HP ESG-D 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-D1000A: 250 kHz to 1000 MHz

HP ESG-D2000A: 250 kHz to 2000 MHz

HP ESG-D3000A: 250 kHz to 3000 MHz

HP ESG-D4000A: 250 kHz to 4000 MHz

Under-range: 100 kHz

Resolution: 0.01 Hz

Accuracy: Same as timebase

Switching Speed[1]**:**

Modulation On[2]**:** *< 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.
2. With digital modulation active, performance is typically 80 ms when crossing frequency bands at 500 kHz, 250, 500, or 700 MHz, 1, 2, 2.4, 3.2, or 3.7 GHz.

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	< ±*2 ppm/year*	< ±0.1 ppm/year or < ±0.0005 ppm/day after 45 days
Temperature (0 to 55°C)	< ±*1 ppm*	< ±*0.05 ppm, typical*
Line Voltage	< ±*0.1 ppm (+5%, –10%)*	< ±*0.002 ppm, typical (+5%, –10%)*

Timebase Reference Output:

Frequency: 10 MHz

Amplitude: > 0.35 V_{rms} into 50Ω load

External Reference Input:

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

Amplitude: > 0.15 V_{rms}

Input Impedance: 50Ω

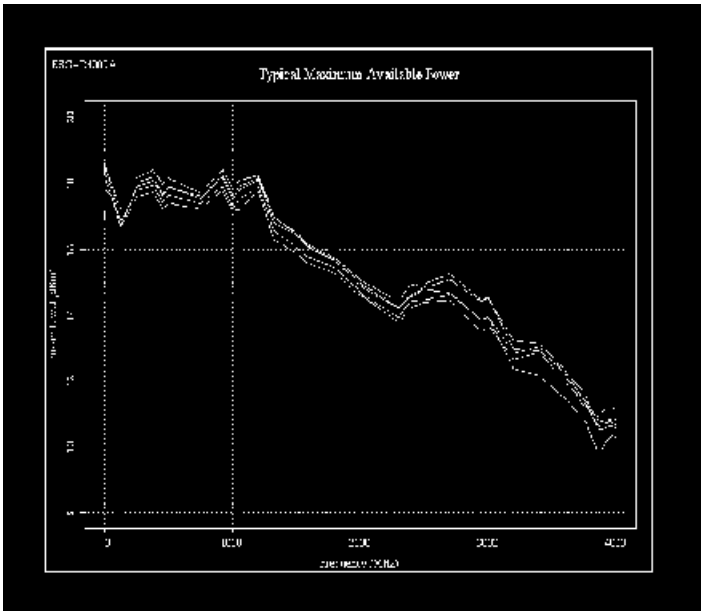
Output

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:

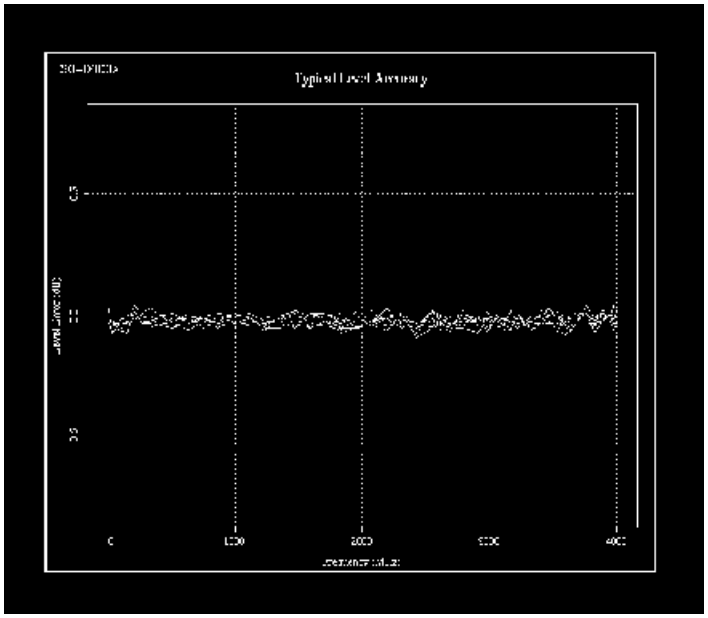
250 kHz to 1000 MHz: 23 dB

> 1000 MHz to 3000 MHz: 20 dB

> 3000 MHz to 4000 MHz: 17 dB

Level Accuracy[1]**:**		
	+7 to –127 dBm	**< –127 dBm**
250 kHz to 2 GHz:	±0.5 dB	±1.5 dB
> 2 to 4 GHz:	±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.



Amplitude Switching Speed: *< 25 ms, typical*

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

Reverse Power Protection[1]**:**

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)*:

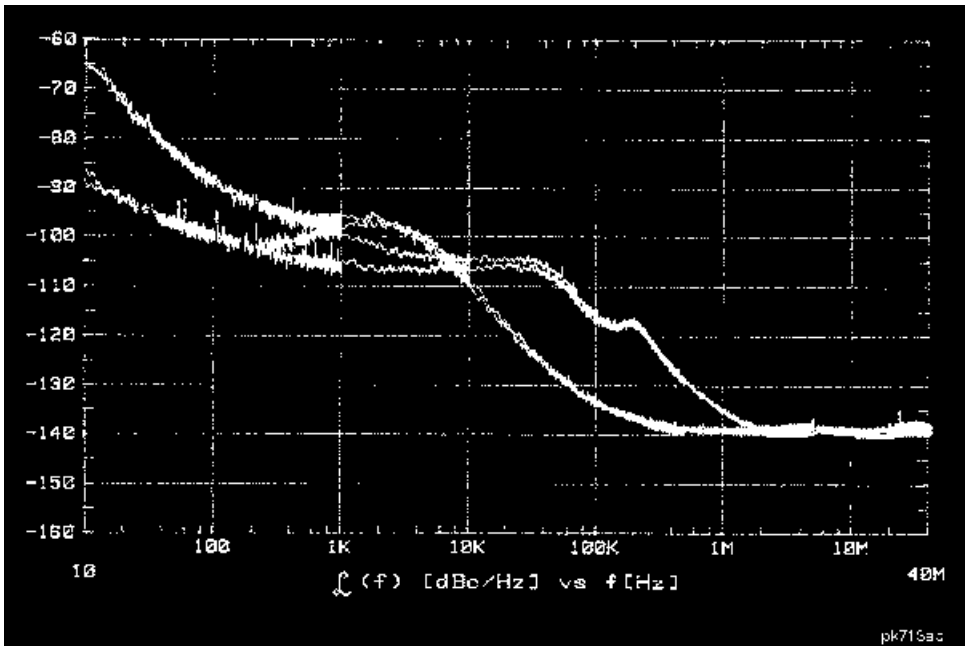
at 500 MHz: < *–120 dBc/Hz*

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 x 2 Hz

Phase Noise Mode 2: < N x 4 Hz

Harmonics (≤ +4 dBm output level): < –30 dBc

Nonharmonics (< +7 dBm output level)[1]**:**		
At Offsets:	> 3 kHz	*> 10 kHz (typical)*
250 kHz to 1000 MHz:	< –65 dBc	*< –75 dBc*
> 1000 to 2000 MHz:	< –59 dBc	*< –69 dBc*
> 2000 MHz:	< –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 ΦM. Performance is typically limited to –45 dBc at the symbol rate of π/4DQPSK modulating signals.

Subharmonics:

≤ 1000 MHz: None

> 1000 MHz: < –40 dBc

Frequency Modulation

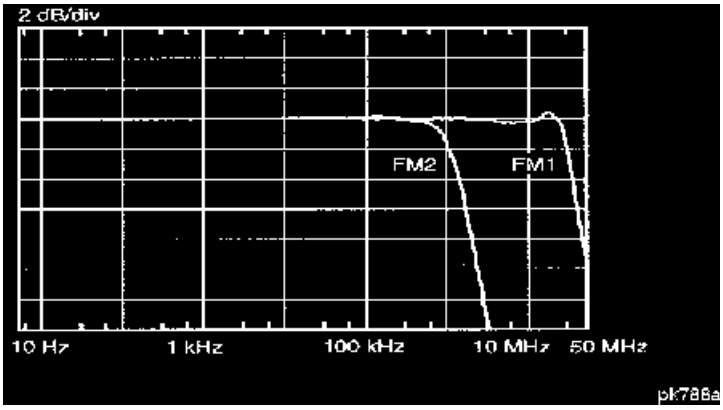
Maximum Deviation: N x 10 MHz

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[1]**:**		
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 Relative to CW in DCFM[1]**:** ±0.1% of set deviation + (N x 1 Hz)

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

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)

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

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: ΦM 1 and ΦM 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext2. The ΦM 2 path is limited to a maximum rate of 1 MHz. The ΦM 2 path must be set to a deviation less than ΦM 1.

Amplitude Modulation at fc > 500 kHz

AM is typical above 3 GHz or if wideband AM or I/Q modulation is simultaneously enabled.

Range (envelope peak ≤ maximum specified power)**:** 0 to 100%

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

Resolution: 0.1%

Accuracy (1 kHz rate)**:** < ±(5% 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: *50Ω , 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.

Wideband AM

Rate (1 dB bandwidth, *typical*)**:**

ALC On: *400 Hz to 10 MHz*

ALC Off: *dc to 10 MHz*

External Input: I input

Sensitivity: 0.5 V = 100%

Input Impedance: *50Ω , nominal*

Pulse Modulation

On/Off Ratio:

≤ 3 GHz: > 80 dB

< 3 GHz: > 60 dB

Rise/Fall Times: *150 ns, typical*

Minimum Width:

ALC On: *2 µs, typical*

ALC Off: *0.4 µs, 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)[1]: *±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 ≥5 µs.

External Input: Ext 2

Input Voltage:

RF On: *> +0.5 V, nominal*

RF Off: *< +0.5 V, nominal*

Input Impedance: *50Ω, nominal*

Internal Pulse Generator:

Squarewave Rate: 0.1 Hz to 50 kHz

Period: 16 µs to 30s

Width: 8 µs to 30s

Resolution: 4 µs

Internal Modulation Source

Provides FM, ΦM, 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

Resolution: 0.1 Hz

Pulse Only: 4 µs

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 50Ω

Output Impedance: < 1Ω

External Modulation Inputs

Modulation Types:

Ext 1: FM, ΦM, AM, and Burst Envelope

Ext 2: FM, ΦM, AM, and Pulse

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

Simultaneous Modulation

All modulation types may be simultaneously enabled, except FM with ΦM, AM with burst envelope, and wideband AM with I/Q. AM, FM and ΦM 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.

Level Accuracy with Digital Modulation

(With ALC On; relative to CW; with PRBS modulated data; if using I/Q inputs, $\sqrt{I^2 + Q^2}$ = 0.5 V_{rms} nominal)[1]

1. The optimum I/Q input level is $\sqrt{I^2 + Q^2}$ = 0.5 V_{rms}. I/Q drive affects EVM, origin offset, spectral regrowth, and noise floor. Typically, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V_{rms}.

π/4 DQPSK or QPSK Formats: ±0.15 dB
(Relative to CW; with raised cosine or root raised cosine filter and $\alpha \geq 0.35$; with 10 kHz < symbol rate < 1 MHz; at RF frequency > 25 MHz; power < maximum specified – 3 dB)

Constant Amplitude Formats (FSK, GMSK, etc)**:** No degradation in power level accuracy

Level Accuracy with ALC Off[1]**:** *±0.5 dB, typical*
(After power search is executed; relative to CW level with ALC on; if external I/Q is enabled: $\sqrt{I^2 + Q^2}$ = 0.5 V_{rms})

1. When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level. Power search is an internal calibration routine used to set output power when ALC is off. The routine disables all modulation inputs, adjusts output power while applying 0.5 V_{rms} to the I/Q modulator, then enables modulation.

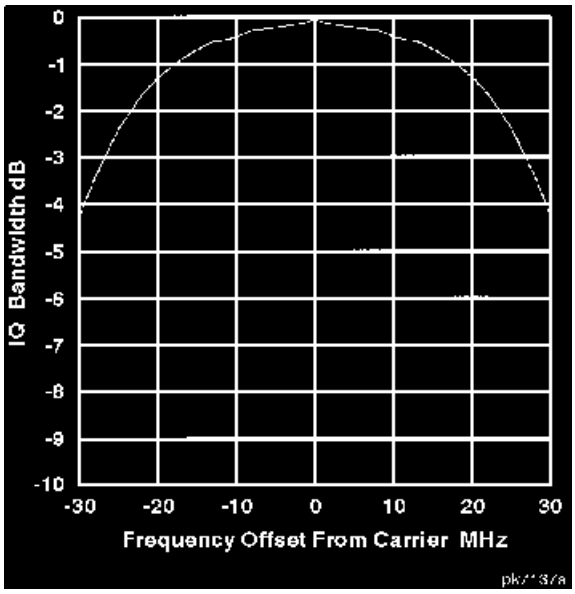
I/Q Modulation

I/Q Inputs:

Input Impedance: 50Ω

Full Scale Input[1]**:** $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$

1. The optimum I/Q input level is $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$. I/Q drive affects EVM, origin offset, spectral regrowth, and noise floor. Typically, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V_{rms}.



Typical I/Q Frequency Response

Adjustments/Impairments *(nominal)***:**

DC Offset (I and Q independently adjustable)**:** *±100%*

I/Q Gain Ratio: *±4 dB*

DC Vector Accuracy[1]: (relative to full scale, power < +7 dBm)				
Frequency (GHz):	**< 0.6**	**0.6 to 2**	**2. to 3.7**	≤4
Static EVM (rms)[2]**:**	< 0.75%	< 0.5%	< 0.75%	< 1%
Magnitude Error (rms)[2]**:**	< 0.5%	< 0.35%	< 0.5%	< 0.75%
Phase Error (rms)[2]**:**	< 0.35°	< 0.25°	< 0.35°	< 0.5°
Origin Offset (dBc):	< –46	< –46	< –40	< –40

1. Valid for 10 days after executing internal calibration routine, when operated within ±5°C of calibration temperature.
2. Measured at full scale with origin offset removed.

External Burst Envelope

Input Voltage:

RF On: 0 V

RF Off: –1 V

Linear Control Range: 0 to –1 V

On/Off Ratio:

≤ 3 GHz: > 75 dB

> 3 GHz: > 60 dB

V_{IN}: ≤ –1.05 V

Rise/Fall Time: *< 2 µs with rectangular input, typical*

Minimum Burst Repetition Frequency:

ALC On: *10 Hz, typical*

ALC Off: DC

External Input: Ext 1

Input Impedance: *50Ω, nominal*

I/Q Baseband Generator (Options UN3 and UN4)

Data Structure:

Frames and timeslots may be configured as different types of traffic or control channels. The data field of a timeslot can accept a user file, PRBS (PN9 or PN15), or external data with the appropriate clock.

Internal Data:

Pseudorandom Patterns (meets ITU-T standard)**:**	Continuous PN9 (PRBS $2^9 - 1$) or PN15[1] (PRBS $2^{15} - 1$)
Repeating Sequence:	Any 4 bit sequence

1. PN15 is not continuous in bursted mode for TETRA applications.

Downloadable Data (User Files)**:**

Type: Serial Data

Minimum Size: Must fill entire field for which it was selected

Maximum Size: 1 Mbits (Option UN3), 8 Mbits (Option UN4)

External Data:

Type: Serial Data

Inputs: Data, Bit/Symbol Clocks; Accepts data rates ±5% of specified data rate

Reference Frequency:

Internal or External 1, 2, 5, 10 MHz reference

Data clock can be locked to the external 13 MHz (GSM)

Frame Trigger Delay Control:

Range: 0 to 65,000 bits

Resolution: 1 bit

Internal burst Shape Control:

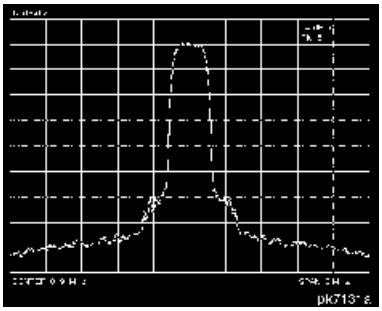
Rise/Fall Time Range: Up to 30 bits

Rise/Fall Delay Range: 0 to 63.5 bits (varies with standard)

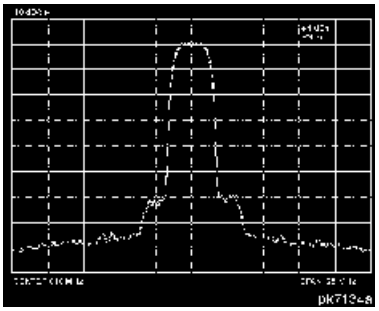
Specifications for Digital Communications Standards

	NADC		PDC		PHS		TETRA		DECT	GSM (DCS, PCS)	
Modulation Format	π/4 DQPSK								GFSK	GMSK	
Data Rate (default, kbits/sec)	48.6		42		384		36		1,152	270.83	
Adjustment Range (default, kbits/sec)	40 to 75.5		40 to 75.5		320 to 605		31 to 37.8		922 to 1209.6	163 to 300	
Filter	Root Raided Cosine or Raised Cosine								Gaussian		
Default Value	α = 0.35		α = 0.5		α = 0.5		α = 0.35		BbT = 0.5	BbT = 0.3	
Range (α or BbT)	Root Raided Cosine or Raised Cosine								Gaussian		
Error Vector Magnitude[1] (% rms)	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst	NA	NA	
Low EVM Mode	1.4	1.9	1.9	1.8	1.5	1.5	1.5	1.9			
Low EVM Mode *(typical)*	*0.8*	*1.4*	*0.9*	*1.4*	*0.9*	*0.9*	*0.8*	*1.5*			
Low ACP Mode *(typical)*	*1.4*	*1.8*	*1.0*	*1.2*	*1.2*	*1.2*	*3.1*	*3.2*			
Global Phase Error[1] (rms/pk), *typical*	NA		NA		NA		NA		NA	0.8°/2.8° *0.8°/2.8°*	
Deviation Accuracy[1] (kHz)	NA		NA		NA		NA		6.1 *(2.5, typ)*	NA	
Channel Spacing (kHz)	30		25		300		25		1728	200	
Adj. Channel Power (ACP) (Low ACP Mode, dBc, typical)	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst[2]	NA	Cont.	Burst
at Adjacent Channel[3]	*−35*	*−34*	--	--	--	--	*−68*	*−65*		*−38*	*−37*
at 1st Alternate Channel[3]	*−75*	*−73*	*−72*	*−70*	*−76*	*−75*	*−77*	*−76*		*−71*	*−70*
at 2nd Alternate Channel[3]	*−77*	*−77*	--	--	*−77*	*−76*	*−79*	*−78*		*−80*	*−79*
at 3rd Alternate Channel[3]	*−79*	*−78*	*−78*	*−78*	--	--	*−79*	*−79*		*−81*	*−82*
Supported Burst Types	Custom, Up/Down TCH		Custom, Up/Down TCH, Up Vox		Custom, TCH, Sync		Custom, Up Control 1&2, Up Normal, Down Normal, Down Sync		Custom Dummy B 1&2, Traffic B, Low Capacity	Custom, Normal, FCorr, Sync, Dummy, Access	
Scramble Capabilities					Yes		Yes				

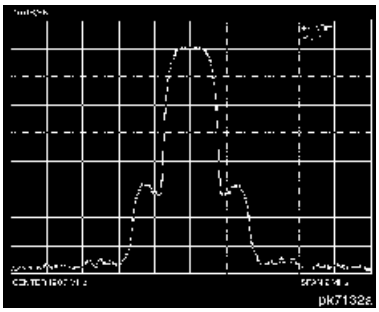
1. **Specifications apply for the frequency range, data rates, root raised cosine filter and filter factors (α or BbT) specified for each standard and at power levels ≤ +7 dBm (≤ +4 dBm for TETRA).**
2. **ACP for TETRA is measured over a 25 kHz bandwidth, with an 18 kHz root raised cosine filter applied.**
3. **The "channel spacing" determines the offset size of the adjacent and alternate channels: adjacent channel offset = 1 x channel spacing, 1st alternate channel = 2 x channel spacing, 2nd alternate channel = 3 x channel spacing, etc.**



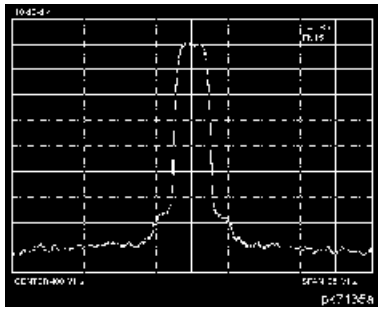
NADC Spectrum
Fc = 849 MHz
Span = 0.3 MHz
Scale = 10 dB/div
Level = +4 dBm



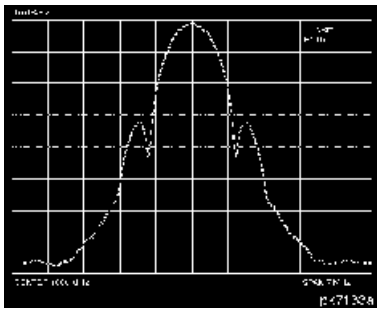
PDC Spectrum
Fc = 810 MHz
Span = 0.25 MHz
Scale = 10 dB/div
Level = +4 dBm



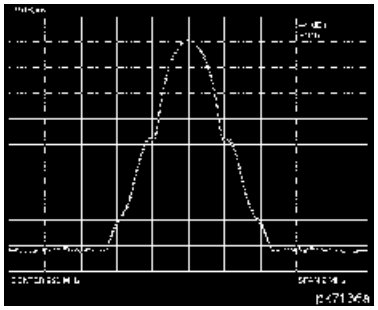
PHS Spectrum
Fc = 1907 MHz
Span = 2 MHz
Scale = 10 dB/div
Level = +4 dBm



TETRA Spectrum
Fc = 400 MHz
Span = 0.25 MHz
Scale = 10 dB/div
Level = +4 dBm



DECT Spectrum
Fc = 1800 MHz
Span = 7 MHz
Scale = 10 dB/div
Level = +4 dBm



GSM Spectrum
Fc = 920 MHz
Span = 2 MHz
Scale = 10 dB/div
Level = +4 dBm

Coherent Carrier Out

Coherent Carrier is modulated by FM or ΦM when enabled.

Range: 250 MHz to maximum carrier frequency

Level: *0 dBm ±5 dB, typical*

Impedance: 50Ω

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[1] mnemonics.

1. HP ESG-D 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-D 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 µV (nominally 0.1 µV with a 2-turn loop) at ≤ 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
UN3	Add I/Q Baseband Generator with 1 Mbits of RAM (includes pre-mod filtering and PRBS)
UN4	Add I/Q Baseband Generator with 8 Mbits of RAM (includes pre-mod filtering and PRBS)
1EM	Move All Front Panel Connectors to Rear Panel
W30	Three Year Warranty