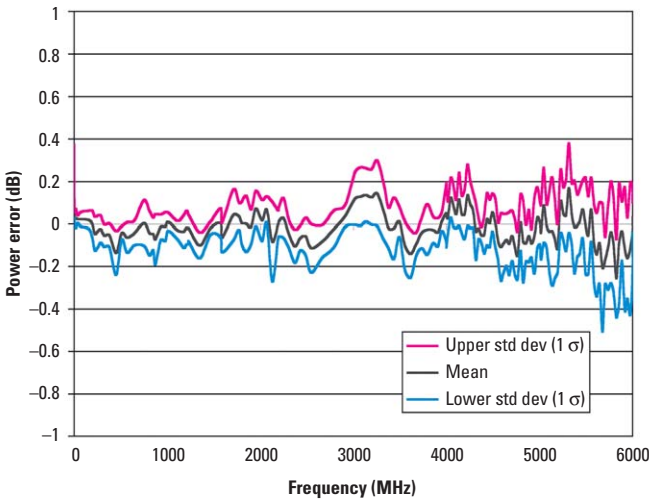
1. Time from receipt of SCPI command or trigger signal to amplitude settled within 0.2 dB when switching to or from amplitudes < +5 dBm.
2. Quoted specifications between 20 °C and 30 °C. For temperatures outside this range, absolute level accuracy degrades by 0.01 dB/degree C for frequencies ≤ 4.5 GHz and 0.02 dB/degree C for frequencies > 4.5 GHz.

Absolute level accuracy [ALC off, relative to ALC on] ±0.35 dB (typ)

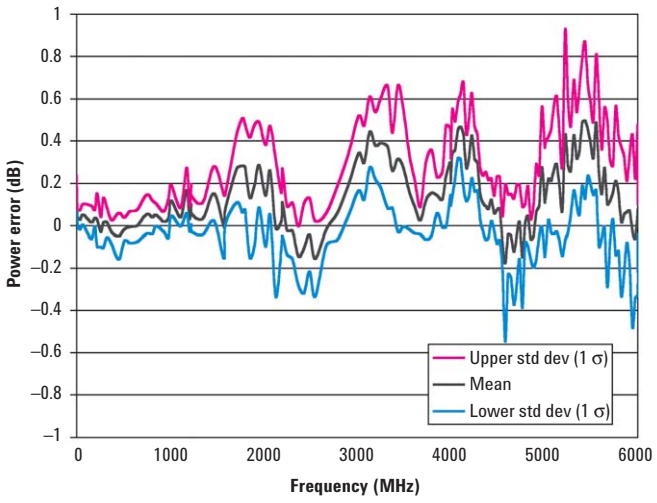
Level accuracy at –110 dBm

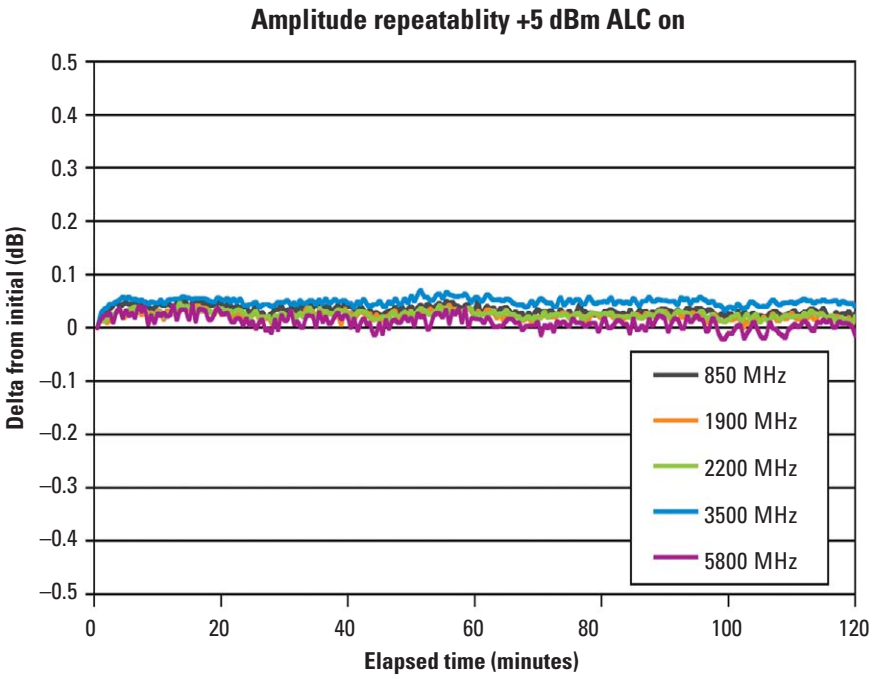


Level accuracy at –130 dBm

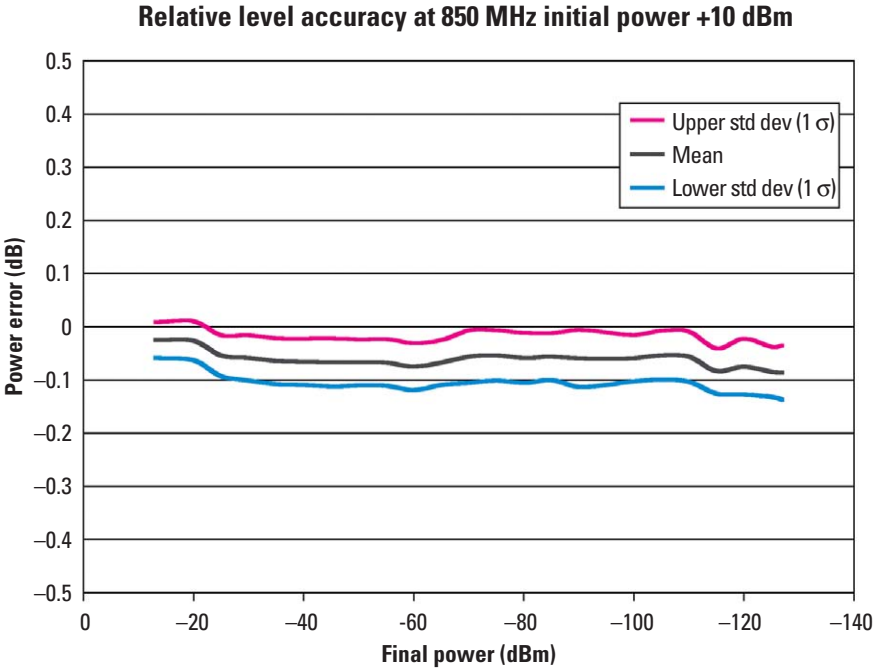


Level accuracy at –140 dBm



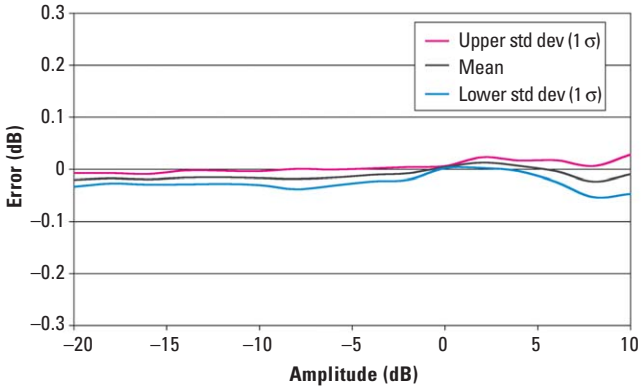


Repeatability measures the ability of the instrument to return to a given power setting after a random excursion to any other frequency and power setting. It should not be confused with absolute level accuracy.

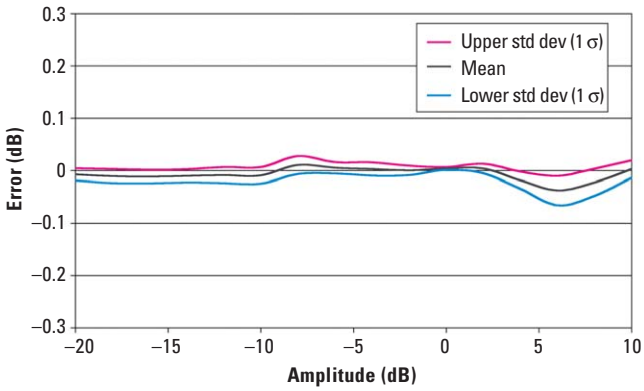


Relative level accuracy measures the accuracy of a step change from any power level to any other power level. This is useful for large changes (i.e. 5 dB steps).

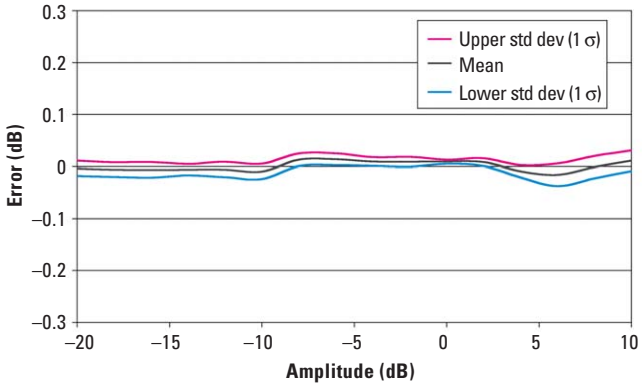
ALC linearity 850 MHz, CW, relative to 0 dBm



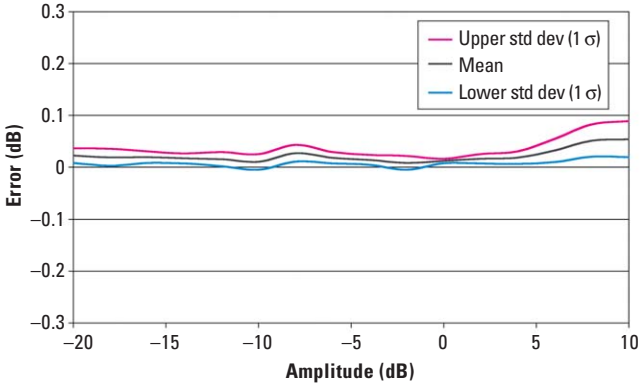
ALC linearity 1900 MHz, CW, relative to 0 dBm



ALC linearity 2200 MHz, CW, relative to 0 dBm

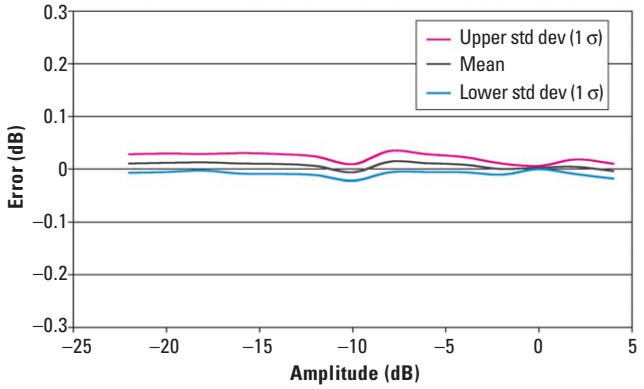


ALC linearity 3500 MHz, CW, relative to 0 dBm



Linearity measures the accuracy of small changes while the attenuator is held in a steady state. This is useful for fine resolution changes.

ALC linearity 5800 MHz, CW, relative to 0 dBm



User flatness correction

Number of points	1601
Number of tables	Dependent on available free memory in instrument

Digital sweep modes

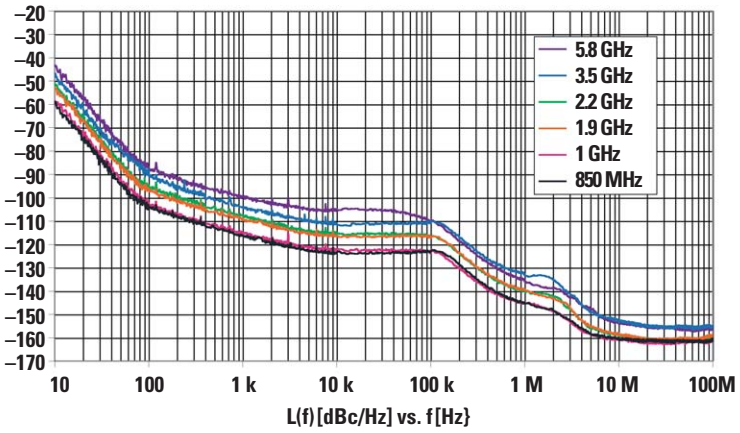
Operating modes	Step sweep (evenly spaced amplitude steps) List sweep (arbitrary list of amplitude steps) Can also simultaneously sweep frequency. See frequency section for more detail.
Sweep range	Within instrument amplitude range
Dwell time	100 µs to 100 s
Number of points	2 to 65535 (step sweep) 1 to 1601 (list sweep)
Step change	Linear
Triggering	Free run, trigger key, external, timer, bus (GPIB, LAN, USB)

Spectral Purity

Single sideband phase noise [at 20 kHz offset]

500 MHz	≤ –126 dBc/Hz (typ)	3 GHz	≤ –110 dBc/Hz (typ)
1 GHz	≤ –121 dBc/Hz (typ)	4 GHz	≤ –109 dBc/Hz (typ)
2 GHz	≤ –115 dBc/Hz (typ)	6 GHz	≤ –104 dBc/Hz (typ)

Single sideband phase noise in CW mode



Residual FM [CW mode, 300 Hz to 3 kHz BW, CCITT, rμs] < N x 2 Hz (typ)

Harmonics [1] [CW mode, output level < 4 dBm]

≤ 3 GHz	< –30 dBc
> 3 to 6 GHz	< –44 dBc (typ)

Nonharmonics [1] [CW mode]

	>10 kHz offset
250 kHz to 250 MHz	< –54 dBc, < –70 dBc (typ)
> 250 to 375 MHz	< –61 dBc, < –81 dBc (typ)
> 375 to 750 MHz	< –55 dBc, < –73 dBc (typ)
> 750 MHz to 1.5 GHz	< –48 dBc, < –62 dBc (typ)
> 1.5 to 3 GHz	< –48 dBc, < –62 dBc (typ)
> 3 to 6 GHz	< –42 dBc, < –56 dBc (typ)

Subharmonics [1] [CW mode]

≤ 4 GHz	< –76 dBc
> 4 to 5 GHz	< –64 dBc
> 5 to 5.5 GHz	< –50 dBc
> 5.5 to 6 GHz	< –46 dBc

Jitter [2]

Carrier	SONET/SDH			
Frequency	*Data rate*	*rms jitter BW*	*μUI rms*	*Femtoseconds*
155 MHz	155 MB/s	100 Hz to 1.5 MHz	84	537
622 MHz	155 MB/s	1 kHz to 5 MHz	47	75
2.488 GHz	2488 MB/s	5 kHz to 20 MHz	178	72

1. Harmonics, sub-harmonics, and non-harmonics outside the frequency range of the instrument are typical.
2. Calculated from phase noise performance in CW mode at +10 dBm. For other frequencies, data rates, or bandwidths, please consult your sales representative.

Analog Modulation

Frequency modulation

(Option UNT)

Max deviation	N times 10 MHz (nom)	
Resolution	0.1% of deviation or 1 Hz, which ever is greater (nom)	
Deviation accuracy [1 kHz rate, deviation is N x 100 kHz]	< ±2% + 20 Hz	
Modulation frequency response [at 100 kHz deviation]		
	1 dB bandwidth	*3 dB bandwidth*
DC coupled	DC to 3 MHz (nom)	DC to 7 MHz (nom)
AC coupled	5 Hz to 3 MHz (nom)	5 Hz to 7 MHz (nom)
Carrier frequency accuracy relative to CW in DCFM		< ±0.2% of set deviation + (Nx1 Hz) [1]
		< ±0.06% of set deviation + (Nx1 Hz) (typ) [2]
Distortion [1 kHz rate, deviation is N x 100 kHz]		< 0.4%
Sensitivity when using external input		+1V peak for indicated deviation (nom)

Phase modulation

(Option UNT)

Modulation deviation and frequency response:

	Max dev	*3 dB bandwidth*
Normal BW	N times 10 radians (nom)	DC to 1 MHz (nom)
High BW mode	N time 1 radian (nom)	DC to 4 MHz (nom)
Resolution	0.1% of deviation (nom)	

Deviation accuracy [1 kHz rate, normal BW mode]	< +0.5% + 0.01 rad (typ)
Distortion [1 kHz rate, deviation normal BW mode]	< 0.2% (typ)
Sensitivity when using external input	+1V peak for indicated deviation (nom)

Amplitude modulation [3]

(Option UNT)

AM depth type	Linear or exponential
Depth	
Maximum	90%
Resolution	0.1% of depth (nom)
Depth accuracy [1 kHz rate]	< ±4% of setting +1% (typ)
Modulation rate [3 dB BW]	
DC coupled	0 to 10 kHz (typ)
AC coupled	5 Hz to 10 kHz (typ)
Distortion [1 kHz rate]	< 2% (typ)
Sensitivity when using external input	+1V peak for indicated depth (nom)

1. Specification valid for temperature changes of less than ± 5 °C since last DCFM calibration.
2. Typical performance immediately after a DCFM calibration.
3. AM is specified at carrier frequencies from 500 kHz to 3 GHz, power levels ≤ ±4 dBm, and depths ≤ 90%.

Pulse modulation

(Option UNU) [1]

On/Off ratio	> 80 dB (typ)
Rise time	< 50 ns (typ)
Fall time	< 50 ns (typ)
Minimum width	
ALC on	≥ 2 µs (typ)
ALC off	≥ 500 ns
Resolution	20 ns (nom)
Pulse repetition frequency	
ALC on	DC to 500 kHz
ALC off	DC to 2 MHz
Level accuracy (relative to CW, ALC on or off)	< 1 dB (typ)
Video feedthrough	< 0.5 V (typ)
Pulse overshoot	< 15% (typ)
Pulse compression	15 ns (typ)
Pulse delay	
Internal delay	50 ns (nom)
External delay	65 ns (nom)
External input	
Input impedance	50 ohm (nom)
Level	+1Vpeak = ON (nom)
Internal pulse generator	
Modes	Free-run, square, triggered, adjustable doublet, trigger doublet, gated, and external pulse
Square wave rate	0.1 Hz to 10 MHz, 0.1 Hz resolution (nom)
Pulse period	500 ns to 42 seconds (nom)
Pulse width	500 ns to pulse period – 10 ns (nom)
Resolution	10 ns (nom)
Adjustable trigger delay:	–pulse period + 10 ns to pulse period to pulse width –10 ns
Settable delay	
Free run	–3.99 to 3.97 µs
Triggered	0 to 40 s
Resolution	
[delay, width, period]	10 ns (nom)
Pulse doublets	
1st pulse delay	
(relative to sync out)	0 to 42 s – pulse width – 10 ns
1st pulse width	500 ns to 42 s – delay – 10 ns
2nd pulse delay	
(relative to pulse 1)	0 to 42 s – (delay1 + width2) – 10 ns
2nd pulse width	20 ns to 42 s – (delay1 + delay2) – 10 ns

1. Pulse specifications apply to frequencies > 10 MHz.

Internal analog modulation source

(Option UNT)

Waveform	Sine
Rate range	100 mHz to 2 MHz
Resolution	1 mHz
Frequency accuracy	Same as RF reference source (nom)

External modulation inputs

Modulation types	FM, AM, phase mod, pulse mod
Input impedance	50 Ω (nom)

Simultaneous modulation [1]

All modulation types (FM, AM, ϕM and pulse modulation) may be simultaneously enabled except: FM and phase modulation can not be combined; two modulation types can not be simultaneously generated using the same modulation source. For example, AM and FM can run concurrently and will modulate the output RF. This is useful for simulating signal impairments.

1. If AM or pulse modulation are on then phase and FM specifications do not apply

General Characteristics

Remote programming

Interfaces	GPIB	IEEE-488.2, 1987 with listen and talk
	LAN	100BaseT LAN interface, LXI class C compliant
	USB	Version 2.0
Control languages	SCPI	Version 1997.0

Compatibility languages supporting a subset of common commands [1]

Agilent Technologies	E4438C, E4428C, E442xB, E443xB, E8241A, E8244A, E8251A, E8254A, E8247C, E8257C/D, E8267C/D, 8648 series, 8656B, E8663B, 8657A/B
Aeroflex Incorporated	3410 series
Rohde & Schwarz	SMU200A, SMJ100A, SMATE200A, SMIQ, SML, SMV

Power requirements
100 to 120 VAC, 50 to 60 Hz
220 to 240 VAC, 50 to 60 Hz
250 W maximum

Operating temperature range
0 to 55 °C

Storage temperature range
–40 to 70 °C

Operating and storage altitude
15,000 feet

Environmental stress
Samples of this product have been type tested in accordance with the Agilent Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

Safety
Complies with European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- USA: UL 61010-1

EMC
Complies with European EMC Directive 89/336/EEC, amended by 93/68/EEC

- IEC/EN 61326
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11:2002
- ICES/NMB-001

Memory
Memory is shared by instrument states, sweep list files, and other files. There is 512 MB of flash memory available in the N5181A MXG. Depending on how the memory is utilized, a maximum of 1000 instrument states can be saved.

Security (Option 006)
Memory sanitizing, memory sanitizing on power on, and display blanking

Self test
Internal diagnostic routines test most modules in a preset condition. For each module, if its node voltages are within acceptable limits, the module "passes" the test.

1. Firmware version A.01.10 and later.

Weight	≤ 12.5 kg (27.5 lb.) net, ≤ 27.2 kg (60 lb.) shipping
Dimensions	103 mm H x 426 mm W x 432 mm L [4.07 in H x 16.8 in W x 17 in L]
Recommended calibration cycle	24 months
ISO compliant	The Agilent N5181A MXG is manufactured in an ISO-9001 registered facility in concurrence with Agilent Technologies' commitment to quality.
Front panel connectors [1]	
RF output	Outputs the RF signal via a precision N type female connector.
USB 2.0	Used with a memory stick for transferring instrument states, licenses and other files into or out of the instrument. Licenses can only be transferred into the instrument. For a current list of supported memory sticks, visit **www.agilent.com/find/MXG**, click on Technical Support, and refer to FAQs: Waveform Downloads and Storage.
Rear panel connectors [1]	
RF output (Option 1EM)	Outputs the RF signal via a precision N type female connector.
Sweep out	Generates output voltage, 0 to +10 V when the signal generator is sweeping. This output can also be programmed to indicate when the source is settled or output pulse video and is TTL and CMOS compatible in this mode. Output impedance < 1 Ω, can drive 2k Ω. Damage levels are ±15 V.
AM	External AM input. Nominal input impedance is 50 Ω. Damage levels are ± 5 V.
FM	External FM input. Nominal input impedance is 50 Ω. Damage levels are ± 5 V.
Pulse	External pulse modulation input. This input is TTL and CMOS compatible. Low logic levels are 0 V and high logic levels are +1 V. Nominal input impedance is 50 Ω. Input damage levels are ≤ –0.3 V and ≥ +5.3 V.

1. All connectors are BNC unless otherwise noted.

Trigger in	Accepts TTL and CMOS level signals for triggering point-to-point in sweep mode. Damage levels are ≤ –0.3 V and ≥ +5.3 V.
Trigger out	Outputs a TTL and CMOS compatible level signal for use with sweep mode. The signal is high at start of dwell, or when waiting for point trigger in manual sweep mode; low when dwell is over or point trigger is received. This output can also be programmed to indicate when the source is settled, pulse synchronization, or pulse video. Nominal output impedance 50 ohms. Input damage levels are ≤ –0.3 V and ≥ +5.3 V.
Reference input	Accepts a 10 MHz reference signal used to frequency lock the internal timebase. Option 1ER adds the capability to lock to a frequency from 1 MHz to 50 MHz. Nominal input level -3.5 to +20 dBm, impedance 50 Ω.
10 MHz out	Outputs the 10 MHz reference signal used by internal timebase. Level nominally +3.9 dBm. Nominal output impedance 50 Ω. Input damage level is +16 dBm.
USB 2.0	The USB connector provides remote programming functions via SCPI.
LAN (100 BaseT)	The LAN connector provides the same SCPI remote programming functionality as the GPIB connector. The LAN connector is also used to access the internal web server and FTP server. The LAN supports DHCP, sockets SCPI, VXI-11 SCPI, connection monitoring, dynamic hostname services, TCP keep alive. This interface is LXI class C compliant.
GPIB	The GPIB connector provides remote programming functionality via SCPI.

Ordering Information

Frequency	501	Frequency range from 250 kHz to 1 GHz
	503	Frequency range from 250 kHz to 3 GHz
	506	Frequency range from 250 kHz to 6 GHz
Performance enhancements	UNZ	Fast switching
	1EQ	Low power (<-110 dBm)
	UNU	Pulse modulation
	UNT	AM, FM, phase modulation
	006	Instrument security
	1ER	Flexible reference input (1-50 MHz)
	1EM	Move RF output to rear panel
	UK6	Commercial calibration certificate with test data
Accessories	1CM	Rackmount kit
	1CN	Front handle kit
	1CP	Rackmount and front handle kit
	1CR	Rack slide kit

Related Literature

Application literature

- ***RF Source Basics, a self-paced tutorial*** (CD-ROM), literature number 5980-2060E.
- ***Improving Throughput with Fast RF Signal Generator Switching,*** literature number 5989-5487EN
- ***Digital Modulation in Communications Systems-An Introduction***, Application Note 1298, literature number 5965-7160E.
- ***Testing CDMA Base Station Amplifiers***, Application Note 1307, literature number 5967-5486E.

Product literature

- ***Agilent MXG Signal Generator***, Brochure, literature number 5989-5074EN
- ***Agilent MXG Signal Generator***, Configuration Guide, literature number 5989-5485EN
- ***Agilent N5182A vector signal generator***, Data Sheet, literature number 5989-5261EN

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