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## **HP ESG Series Signal Generators Specifications**

Specifications describe the instrument's warranted performance and apply after a 45 minute warm-up. All specifications are valid over the signal generator's entire operating and environmental range while in phase noise mode 2, unless otherwise noted.

Supplemental characteristics (shown in italics and denoted typical or nominal) provide additional, non-warranted, information useful in applying the signal generator.

### **Frequency**

**Range:**

**HP ESG-1000A:** 250 kHz to 1000 MHz

**HP ESG-2000A:** 250 kHz to 2000 MHz

**HP ESG-3000A:** 250 kHz to 3000 MHz

**HP ESG-4000A:** 250 kHz to 4000 MHz

**Underrange:** 100 kHz

**Resolution:** 0.01 Hz

**Accuracy:** Same as timebase

**Switching Speed<sup>1</sup>:**

**Modulation On:** < 45 ms, typical

**Modulation Off:** < 35 ms, typical

1. To within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below 250 MHz.

**Phase Offset:** *Phase is adjustable via HP-IB or from the front panel in nominal 0.1 degree increments.*

Frequency Bands:		
Band	Frequency Range	N #
1	250 kHz to ≤ 249.999 MHz	1
2	> 249.999 to ≤ 500 MHz	0.5
3	> 500 MHz to ≤ 1 GHz	1
4	> 1 to ≤ 2 GHz	2
5	> 2 to 4 GHz	4

## Sweep Modes

**Operating Modes:** Frequency Step, Amplitude Step, and Arbitrary List

**Dwell Time:** 1 ms to 60 s

**Number of Points:** 2 to 401

## Internal Reference Oscillator

Stability:		
	Standard (typical)	High Stability (Option 1E5)
Aging Rate	$< \pm 2 \text{ ppm/year}$	$< \pm 0.1 \text{ ppm/year}$ or $< \pm 0.0005 \text{ ppm/day}$ after 45 days
Temperature (0 to 55°C)	$< \pm 1 \text{ ppm}$	$< \pm 0.05 \text{ ppm, typical}$
Line Voltage	$< \pm 0.1 \text{ ppm}$ (+5%, -10%)	$< \pm 0.002 \text{ ppm, typical}$ (+5%, -10%)

### Timebase Reference Output:

**Frequency:** 10 MHz

**Amplitude:**  $> 0.35 \text{ V}_{\text{rms}}$  into 50Ω load

### External Reference Input:

**Frequency:** 1, 2, 5, 10 MHz  $\pm$  typically 10 ppm (typically 1 ppm, Opt. 1E5)

**Amplitude:**  $> 0.15 \text{ V}_{\text{rms}}$

**Input Impedance:** 50Ω

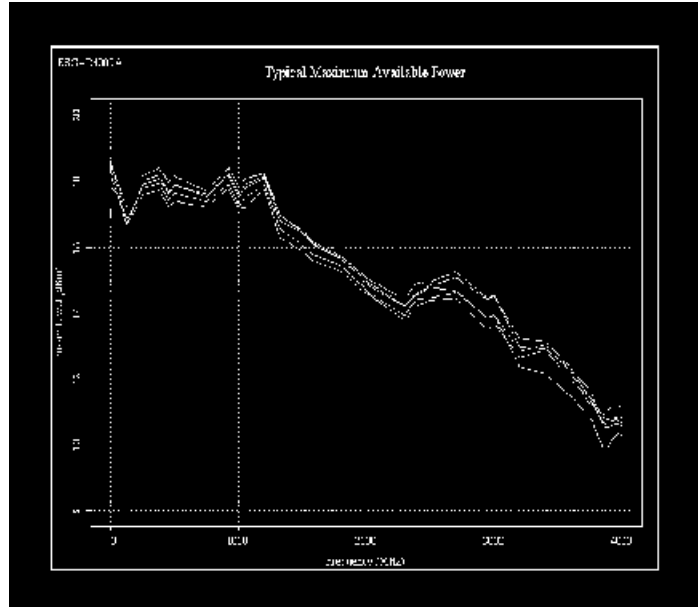
## Output

### Range:

**250 kHz to 1000 MHz:** +13 to -136 dBm

**> 1000 MHz to 3000 MHz:** +10 to -136 dBm

**> 3000 MHz to 4000 MHz:** +7 to -136 dBm



**Resolution:** 0.02 dB

**Attenuator Hold Level Range:**

**250 kHz to 1000 MHz:** 23 dB

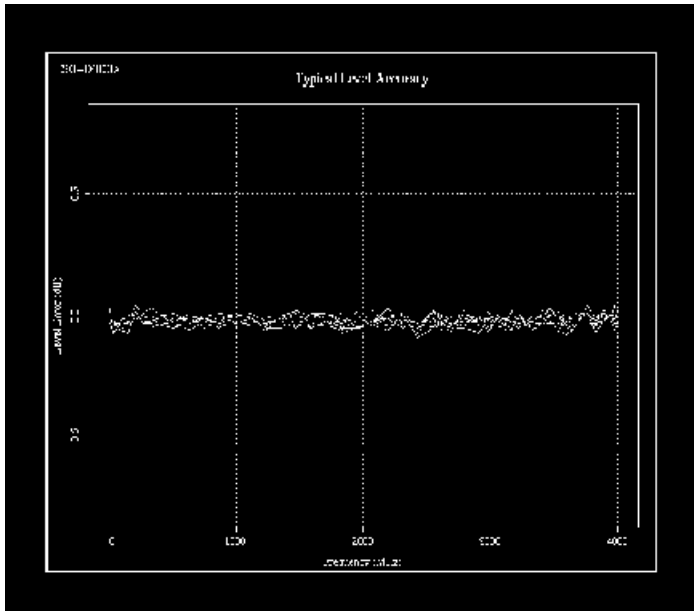
**> 1000 MHz to 3000 MHz:** 20 dB

**> 3000 MHz to 4000 MHz:** 17 dB

<b>Level Accuracy<sup>1</sup>:</b>		
	<b>+7 to -127 dBm</b>	<b>&lt; -127 dBm</b>
<b>250 kHz to 2 GHz:</b>	±0.5 dB	±1.5 dB
<b>&gt; 2 to 4 GHz:</b>	±0.9 dB	±2.5 dB

1. For 23° ±5°C. Accuracy degrades by 0.02 dB per degree C over the full temperature range and by 0.3 dB above +7 dBm.

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**Amplitude Switching Speed:** *< 25 ms, typical*

**When Using Power Search:** *< 210 ms, typical*

**Reverse Power Protection<sup>1</sup>:**

**250 kHz to 2000 MHz:** 50 watts

**> 2000 MHz to 4000 MHz:** 25 watts

**Maximum DC Voltage:** 50 V

1. The reverse power protection circuitry triggers at nominally 1 watt.

**SWR (typical):**

**250 kHz to 2000 MHz:** *< 1.4:1*

**> 2000 to 4000 MHz:** *< 1.9:1*

**Output Impedance:** 50Ω

## Spectral Purity

SSB Phase Noise (*typical, at 20 kHz offset*):

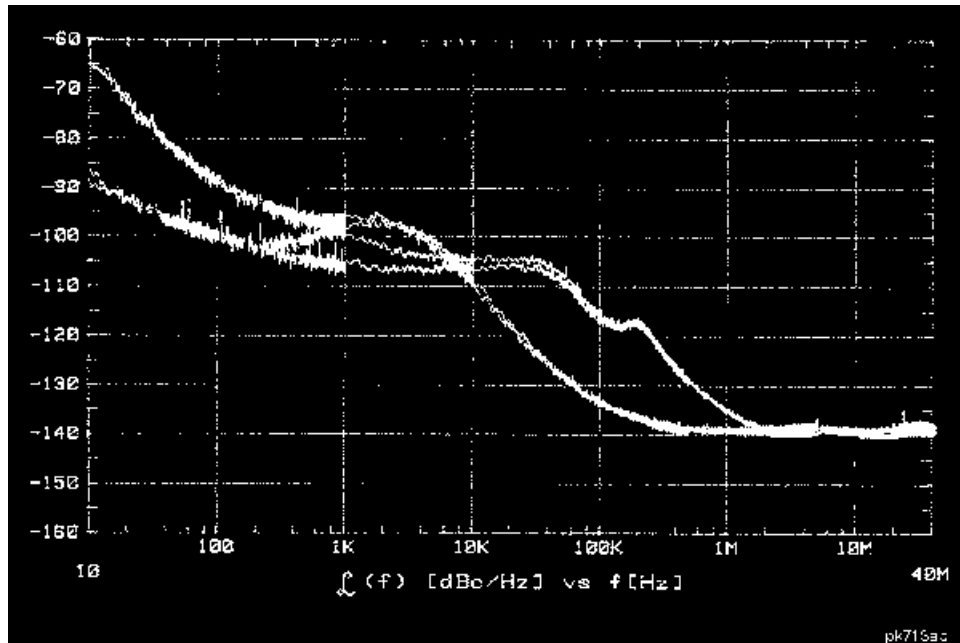
at 500 MHz:  $< -120$  dBc/Hz

at 1000 MHz:  $< -116$  dBc/Hz

at 2000 MHz:  $< -110$  dBc/Hz

at 3000 MHz:  $< -104$  dBc/Hz

at 4000 MHz:  $< -104$  dBc/Hz



Typical Phase Noise Modes 1 and 2 Single Sideband Phase Noise at 1 GHz

Residual FM (CW mode, 0.3 to 3 kHz BW, CCITT, rms):

Phase Noise Mode 1:  $< N \times 2$  Hz

Phase Noise Mode 2:  $< N \times 4$  Hz

Harmonics ( $\leq +4$  dBm output level):  $< -30$  dBc

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<b>Nonharmonics</b> (< +7 dBm output level) <sup>1</sup> :		
At Offsets:	> 3 kHz	> 10 kHz ( <i>typical</i> )
<b>250 kHz to 1000 MHz:</b>	< -65 dBc	< -75 dBc
<b>&gt; 1000 to 2000 MHz:</b>	< -59 dBc	< -69 dBc
<b>&gt; 2000 MHz:</b>	< -53 dBc	< -33 dBc

1. Performance is typical for spurs at frequencies above the maximum operating frequency of the instrument. Performance typically is -60 dBc between 225 and 249.999 MHz. Specifications apply for FM deviations < 100 kHz and are not valid for  $\Phi$ M.

**Subharmonics:**

**≤ 1000 MHz:** None  
**> 1000 MHz:** < -40 dBc

## Frequency Modulation

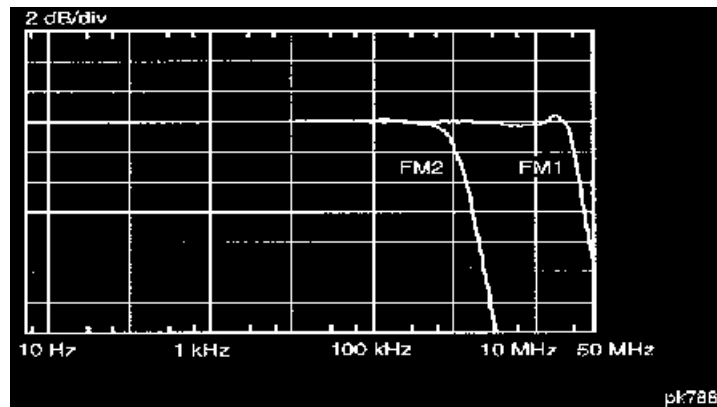
**Maximum Deviation:** N x 10 MHz

**Resolution:** 0.1% of deviation or 1 Hz, whichever is greater

**Deviation Accuracy:** < ±(3.5% of FM deviation setting + 20 Hz)  
 (1 kHz rate, deviation < N x 100 kHz)

Modulation Frequency Response <sup>1</sup> :		
Path	Rates (deviation = 100 kHz)	
	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

1. Since the internal modulation source operates over 0.1 Hz to 50 kHz, FM rates above 50 kHz must be supplied externally.



### Typical FM 1 and FM 2 Frequency Response

**Carrier Frequency Accuracy**      $\pm 0.1\%$  of set deviation + (N x 1 Hz)  
**Relative to CW in DCFM<sup>1</sup>:**

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

**Distortion** (1 kHz rate, THD, Deviations = N x 100 kHz):     < 1%

**External Inputs:**     Ext 1 or Ext 2

**Sensitivity:**     1 Vpk for indicated deviation



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**Input Impedance:** 50Ω, nominal

**Paths:** FM 1 and FM 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext 2. The FM 2 path is limited to a maximum rate of 1 MHz. The FM 2 path must be set to a deviation less than FM 1.

## Phase Modulation

**Maximum Deviation:** N x 90 radians

**Resolution:** 0.1% of set deviation

**Deviation Accuracy (1 kHz rate):** < ±(5% of deviation + 0.01 radians)

<b>Modulation Frequency Response:</b>			
<b>Phase Modulation Mode</b>	<b>Maximum Deviation</b>	<b>Rates (3 dB BW)</b>	
		<b>ΦM1</b>	<b>ΦM2</b>
<b>Normal</b>	N x 90 radians:	dc - 100 kHz	dc - 100 kHz
<b>High Bandwidth</b>	N x 2π radians:	<i>dc - 1.5 MHz, typical</i>	<i>dc - 0.9 MHz, typical</i>
	N x π/2 radians:	<i>dc - 4 MHz, typical</i>	<i>dc - 1 MHz, typical</i>

**Distortion (1 kHz rate, THD, deviations < N x 90 radians):** < 1%

**External Inputs:** Ext 1 or Ext 2

**Sensitivity:** 1 Vpk for indicated deviation

**Input Impedance:** 50Ω, nominal

**Paths:**  $\Phi$ M 1 and  $\Phi$ M 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext 2. The  $\Phi$ M 2 path is limited to a maximum rate of 1 MHz. The  $\Phi$ M 2 path must be set to a deviation less than  $\Phi$ M 1.

### Amplitude Modulation at $f_c > 500$ kHz

AM is typical above 3 GHz.

**Range** (envelope peak  $\leq$  maximum specified power): 0 to 100%

**Rates** (3 dB bandwidth): dc/10 Hz to 10 kHz

**Resolution:** 0.1%

**Accuracy** (1 kHz rate):  $< \pm(5\% \text{ of setting} + 1\%)$

**Distortion** (1 kHz rate, THD):

**30% AM:**  $< 1.5\%$

**90% AM:**  $< 4\%$

**External Inputs:** Ext 1 or Ext 2

**Sensitivity:** 1 Vpk for indicated depth

**Input Impedance:**  $50\Omega$ , nominal

**Paths:** AM 1 and AM 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext 2.

## Pulse Modulation

**On/Off Ratio:**

$\leq 3$  GHz: > 80 dB

< 3 GHz: > 60 dB

**Rise/Fall Times:** *150 ns, typical*

**Minimum Width:**

**ALC On:** *2  $\mu$ s, typical*

**ALC Off:** *0.4  $\mu$ s, typical*

**Pulse Repetition Frequency:**

**ALC On:** *10 Hz to 250 kHz, typical*

**ALC Off:** *dc to 1.0 MHz, typical*

**Level Accuracy** (relative to CW)<sup>1</sup>:  $\pm 0.5$  dB, typical

1. With ALC off, specifications apply after the execution of power search. With ALC on, specifications apply for repetition rates < 10 kHz and pulse widths  $\geq 5$   $\mu$ s.

**External Input:** Ext 2

**Input Voltage:**

**RF On:**  $> +0.5$  V, nominal

**RF Off:**  $< +0.5$  V, nominal

**Input Impedance:** 50 $\Omega$ , nominal

**Internal Pulse Generator:**

**Squarewave Rate:** 0.1 Hz to 50 kHz

**Period:** 16  $\mu$ s to 30s

**Width:** 8  $\mu$ s to 30s

**Resolution:** 4  $\mu$ s

## Internal Modulation Source

Provides FM,  $\Phi$ M, and AM modulation signals and LF Out.

**Waveforms:** Sine, Square, Ramp, Triangle, and Noise

**Rate Range:**

**Sine:** 0.1 Hz to 50 kHz

**Square, Ramp, Triangle:** 0.1 Hz to 10 kHz

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**Resolution:** 0.1 Hz

**Pulse Only:** 4  $\mu$ s

**Frequency Accuracy:** 0.005%

**Swept Sine Mode** (Frequency, Phase Continuous):

**Operating Modes:** Triggered or Continuous Sweeps

**Frequency Range:** 0.1 Hz to 50 kHz

**Sweep Time:** 1 ms to 65s

**Resolution:** 1 ms

**Dual Sinewave Mode:**

**Frequency Range:** 0.1 Hz to 50 kHz

**Amplitude Ratio:** 0 to 100%

**Resolution:** 0.1%

## **LF Out (Internal Modulation Source)**

**Amplitude:** 0 to 3 Vpk into 50 $\Omega$

**Output Impedance:** < 1 $\Omega$

## **External Modulation Inputs**

**Modulation Types:**

**Ext 1:** FM,  $\Phi$ M, and AM

**Ext 2:** FM,  $\Phi$ M, AM, and Pulse

**High/Low Indicator:** *Indicator is activated when input level error exceeds 3% (nominal)*  
(100 Hz to 10 MHz BW, AC-coupled inputs only)

## Simultaneous Modulation

All modulation types may be simultaneously enabled, except FM with  $\Phi$ M, AM, FM and  $\Phi$ M can sum simultaneous inputs from any two sources (Int, EXT 1, and EXT 2.) Any given source (Int, EXT 1, or EXT 2) may only be routed to one activated modulation type.

## Remote Programming

**Interface:** HP-IB (IEEE-488.2-1987) with Listen and Talk. RS-232

**Control Languages:** SCPI version 1992.0, also compatible with HP 8656B and 8657A/B/C/D/J<sup>1</sup> mnemonics.

1. HP ESG series does not implement HP 8657A/B 'Standby' or 'On' (R0 or R1, respectively) mnemonics.

**Functions Controlled:** All front panel functions except power switch and knobs.

**IEEE-488 Functions:** SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2

## ISO Compliant

The HP ESG Series RF signal generators are manufactured in an ISO 9001 registered facility in concurrence with Hewlett-Packard's commitment to quality.

## General

**Power Requirements:** 90 to 132 V; 50, 60, or 400 Hz; 250 W maximum  
198 to 254 V; 50 or 60 Hz; 250 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

**Leakage:** Conducted and radiated interference meets MIL STD 461B RE02 Part 2 and CISPR 11. *Leakage is typically < 1  $\mu$ V (nominally 0.1  $\mu$ V with a 2-turn loop) at  $\leq$  1000 MHz, measured with a resonant dipole antenna one inch from any surface with output level < 0 dBm (all inputs/outputs properly terminated).*

**Storage Registers:** Up to 100 storage registers with sequence and register number displayed. Up to 10 sequences available.

**Weight:** < 12.7 kg (28 lb.) net, < 21 kg (46 lb.) shipping

**Dimensions:** 133 mm H x 426 mm W x 432 mm D  
(5.25 in. H x 16.8 in. W x 17 in. D)

## Accessories

Transit Case, HP Part Number 9211-1296

HP 83300A Remote Interface

## Options

0B0	Delete Manual Set
0B1	Extra Manual Set
0BV	Add Component Level Information Package
0BW	Add Service Documentation (Assembly Level Repair)
0BX	Add Service Documentation and Component Level Information Package
1CM	Rack Flange Kit (without handles)
1CN	Front Handle Kit
1CP	Rack Flange Kit (with handles)
1E5	Add High Stability timebase
1EM	Move All Front Panel Connectors to Rear Panel
W30	Three Year Warranty