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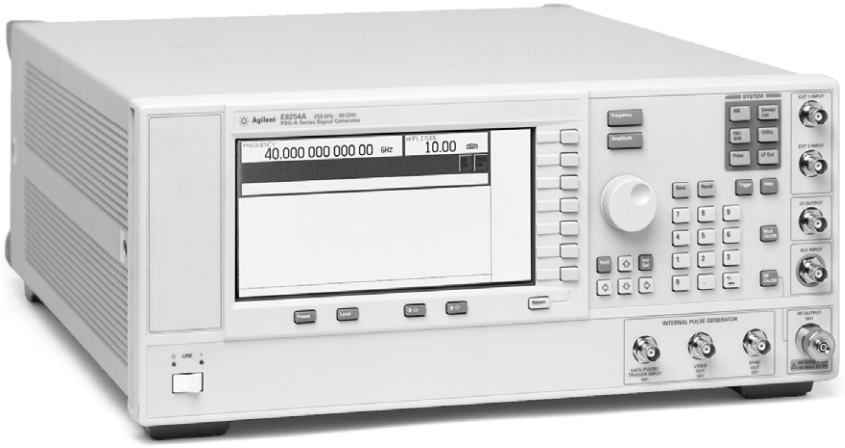
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Agilent E8241A/44A/51A/54A PSG Family Performance Signal Generator

Data Sheet



	CW only PSG-L Series	Analog PSG-A Series
250 kHz to 20 GHz	E8241A	E8251A
250 kHz to 40 GHz	E8244A	E8254A

All specifications and characteristics apply over a 0 to 55°C range (unless otherwise stated) and apply after a 45 minute warm-up time. Supplemental characteristics, denoted as typical or nominal, provide additional (non-warranted) information.

Definitions

Specifications (spec): represent warranted performance.

Typical (typ): performance is not warranted. It applies at 25°C. 80% of all products meet typical performance.

Nominal (nom): values are not warranted. They represent the value of a parameter that is most likely to occur; the expected or mean value. They are included to facilitate the application of the product.

Standard (std): No options are included when referring to the signal generator unless noted otherwise.

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Specifications

L and A Series

Frequency

Range[1]

Frequency Range	PSG-L Series	PSG-A Series
250 kHz to 20 GHz	E8241A	E8251A
250 kHz to 40 GHz	E8244A	E8254A

Resolution	0.01 Hz
Accuracy	Calibration = aging rate ± temperature effects ± line voltage effects
Switching speed (typical)[2]	
Analog modulation	< 15 ms
Modulation off	< 15 ms
Phase offset	Adjustable in nominal 0.1° increments.

Frequency bands

Band	Frequency range	N #
1	250 kHz to 250 MHz	1/8
2	> 250 to 500 MHz	1/16
3	> 500 MHz to 1 GHz	1/8
4	> 1 to 2 GHz	1/4
5	> 2 to 3.2 GHz	1/2
6	> 3.2 to 10 GHz	1
7	> 10 to 20 GHz	2
8	> 20 to 40 GHz	4

Internal timebase reference oscillator

	Standard	Option UNJ
Aging rate	< $\pm 1 \times 10^{-7}$/year or < $\pm 4.5 \times 10^{-9}$/day after 45 days	< $\pm 3 \times 10^{-8}$/year or < $\pm 2.5 \times 10^{-10}$/day after 24 hours
Temperature effects (typical)	< $\pm 5 \times 10^{-8}$ 0 to 55°C	< $\pm 4.5 \times 10^{-9}$ 0 to 55°C
Line voltage effects (typical)	< $\pm 2 \times 10^{-9}$ for +5% –10% change	< $\pm 2 \times 10^{-10}$ for ±10% change
External reference frequency	1, 2, 2.5, 5, 10 MHz (within 1 ppm)	10 MHz only (within 1 ppm)

Reference output	
Frequency	10 MHz
Amplitude	> +4 dBm typical into 50Ω load
External reference input	
Amplitude	> –3 dBm
Opt UNJ	5 dBm ±5 dB[3]
Input impedance	50Ω↔ nominal

Digital sweep	
Operating modes	Step sweep of frequency or amplitude or both (Start to stop)
	List sweep of frequency or amplitude or both (Arbitrary list)

[1] Useable to 100 kHz

[2] To within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below 250 MHz

[3] To optimize phase noise 5 dBm ± 2 dB

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Sweep range	
Frequency sweep	Within instrument frequency range
Amplitude sweep	Within attenuator hold range
Dwell time	1 ms to 60 s
Frequency settling time	28 ms typical
Amplitude settling time	10 ms typical
Number of points	2 to 1601
Triggering	Auto, external, single, or GPIB

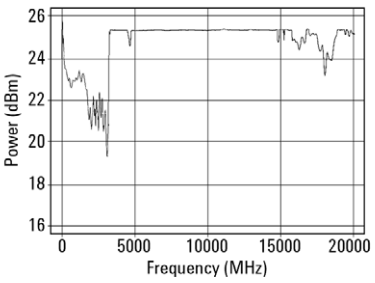
Output

Power[4] (dBm)

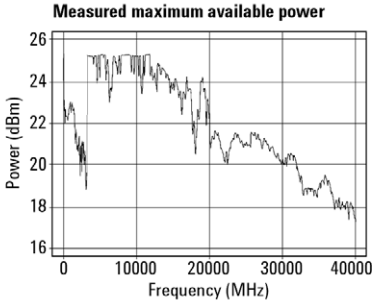
Frequency range	**Standard**	**Option 1EA**
20 GHz Models		
250 kHz to 3.2 GHz	–20 to +13	–20 to +16
> 3.2 to 20 GHz	–20 to +13	–20 to +20
40 GHz Models		
250 kHz to 3.2 GHz	–20 to +9	–20 to +15
> 3.2 to 20 GHz	–20 to +9	–20 to +18
> 20 to 40 GHz	–20 to +9	–20 to +14
20 GHz Models with option 1E1		
250 kHz to 3.2 GHz	–135 to +11	–135 to +15
> 3.2 to 20 GHz	–135 to +11	–135 to +18
40GHz Models with option 1E1		
250 kHz to 3.2 GHz	–135 to +7	–135 to +14
> 3.2 to 20 GHz	–135 to +7	–135 to +16
> 20 to 40 GHz	–135 to +7	–135 to +12

Option 1E1 step attenuator	0 dB and 5 to 115 dB in 10 dB steps

20 GHz Models with option 1EA
Measured maximum available power



40 GHz Models with option 1EA
Measured maximum available power



Attenuator hold range
(Same as max power sweep range)

Minimum	From –20 dBm to maximum specified output power. Can be offset using Option 1E1 attenuator.
Amplitude switching speed[5]	
CW or analog modulation	< 25 ms, typical
When using power search	< 25 ms, typical

CW level accuracy[6] (dB)

Frequency	**> +10 dBm**	**+10 to –10 dBm**	**–10 to –20 dBm**
250 kHz to 2 GHz	±0.6	±0.6	±1.4
2 GHz to 20 GHz	±0.8	±0.8	±1.2
> 20 to 40 GHz	±1.0	±0.9	±1.3

[4] Maximum power specification is warranted from 15 to 35°C, and is typical from 0 to 15°C. Maximum power over the 35 to 55°C range typically degrades less than 2 dB.

[5] To within 0.1 dB of final amplitude within one attenuator range

[6] Specifications apply over the 15 to 35°C temperature range. Degradation outside this range, for power levels > -10 dBm, is typically < 0.3 dB.

For instruments with type-N connectors (Option 1ED), specifications are degraded typically 0.2 dB above 18 GHz.

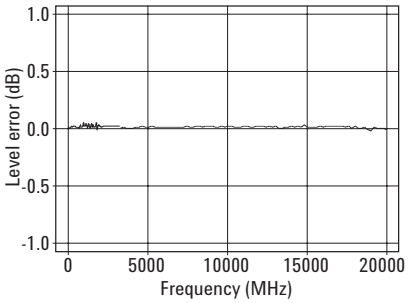
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CW level accuracy with option 1E1[7] (dB)

Frequency	> +10 dBm	+10 to –10 dBm	–10 to –70 dBm	–70 to –90 dBm	–90 to –110 dBm
250 kHz to 2 GHz	±0.6	±0.6	±0.7	±0.8	±1.4
> 2 to 20 GHz	±0.8	±0.8	±0.9	±1.0	±1.7
> 20 to 40 GHz	±1.0	±0.9	±1.0	±2.0	

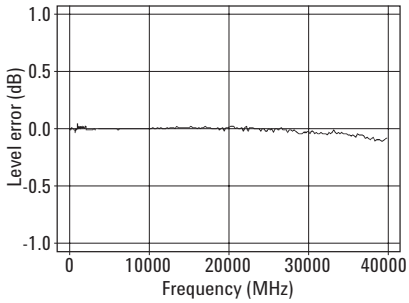
20 GHz level accuracy

Measured level accuracy +5 dBm option 1E1



40 GHz level accuracy

Measured level accuracy +5 dBm option 1E1



Resolution	0.01 dB
Temperature stability	0.01 dB/°C, typical
User flatness correction	
Number of points	2 to 1601 points/table
Number of tables	Up to 10,000, memory limited
Path loss	Arbitrary, within attenuator range
Entry modes	Remote power meter[8], remote bus, manual (user edit/view)
Output impedance	50 Ω, nominal
SWR (internally leveled, typical)	
250 kHz to 2 GHz	< 1.4:1
> 2 GHz to 20 GHz	< 1.6:1
> 20 GHz to 40 GHz	< 1.8:1
Leveling modes	Internal leveling, external detector leveling, millimeter source module, ALC Off
External detector leveling	
Range	–0.2 mV to –0.5 V, nominal (–36 dBm to +4 dBm using Agilent 33330D/E detector)
Bandwidth	Typically 10 kHz (Note: not intended for pulsed operation)
Maximum reverse power	1/2 Watt nominal

Spectral purity

Harmonics[9] (dBc at +10 dBm or maximum specified output power, whichever is lower)	
< 1 MHz	–30 dBc typical
1 MHz to 2 GHz	–30 dBc
> 2 GHz to 20 GHz	–55 dBc
> 20 GHz to 40 GHz	–50 dBc typical

[7] Specifications apply over the 15 to 35°C temperature range, with attenuator lock off (normal operating mode). Degradation outside this range, for ALC power levels > -10 dBm, is typically < 0.3 dB.

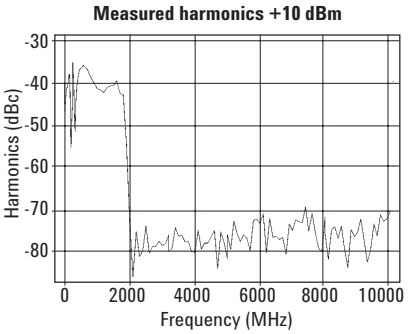
For instruments with type-N connectors (Option 1ED), specifications are degraded typically 0.2 dB above 18 GHz. Level accuracy is not specified below -110 dBm.

[8] Compatible with Agilent Technologies EPM Series (E4418B and E4419B) power meters.

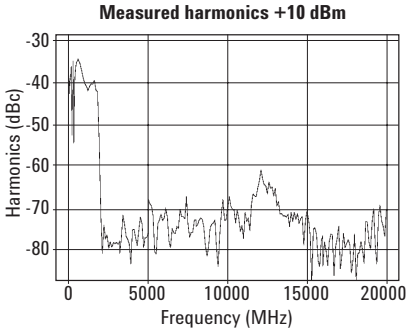
[9] Specifications for harmonics beyond maximum instrument frequencies are typical.

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20 GHz Measured harmonics



40 GHz Measured harmonics



Sub-harmonics: [10] (dBc at +10 dBm or maximum specified output power, whichever is lower)

250 kHz to 10 GHz	None
> 10 GHz to 20 GHz	< –60 dBc
> 20 GHz to 40 GHz	< –50 dBc

Non-harmonics: (dBc at +10 dBm or maximum specified output power, whichever is lower, for offsets > 3 KHz (>300 Hz with Option UNJ))[11]

Frequency	Spec	Typical
250 kHz to 250 MHz	< –65	–72 for > 10 kHz offsets
> 250 MHz to 1 GHz	< –80	< –88
> 1 to 2 GHz	< –74	< –82
> 2 to 3.2 GHz	< –68	–76
> 3.2 to 10 GHz	< –62	–70
> 10 to 20 GHz	< –56	–64
> 20 to 40 GHz	< –50	–58

SSB phase noise (CW)
Offset from Carrier (dBc/Hz)

Frequency	20 kHz	20 kHz typical
250 kHz to 250 MHz	–130	–134
> 250 to 500 MHz	–136	–140
> 500 MHz to 1 GHz	–130	–134
> 1 to 2 GHz	–124	–128
> 2 to 3.2 GHz	–120	–124
> 3.2 to 10 GHz	–110	–113
> 10 to 20 GHz	–104	–108
> 20 to 40 GHz	–98	–102

[10] Specifications for harmonics beyond maximum instrument frequencies are typical.

[11] Performance is typical for spurs at frequencies above the maximum operating frequency of the instrument. Specifications apply for CW mode only. Performance typically is –60 dBc between 200 and 250 MHz.

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Option UNJ: Improved SSB phase noise
Offset from carrier (dBc/Hz)

Frequency	100 Hz spec (typ)	1 kHz spec (typ)	10 kHz spec (typ)	100 kHz spec (typ)
250 kHz to 250 MHz	–94 (–115)	–110 (–123)	–128 (–132)	–130 (–133)
> 250 to 500 MHz	–100 (–110)	–124 (–130)	–132 (–136)	–136 (–141)
> 500 MHz to 1 GHz	–94 (–104)	–118 (–126)	–130 (–135)	–130 (–135)
> 1 to 2 GHz	–88 (–98)	–112 (–120)	–124 (–129)	–124 (–129)
> 2 to 3.2 GHz	–84 (–94)	–108 (–116)	–120 (–125)	–120 (–125)
> 3.2 to 10 GHz	–74 (–84)	–98 (–106)	–110 (–115)	–110 (–115)
> 10 to 20 GHz	–68 (–78)	–92 (–100)	–104 (–107)	–104 (–109)
> 20 to 40 GHz	–62 (–72)	–86 (–94)	–98 (–101)	–98 (–103)

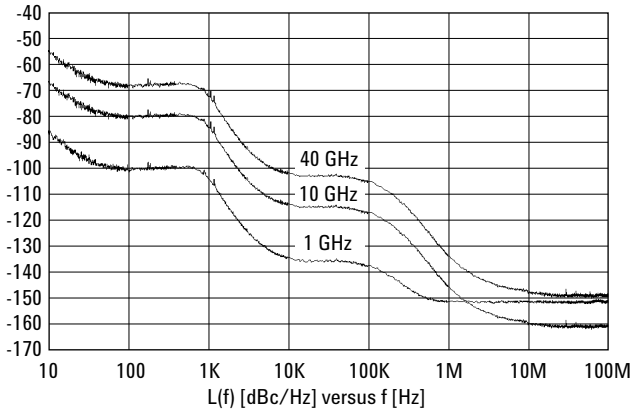
Residual FM < N x 6 Hz, typical
Option UNJ < N x 4 Hz, typical
(rms, 50 Hz to 15 kHz bandwidth)

Broadband noise (CW mode at +10 dBm output, for offsets > 10 MHz)

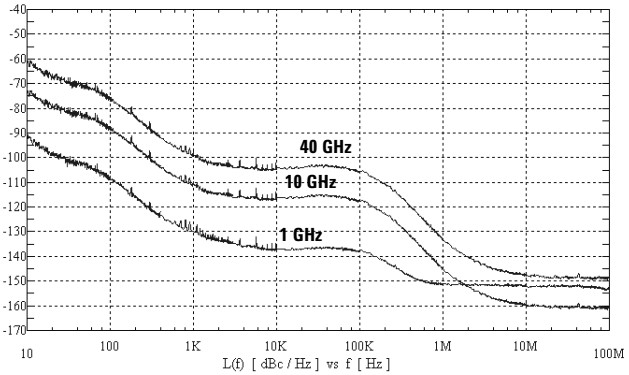
> 0.25 to 20 GHz	< –148 dBc/Hz typical
> 20 to 40 GHz	< –141 dBc/Hz typical

Measured phase noise

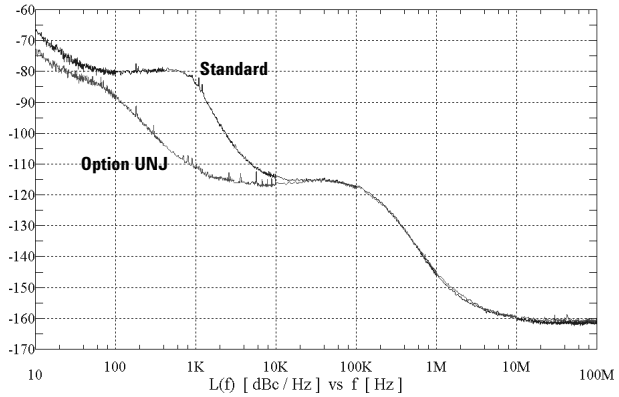
Standard Product



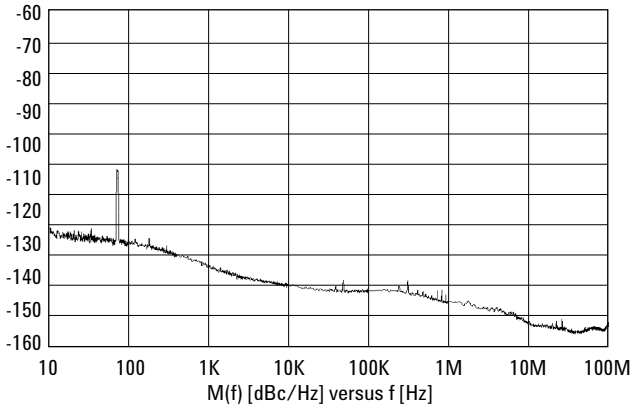
Option UNJ



Measured Standard vs. Option UNJ at 10 GHz



Measured AM noise at 10 GHz



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Frequency modulation

Maximum deviation		N x 8 MHz
Resolution		0.1% of deviation or 1 Hz, whichever is greater
Deviation accuracy		< ± 3.5% of FM deviation + 20 Hz (1 kHz rate, deviations < N x 800 kHz)
Modulation frequency response		
Path	**Rates (at 100 kHz deviation)** **1 dB Bandwidth**	**3 dB Bandwidth, typical**
FM 1	dc/20 Hz to 100 kHz	dc/5 Hz to 10 MHz
FM 2	dc/20 Hz to 100 kHz	dc/5 Hz to 1 MHz
dc FM[12] carrier offset		±0.1% of set deviation + (N x 8 Hz)
Distortion		< 1% (1 kHz rate, deviations < N x 800 kHz)
Sensitivity		±1 Vpeak for indicated deviation
Paths		FM1 and FM2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Ext1, Ext2, internal1, internal2. The FM2 path is limited to a maximum rate of 1 MHz. The FM2 path must be set to a deviation less than FM1.

Phase modulation

Maximum deviation		N x 80 radians (N x 8 radians in high-bandwidth mode)
Resolution		0.1% of set deviation
Deviation accuracy		< ±5% of deviation + 0.01 radians (1 kHz rate, normal BW mode)
Modulation frequency response		
Mode	Maximum Deviation	Rates (3 dB BW)
Normal BW	N x 80 rad	dc – 100 kHz
High BW	N x 8 rad	dc – 1 MHz (typ)
Distortion		< 1 % (1 kHz rate, THD, dev < N x 80 rad, normal BW mode)
Sensitivity		±1 Vpeak for indicated deviation
Path		ΦM1 and ΦM2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Ext1, Ext2, internal1, internal2. The ΦM2 path must be set to a deviation less than ΦM1.

[12] At the calibrated deviation and carrier frequency, within 5°C of ambient temperature at time of user calibration.

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Amplitude modulation (f_c > 2 MHz)[13] (typical)

Depth	Linear mode	Exponential (log) mode (Downward modulation only)
Maximum	> 90%	> 20 dB
Settable[14]	0 - 100 %	0 to 40 dB
Resolution	0.1%	0.01 dB
Accuracy (1 kHz rate)	< ±(6 % of setting + 1 %)	< ±(2% of setting + 0.2 dB)
Ext sensitivity	±1 Vpeak for indicated depth	–1 V for indicated depth

Rates (3 dB bandwidth, 30% depth)	dc/10 Hz to 100 kHz typical (useable to 1 MHz)
Distortion (1 kHz rate, linear mode, THD)	
30% AM	< 1.5%
90% AM	< 4 %
Path	AM1 and AM2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Ext1, Ext2, internal1, internal2.

External modulation inputs (Ext1 & Ext2)

Modulation types	AM, FM, and ΦM
Input impedance	50 or 600 Ω, nominal, switched
High/low indicator	
(100 Hz to 10 MHz BW, ac coupled inputs only)	Activated when input level error exceeds 3%, nominal

Simultaneous modulation	All modulation types may be simultaneously enabled except: FM with ΦM, and linear AM with exponential AM. AM, FM, and ΦM can sum simultaneous inputs from any two sources (Ext1, Ext2, internal1, or internal2) Any given source (Ext1, Ext2, internal1, or internal2) may be routed to only one activated modulation type.
Internal modulation source	Dual function generators provides two independent signals (internal1 and internal2) for use with AM, FM, ΦM, or LF Out.
Waveforms	Sine, square, positive ramp, negative ramp, triangle, Gaussian noise, uniform noise, swept sine, dual sine[15]
Rate range	
Sine	0.5 Hz to 1 MHz
Square, ramp, triangle	0.5 Hz to 100 kHz
Resolution	0.5 Hz
Accuracy	Same as timebase

[13] For f c < 2 MHz AM is usable but not specified. AM specifications apply with ALC on, and envelope peaks < maximum specified power. For instruments without Option 1E1 attenuator, specs apply for carrier amplitude > –2 dBm.

[14] For AM depth settings > 90% or > 20 dB, deep AM mode or 1 kHz ALC BW is recommended.

[15] Internal2 is not available when using swept sine or dual sine modes.

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LF out	
Output	Internal1 or internal2. Also provides monitoring of internal1 or internal2 when used for AM, FM, or ΦM.
Amplitude	0 to 3 Vpeak, nominal into 50 Ω
Output impedance	50 Ω, nominal
Swept sine mode: (frequency, phase continuous)	
Operating modes	Triggered or continuous sweeps
Frequency range	1 Hz to 1 MHz
Sweep rate	0.5 Hz to 100 k sweeps/s, equivalent to sweep times 10 us to 2 s
Resolution	0.5 Hz (0.5 sweep/s)

Pulse modulation

	≥ 500 MHz to ≤ 3.2 GHz[16]	**> 3.2 GHz**
Power range		
Internally leveled	0 to +10 dBm	0 to +10 dBm
With option 1E1	–110 to +10 dBm	–110 to +10 dBm
On/off ratio	80 dB typical	80 dB
Rise/fall times (T_r, T_f)	100 ns typical	10 ns (6 ns typical)
Pulse width		
Internally leveled	≥ 2 µs typical	≥ 1µs
ALC Off	≥ 0.5 µs typical	≥ 20 ns typical
Repetition freq		
Internally leveled	10 Hz to 250 kHz typical	10 Hz to 500 kHz typical
ALC Off	dc to 1 MHz typical	dc to 10 MHz typical
Level accuracy (relative to CW)		
Internally leveled	±0.5 dB	±0.4 dB (±0.15 typical)
ALC Off with power search[17]	±0.5 dB typical	≤ 20 GHz ±0.8 dB typical ≤ 40 GHz ±1.2 dB typical
Width compression	±50 ns typical	±5 ns typical
Video feedthrough[18]	< 200 mV typical	< 2 mV typical
Pulse delay (ext input to RF output)	300 ns nominal	70 ns nominal

Pulse overshoot (V_{or})	< 10% typical
Input level	+1 Vpeak = RF On
Input impedance	50 Ω, nominal

[16] For improved performance ≤ 3.2 GHz, special Option HE6 is available. Contact your local Agilent Online representative.

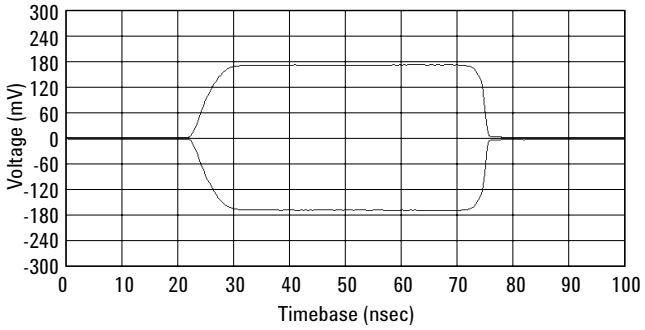
[17] Power search is a calibration routine that improves level accuracy in ALC-off mode. Unpulsed RF power will be present typically up to 5 ms when executing power search.

[18] With attenuator in 0 dB position. Video feed-through decreases with attenuator setting.

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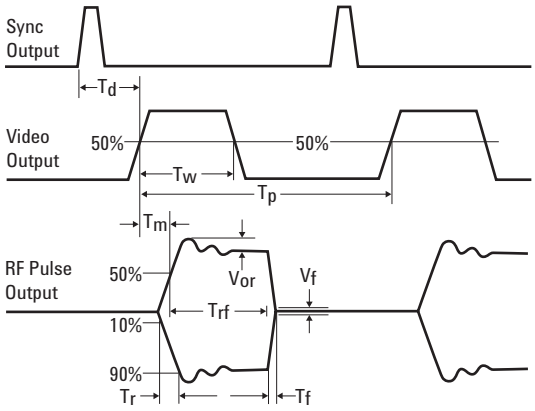
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Measured pulse modulation envelope



Internal pulse generator	
Modes	Free-run, triggered, triggered with delay, doublet, and gated. Triggered with delay, doublet, and gated require external trigger source.
Period (PRI) (T_p)	70 ns to 42 s (Repetition frequency: 0.024 Hz to 14.28 MHz)
Pulse width (T_w)	10 ns to 42 s
Delay (T_d)	
Free-run mode	0 to ±42 s
Triggered with delay and doublet modes	75 ns to 42s with ±10 ns jitter
Resolution	10 ns (width, delay, and PRI)
RF delay (T_m)	< 20 ns typical

T_d Video delay (variable)
T_w Video pulse width (variable)
T_p Pulse period (variable)
T_m RF delay
T_{rf} RF pulse width
T_f RF pulse fall time
T_r RF pulse rise time
V_{or} Pulse overshoot
V_f Video feedthrough



L and A Series

Remote programming	
Interfaces	GPIB (IEEE-488.2,1987) with listen and talk, RS-232, and 10-base T-LAN interface.
Control languages	SCPI version 1992.0. Also will emulate most applicable Agilent 836xxB, Agilent 8373xB, and Agilent 8340/41B commands, providing general compatibility with ATE systems which include these signal generators.
IEEE-488 functions	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2.
VXI*plug&play* drivers	Are available.

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ISO compliant	This family of signal generators is manufactured in an ISO-9001 registered facility in concurrence with Agilent Technologies commitment to quality.

General

Power requirements	90 to 132 Vac 50 to 60 Hz, or 195 to 267 Vac 50 to 60 or 400 Hz, (automatically selected), 300 W maximum.
Operating temperature range	0 to 55°C
Storage temperature range	–40 to 71°C
Shock and vibration	Meets MIL-STD-28800E Type III, Class 3.
EMC	Conducted and radiated interference and immunity meets IEC/EN 61326-1 and MIL-STD-461C Part 2, RE02. Meets radiated emission requirements of CISPR Pub 11/1997 Group 1 class A.
Storage registers	Memory is shared by instrument states, user data files, sweep list files, and waveform sequences. Depending on the number and size of these files, up to 800 storage registers and 10 register sequences are available.
Security	Display blanking.
Compatibility	Agilent 83550 Series millimeter heads
Self-test	Internal diagnostic routine tests most modules (including microcircuits) in a preset condition. For each module, if its node voltages are within acceptable limits, then module "passes" the test.
Weight	< 22 kg (48 lb.) net, < 30 kg (68 lb.) shipping.
Dimensions	178 mm H x 426 mm W x 498 mm D (7" H x 16.8" W x 19.6" D in.).

Front panel connectors

(All connectors are BNC female unless otherwise noted.)

RF output	Nominal output impedance 50 Ω.
For 20 GHz models	Precision APC-3.5 male, or Type-N with Option 1ED.
For 40 GHz models	Precision 2.4 mm male; plus 2.4-2.4 mm and 2.4-2.9 mm female adaptors also included.
ALC input	Used for negative external detector leveling. Nominal input impedance 120 kΩ, damage level ±15 V.
LF output (PSG–A Series only)	Outputs the internally generated LF source. Nominal output impedance 50 Ω.
External input 1 (PSG–A Series only)	Drives either AM, FM, or ΦM. Nominal input impedance 50 or 600 Ω, damage levels are 5 Vrms and 10 Vpeak.
External input 2 (PSG–A Series only)	Drives either AM, FM, or ΦM. Nominal input impedance 50 or 600 Ω, damage levels are 5 Vrms and 10 Vpeak.
Pulse/trigger gate input (PSG–A Series only)	Accepts input signal for external fast pulse modulation. Also accepts external trigger pulse input for internal pulse modulation. Nominal impedance 50 Ω. Damage levels are 5 Vrms and 10 Vpeak.
Pulse video out (A series only)	Outputs a signal that follows the RF output in all pulse modes. TTL-level compatible, nominal source impedance 50 Ω.

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Pulse sync out (A series only)	Outputs a synchronizing pulse, nominally 50 ns width, during internal and triggered pulse modulation. TTL-level compatible, nominal source impedance 50 Ω.

Rear panel connectors

(All connectors are BNC female unless otherwise noted.)

Serial interface	Used for serial communication (9-pin RS-232 connector female).
GPIB	Allows communication with compatible devices.
LAN	Allows LAN communication
10 MHz input	Accepts an external reference (timebase) input (at 1, 2, 2.5, 5, 10 MHz for standard and 10 MHz only for option UNJ) Nominal input impedance 50 Ω. Damage levels > +10 dBm
10 MHz output	Outputs internal or external reference signal. Nominal output impedance 50 Ω. Nominal output power +4 dBm
Sweep output	Generates output voltage, 0 to +10 V when signal generator is sweeping. Output impedance < 1 Ω, can drive 2000 Ω.
Trigger output	Outputs a TTL signal: 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, high or low 4 us pulse at start of LF sweep.
Trigger input	Accepts TTL signal for triggering point-to-point in manual sweep mode, or to trigger start of LF sweep. Damage levels ≥ +10 V or ≤ –4 V.
Source module interface	Provides bias, flatness correction, and leveling connections to the model 83550 Series mm-wave source modules.
Source settled output	Provides an output trigger that indicates when the signal generator has settled to a new frequency or power level (open-collector output).
EFC	> 0.25 ppm for -5 to +5 V
Recommended calibration cycle	24 months

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Other Asia Pacific Countries:
(tel) (65) 375 8100
(fax) (65) 836 0252
tm_asia@agilent.cm

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