



# E4433A Digital RF Signal Generator, 250 kHz to 4000 MHz (Discontinued - Support Information Only)

## Data Sheet

### Frequency Specifications

**Frequency Range**<sup>1</sup> Agilent ESG-D4000A: 250 kHz to 4000 MHz

**Resolution:** 0.01 Hz

**Switching Speed** Modulation On: <45 ms, typical Modulation Off: <35 ms, typical

**Accuracy:** Same as timebase <sup>1</sup>Analog only RF Signal Generators are also available. See ESG Series Analog RF Signal Generators. Sweep Modes

**Operating modes** Step: frequency & power, and arbitrary list

**Dwell Time:** 2 ms to 60 sec

**Number of Points:** 2 to 401 Internal Reference Oscillator

**Stability Standard (typical) High Stability (Opt 1E5) Aging Rate** <±2 ppm/yr <±0.1 ppm/yr or <± 0.0005 ppm/day after 45 days

**Temperature** <±1 ppm <±0.05 ppm, typical (0° to 55° C)

**Line Voltage** <±0.1 ppm <±0.002 ppm, typical (+5%, -10%) (+5%, -10%)

**Timebase Reference Output** Frequency: 10 MHz Amplitude: >0.35 V<sub>rms</sub> into 50 ohm load

**External Reference Input** Frequency: 1, 2, 5, 10 MHz ± typ. 10 ppm Option 1E5: 1 ppm, typical Amplitude: >0.15 V<sub>rms</sub> Input Impedance: 50 ohm 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

**Level Accuracy**<sup>2</sup> (at 23 ±5°C) +7 to -127 dBm <-127 dBm 250 kHz to 2 GHz: ±0.5 dB ±1.5 dB

2 GHz to 4 GHz: ±0.9 dB ±2.5 dB

**Attenuator Hold Level Range:** >17 dB

**Switching Speed:** <25 ms typical With Power Search Mode: <210 ms typical

**Reverse Power Protection:** 250 kHz to 2000 MHz: 50 Watts >2000 MHz to 4000 MHz: 25 Watts Max DC Voltage: 50 V

**SWR (typical)** 250 kHz to 2000 MHz: <1.4:1 >2000 to 4000 MHz: <1.9:1

**Output Impedance:** 50 ohms <sup>2</sup>Accuracy degrades by 0.02 dB/°C over full temperature range and by 0.3 dB above +7 dBm. Level Accuracy with Digital Modulation (With ALC on; relative to CW; with PRBS-modulated data; if using I/Q inputs, = [square root of (I<sup>2</sup> + Q<sup>2</sup>)] = 0.5 V<sub>rms</sub> nominal)<sup>3</sup>

**pi/4 DQPSK or QPSK Formats:** ±0.15 dB (with raised cosine or root-raised cosine filter and alpha ≥=0.35; with 10 kHz <symbol rate <1 MHz; at RF Freq. >25 MHz; power <max. specified -3 dBm)

**Constant Amplitude Formats** (FSK, GSMK, etc.): no degradation in power level accuracy

**Level Accuracy with ALC Off**<sup>4</sup>: ±0.5 dB, typical (after power search is executed; relative to CW level accuracy with ALC on; with burst off if external I/Q is enabled: [square root of (I<sup>2</sup> + Q<sup>2</sup>)] = 0.5 V<sub>rms</sub>)<sup>3</sup>Typical, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V<sub>rms</sub>.<sup>4</sup>When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level.

### 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



**Agilent Technologies**

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

**Residual FM (CW mode, 0.3-3 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 (>3 kHz offset, <+7 dBm output level)** 250 kHz to 1000 MHz: <-65 dBc >1000 MHz to 2000 MHz: <-59 dBc >2000 MHz: <-53 dBc

**Subharmonics <=1000 MHz:** None >1000 MHz: <-40 dBc

**I/Q Modulation**

**I&Q Inputs:** Input Impedance: 50 ohms Full Scale Input:  $[\text{square root of } (I^2 + Q^2)] = 0.5 V_{\text{rms}}$  External Input RF

Bandwidth (1 dB): 20 MHz, typical Adjustments/Impairments (nominal) DC Offset (I + Q independently adjustable):  $\pm 100\%$  I/Q Gain Ratio:  $\pm 4$  dB

**DC Vector Accuracy<sup>5</sup>:** (relative to full scale, at <=+7 dBm) Frequency GHz: <0.6 0.6 to 2 2 to 3.7 <=4 Static EVM<sup>6</sup> (rms): <0.75% <0.5% 0.75% <1% Magnitude Error<sup>6</sup> (rms): <0.5% <0.35% <0.5% <0.75% Phase Error<sup>6</sup> (rms): <0.35° <0.25° <0.35° <0.5° Origin Offset dBc: <-46 <-46 <-40 <-40 <sup>5</sup>Valid for 10 days after executing internal calibration routine, provided temperature is maintained within  $\pm 5^\circ$  C of calibration temperature. <sup>6</sup>Measured at full scale with origin offset removed.

**Frequency Modulation**

**Maximum Deviation:** N x 10 MHz

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

**Deviation Accuracy (1 kHz rate, dev. <N x 100 kHz):**  $\pm (3.5\% \text{ of FM deviation} + 20 \text{ Hz})$

**Modulation Frequency Response (deviation = 100 kHz)**

**Path Rates 1 dB Bandwidth 3 dB Bandwidth, typical FM1** dc/20 Hz to 100 kHz dc/5 Hz to 10 MHz **FM2** dc/20 Hz to 100 kHz dc/5 Hz to 1 MHz

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

**Phase Modulation**

**Maximum Deviation:** N x 90 radians

**Resolution:** 0.1% of set deviation

**Deviation Accuracy (1 kHz rate):**  $\pm (5\% \text{ of deviation} + 0.01 \text{ radians})$

**Modulation Frequency Response**

**PM Mode Maximum Rates (3 dB BW) Deviation PM1 PM2 Normal BW** N x 90 rad dc to 100 kHz dc to 100 kHz

**High BW** N x 2pi rad dc to 1.5 MHz (typ) dc to 1 MHz (typ) N x pi/2 rad dc to 4 MHz (typ) dc to 0.9 MHz (typ)

**Distortion (1 kHz rate, THD, dev <N x 90 rad):** <1% Amplitude Modulation fc > 500 kHz

**Range (envelope peak <= max specified power):** 0 to 100%

**Resolution:** 0.1%

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

**Distortion (1 kHz rate, THD)** 30% AM: <1.5% 90% AM: <4%

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

**Rate (1 dB Bandwidth, typical) ALC On:** 400 Hz to 10 MHz ALC Off: DC to 10 MHz

**Input:** I Input

**Impedance:** 50 ohms

**Sensitivity:** 0.5 V = 100% Pulse Modulation

**On/Off Ratio <= 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>7</sup>:**  $\pm 0.5$  dB, typical

**External Input:** Ext 2

**Input Voltage RF On:** >+0.5 V, nominal RF Off: <+0.5 V, nominal

**Input Impedance:** 50 ohms, nominal

**Internal Pulse Generator** Squarewave Rate: 0.1 Hz to 50 kHz Pulse Period: 16  $\mu$ s to 30 sec Pulse Width: 8  $\mu$ s to 30

sec Pulse Resolution: 4  $\mu$ s <sup>7</sup>Typical, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V<sub>rms</sub>. Burst Envelope

**On/Off Ratio V<sub>IN</sub>:** <=-1.05 V <= 3 GHz: >75 dB >3 GHz: >65 dB

**Rise/Fall Time:** <2  $\mu$ s, typical

**Minimum Burst Repetition Frequency ALC On:** 10 Hz, typical ALC Off: DC

**External Input:** Ext 1

**Input Impedance:** 50 ohms

**Input Voltage** RF Off: -1.0 V RF On: 0 V Linear Control Range: 0 to -1.0 V Internal Modulation Source Provides FM, PM, and AM Modulation Signals and LF Out

**Waveforms:** sine, square, ramp, triangle, pulse, noise

**Rate Range** Sine: 0.1 Hz to 50 kHz Square, Ramp, Triangle Optional I/Q Baseband Generator (Option UN3 or UN4)

**Supported Standards:** DECT, GSM, NADC, PDC, PHS, and TETRA

**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<sup>9</sup>-1) or PN15<sup>7</sup> (PRBS 2<sup>15</sup>-1) Repeating Sequence: any 4-bit sequence

**Downloadable Data (User Files):** Type: Serial Data Minimum Size: Must fill entire field for which it was selected Maximum Size: 1 Mbits (Opt UN3), 8 Mbits (Opt UN4)

**External Data:** Type: Serial Data Inputs: Data, Bit/Symbol Clocks Accepts data rates  $\pm 5\%$  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 reference (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)<sup>7</sup> PN15 is not continuous in burst mode for TETRA applications. NADC (Option UN3 or UN4)

**Modulation Format:** pi/4 DQPSK

**Data Rate** (default): 48.6 kbits/sec Adjustment Range: 40 to 75.5 kbits/sec

**Filter:** Root-Raised Cosine or Raised Cosine Default Value: alpha = 0.35 Range (alpha): 0.3, 0.35, 0.4, 0.5, 0.6

**Error Vector Magnitude** (%rms)<sup>8</sup>

[see table 1]

**Channel Spacing:** 30 kHz

**Adjacent Channel Power<sup>8</sup> (ACP)**

(Low ACP Mode, dBc, typical)

[see table 2]

**Supported Burst Types:** Custom, Up/Down TCH

<sup>8</sup>Specifications apply for the frequency range, data rates and filter factors (alpha) specified at power levels  $\geq +7$  dBm.

<sup>9</sup>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, 3rd Alternate Channel = 4 x channel spacing.

PDC (Option UN3 or UN4)

**Modulation Format:** pi/4 DQPSK

**Data Rate** (default): 42 kbits/sec

Adjustment Range: 40 to 75.5 kbits/sec

**Filter:** Root-Raised Cosine or Raised Cosine

Default Value: alpha = 0.5

Range (alpha): 0.3, 0.35, 0.4, 0.5, 0.6

**Error Vector Magnitude** (% rms)<sup>10</sup>

[see table 3]

**Channel Spacing:** 25 kHz

**Adjacent Channel Power<sup>10</sup> (ACP)**

(Low ACP Mode, dBc, typical)

[see table 4]

**Supported Burst Types:** Custom, Up/Down TCH, Up Vox

<sup>10</sup>Specifications apply for the frequency range, data rates and filter factors (alpha) specified at power levels  $\geq +7$  dBm.



<sup>11</sup>The "channel spacing" determines the offset size of the adjacent and alternate channels: 1st Alternate Channel = 2 x channel spacing, 3rd Alternate Channel = 4 x channel spacing.

PHS (Option UN3 or UN4)

**Modulation Format:** pi/4 DQPSK

**Data Rate** (default): 384 kbits/sec

Adjustment Range: 320 to 605 kbits/sec

**Filter:** Root-Raised Cosine or Raised Cosine

Default Value: alpha = 0.5

Range (alpha ): 0.3, 0.35, 0.4, 0.5, 0.6

**Error Vector Magnitude** (% rms)<sup>12</sup>

[see table 5]

**Channel Spacing:** 300 kHz

**Adjacent Channel Power**<sup>12</sup> (ACP)

(Low ACP Mode, dBc, typical)

[see table 6]

**Supported Burst Types:** Custom, TCH, Sync

**Scramble Capabilities:** yes

<sup>12</sup>Specifications apply for the frequency range, data rates and filter factors (alpha) specified at power levels  $\geq +7$  dBm.

<sup>13</sup>The "channel spacing" determines the offset size of the adjacent and alternate channels: 1st Alternate Channel = 2 x channel spacing, 2nd Alternate Channel = 3 x channel spacing.

TETRA (Option UN3 or UN4)

**Modulation Format:** pi/4 DQPSK

**Data Rate** (default): 36 kbits/sec

Adjustment Range: 31 to 37.8 kbits/sec

**Filter:** Root-Raised Cosine or Raised Cosine

Default Value: alpha = 0.35

Range (alpha): 0.3, 0.35, 0.4, 0.5, 0.6

**Error Vector Magnitude:** (% rms)<sup>14</sup>

[see table 7]

**Channel Spacing:** 25 kHz

**Adjacent Channel Power**<sup>14</sup> (ACP)

(Low ACP Mode, dBc, typical)

[see table 8]

**Supported Burst Types:** Custom, Up Control 1 & 2, Up Normal,

Down Normal, Down Sync

**Scramble Capabilities:** Yes

<sup>14</sup>Specifications apply for the frequency range, data rates and filter factors (alpha) specified at power levels  $\geq +4$  dBm.

<sup>15</sup>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, 3rd Alternate Channel = 4 x channel spacing.

<sup>16</sup>ACP for TETRA is measured over a 25 kHz bandwidth, with an 18 kHz root-raised cosine filter applied.

DECT (Option UN3 or UN4)

**Modulation Format:** GFSK

**Data Rate** (default): 1,152 kbits/sec

Adjustment Range: 922 to 1209.6 kbits/sec

**Filter:** Gaussian

Default Value: BT = 0.5

Range (BT in 0.5 steps): 0.2 to 0.7

**Deviation Accuracy:**<sup>17</sup> 6 (1.5, typical)

**Channel Spacing:** 1.728 MHz

**Supported Burst Types:** Custom, Dummy B 1 & 2, Traffic B,  
Low Capacity

<sup>17</sup>Specifications apply for the frequency range, data rates and filter factors (BT) specified at power levels  $\geq +7$  dBm.

GSM (DCS1800/PCS1900) (Option UN3 or UN4)

**Modulation Format:** GMSK

**Data Rate** (default): 270.83 kbits/sec

Adjustment Range: 163 to 300 kbits/sec

**Filter:** Gaussian

Default Value: Bbt = 0.3

Range (BT in 0.5 steps): .02 to 0.7

**Global Phase Error:**<sup>18</sup> (rms/pk)  $1^\circ/4^\circ$

$0.5^\circ/1.75^\circ$  (typical)

**Channel Spacing:** 200 kHz

**Adjacent Channel Power**<sup>18</sup> (ACP)

(Low ACP Mode, dBc, typical)

[see table 9]

**Supported Burst Types:** Custom, Normal, FCorr, Sync,  
Dummy, Access

<sup>18</sup>Specifications apply for the frequency range, data rates and filter factors (alpha) specified at power levels  $\geq +7$  dBm.

<sup>19</sup>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, 3rd Alternate Channel = 4 x channel spacing.

Coherent Carrier Out<sup>20</sup>

**Range:** 250 MHz to maximum carrier frequency

**Level:** 0 dBm  $\pm 5$  dB, typical

**Impedance:** 50 ohms

<sup>20</sup>Coherent carrier is modulated by FM or phase modulation when enabled.

Internal Modulation Source

Provides FM, PM, and AM Modulation Signals and LF Out

**Waveforms:** sine, square, ramp, triangle, pulse, noise

**Rate Range**

Sine: 0.1 Hz to 50 kHz

Square, Ramp, Triangle: 0.1 Hz to 10 kHz

**Resolution:** 0.1 Hz  
**Frequency Accuracy:** 0.005%

#### External Modulation Inputs

#### Modulation Types

Ext1: FM, PM, AM, and Burst Envelope

Ext2: FM, PM, AM, and Pulse

TABLE 1

	Continuous	Burst
Low EVM Mode	1.25	1.75
Low EVM Mode (typical)	0.8	1.25
Low ACP Mode (typical)	1.5	1.75

TABLE 2

	Continuous	Burst
At Adjacent Channel <sup>9</sup>	-35	-34
At 1st Alternate Channel <sup>9</sup>	-75	-73
At 2nd Alternate Channel <sup>9</sup>	-78	-77
At 3rd Alternate Channel <sup>9</sup>	-78	-78

TABLE 3

	Continuous	Burst
Low EVM Mode	1.25	1.75
Low EVM Mode (typical)	0.8	1.25
Low ACP Mode (typical)	1.25	1.25

TABLE 4

	Continuous	Burst
at 1st Alternate Channel <sup>11</sup>	-71	-69
at 3rd Alternate Channel <sup>11</sup>	-78	-78

TABLE 5

	Continuous	Burst
Low EVM Mode	1.5	1.75
Low EVM Mode (typical)	0.9	0.9
Low ACP Mode (typical)	1.25	1.25

TABLE 6

	Continuous	Burst
At 1st Alternate Channel <sup>13</sup>	-76	-75
At 2nd Alternate Channel <sup>13</sup>	-78	-77

TABLE 7

	Continuous	Burst
Low EVM Mode	1.25	2.0
Low EVM Mode (typical)	0.8	1.25
Low ACP Mode (typical)	3.25	3.25

TABLE 8

	Continuous	Burst <sup>16</sup>
At Adjacent Channel <sup>15</sup>	-68	-65
At 1st Alternate Channel <sup>15</sup>	-77	-76
At 2nd Alternate Channel <sup>15</sup>	-79	-79
At 3rd Alternate Channel <sup>15</sup>	-79	-79

TABLE 9

	Continuous	Burst
At AdjacentChannel <sup>19</sup>	-38	-37
At 1st Alternate Channel <sup>19</sup>	-71	-69
At 2nd Alternate Channel <sup>19</sup>	-81	-79
At 3rd Alternate Channel <sup>19</sup>	-83	-81