Agilent
E4438C ESG Vector Signal Generator

Data Sheet

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Introduction

Agilent Technologies E4438C ESG Vector Signal Generator incorporates a broad array of capabilities for testing both analog and digital communications systems. Adding flexible options provide test solutions that will evaluate the performance of a communication system to the requirements of nearly all current and proposed air interface standards. Many test functions can be customized to meet the needs of proprietary and other nonstandard wireless protocols as well. You can configure your instrument to address a wide variety of tests—from altering nearly every aspect of a digital signal or signal operating environment, to creating experimental signals. This flexibility, along with an architecture that accepts future enhancements makes the E4438C ESG Vector Signal Generator an excellent choice for wireless communications system testing now and in the future.

E4438C ESG Vector Signal Generator

Choose your required frequency range as an *Option* when configuring your E4438C ESG Vector Signal Generator.

Please refer to the related literature in the section *ESG application and product information* for additional information.

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/environmental range unless otherwise noted. Supplemental characteristics, denoted typical or nominal, provide additional [nonwarranted] information useful in applying the instrument. Column headings labeled "standard" imply that this level of performance is standard, without regard for option configuration. If a particular option configuration modifies the standard performance, that performance is given in a separate column.

Key features

Key standard features

- Expandable architecture
- Broad frequency coverage
- Choice of electronic or mechanical attenuator
- Superior level accuracy
- Wideband FM and ΦM
- Step and list sweep, both frequency and power
- Built-in function generator
- Lightweight, rack-mountable
- 3-year warranty
- 2-year calibration cycle
- Broadband analog I/Q inputs
- I/Q adjustment capabilities and internal calibration routine
- Excellent modulation accuracy and stability
- Coherent carrier output up to 4 GHz

Optional features

- Multi-carrier W-CDMA personality[1]
- Multi-carrier cdma2000 personality[1]
- Multi-carrier TDMA personality[1]
- Calibrated AWG noise personality
- GPS personality
- 1xEV-DO Signal Studio personality[1]
- 802.11b Signal Studio personality[1]
- 802.11 Signal Studio a personality[1]
- *Bluetooth*™ Signal Studio personality[1]
- Enhanced Multitone Signal Studio personality[1]
- Built-in baseband generator
- 6 GByte non-volatile waveform storage
- Up to 32 megasample volatile waveform storage
- High output power
- Enhanced phase noise performance
- High stability time base
- GSM/EDGE loopback BER capability
- Internal bit-error-rate analyzer

This document contains the measured specifications for the instrument platform and personalities. It does not contain a full list of features for all optional personalities. Please consult the individual product overviews for each personality for a full listing of all features and capabilities. These are listed at the end of this document.

Specifications

Frequency

Frequency range

Option[1]	
501	250 kHz to 1 GHz
502	250 kHz to 2 GHz
503	250 kHz to 3 GHz
504	250 kHz to 4 GHz
506	250 kHz to 6 GHz [requires Option UNJ]

Frequency minimum 100 kHz[2]

Frequency resolution 0.01 Hz

Frequency switching speed[5]

	Standard		*With Option UNJ*		*With Option 506*	
	Freq.[3]	Freq./Amp.[4]	Freq.[3]	Freq./Amp.[4]	Freq.[3]	Freq./Amp.[4]
Digital modulation						
on	(< 58 ms)	(< 64 ms)	(< 61 ms)	(< 68 ms)	(< 61 ms)	(< 68 ms)
off	(< 19 ms)	(< 19 ms)	(< 19 ms	(< 19 ms)	(< 26 ms	(< 26 ms)
[For hops < 5 MHz within a band]						
Digital modulation						
on	(< 14 ms)	(< 14 ms)	(< 14 ms)	(< 19 ms)	(< 47 ms)	(< 65 ms)
off	(< 14 ms)	(< 14 ms)	(< 14 ms)	(< 15 ms)	(< 22 ms)	(< 24 ms)

Phase offset Phase is adjustable remotely [LAN, GPIB, RS-232] or via front panel in nominal 0.1° increments

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[5]

	Standard	*With Option UNJ or 1E5*
Aging rate	< ±1 ppm/yr	< ±0.1 ppm/yr or < ±0.0005 ppm/day after 45 days
Temp [0 to 55° C]	(< ±1 ppm)	(< ±0.05 ppm)
Line voltage	(< ±0.1 ppm)	(< ±0.002 ppm)
Line voltage range	(+5% to –10%)	(+5% to –10%)

RF reference output

Frequency	10 MHz
Amplitude	4 dBm ±2 dB

RF reference input requirements

	Standard	*With Option UNJ or 1E5*
Frequency	1, 2, 5, 10 MHz ± 10 ppm	1, 2, 5, 10 MHz ±1 ppm
Amplitude	–3.5 dBm to 20 dBm	
Input impedance	50 Ω	

1. The E4438C is available as a vector platform only. For analog models refer to the E4420B thru E4426B.
2. Performance below 250 kHz not guaranteed.
3. To within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below 250 MHz.
4. Frequency switching time with the amplitude settled within ±0.1 dB.
5. Parentheses denote typical performance.

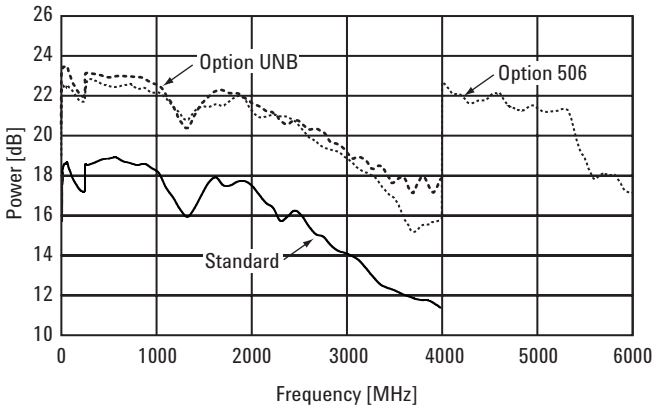
Specifications

Output power

Power

	Standard	*With Option UNB*	*With Option 506*
250 kHz to 250 MHz	+11 to –136 dBm	+15 to –136 dBm	+12 to –136 dBm
> 250 MHz to 1 GHz	+13 to –136 dBm	+17 to –136 dBm	+14 to –136 dBm
> 1 to 3 GHz	+10 to –136 dBm	+16 to –136 dBm	+13 to –136 dBm
> 3 to 4 GHz	+7 to –136 dBm	+13 to –136 dBm	+10 to –136 dBm
> 4 to 6 GHz	N/A	N/A	+10 to –136 dBm

Typical maximum available power



Level resolution 0.02 dB

Level range with *Attenuator Hold* active

	Standard	*With Option UNB*	*With Option 506*
250 kHz to 1 GHz	23 dB	27 dB	24 dB
> 1 to 3 GHz	20 dB	26 dB	23 dB
> 3 to 4 GHz	17 dB	23 dB	20 dB
> 4 to 6 GHz	N/A	N/A	20 dB

Level accuracy [dB]

Standard[1,2]

	Power level			
	+7 to –50 dBm	–50 to –120 dBm	–120 to –127 dBm	< –127 dBm
250 kHz to 2.2 GHz	±0.5	±0.5	±0.6	(±1.5)
2.2 to 3 GHz	±0.5	±0.6	±0.7	(±2.5)
3 to 4 GHz	±0.6	±0.7	±0.8	(±2.5)

With Option UNB[2,3]

	Power level			
	+10 to –50 dBm	–50 to –120 dBm	–120 to –127 dBm	< –127 dBm
250 kHz to 2.2 GHz	±0.5	±0.5	±0.6	(±1.5)
2.2 to 3 GHz	±0.6	±0.7	±0.9	(±2.5)
3 to 4 GHz	±0.8	±0.9	±1.5	(±2.5)

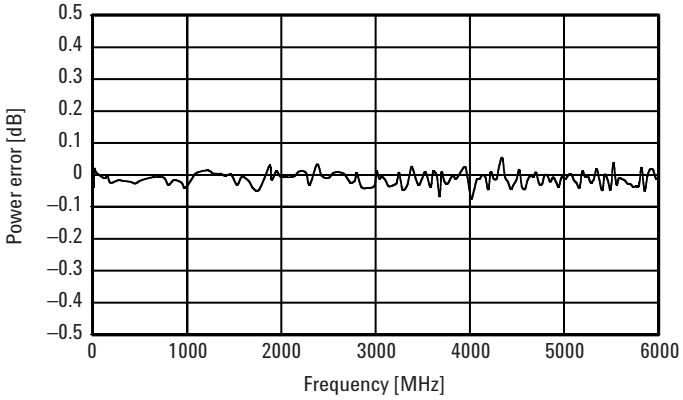
With Option 506[2, 4]

	Power level			
	+7 to –50 dBm	–50 to –110 dBm	–110 to –127 dBm	< –127 dBm
250 kHz to 2.2 GHz	±0.6	±0.6	±0.7	(±1.5)
2.2 to 3 GHz	±0.6	±0.7	±1.0	(±2.5)
3 to 4 GHz	±0.8	±0.9	±1.5	(±2.5)
4 to 6 GHz	±0.8	±0.9	(±2.5)	

1. Quoted specifications for 23 °C ± 5 °C. Accuracy degrades by less than 0.03 dB/°C over full temperature range. Accuracy degrades by 0.3 dB above +7 dBm, and by 0.8 dB above +10 dBm.
2. Parentheses denote typical performance.
3. Quoted specifications for 23 °C ± 5 °C. Accuracy degrades by less than 0.01 dB/°C over full temperature range. Accuracy degrades by 0.2 dB above +10 dBm, and by 0.8 dB above +13 dBm.
4. Quoted specifications for 23 °C ± 5 °C. Accuracy degrades by less than 0.02 dB/°C over full temperature range. Accuracy degrades by 0.2 dB above +7 dBm.

Specifications

Typical level accuracy [0 to –100 dBm]



Level switching speed[1]

	Standard	*With Option UNB*	*With Option 506*
Normal operation [ALC on]	(< 19 ms)	(< 46 ms)	(< 46 ms)
When using power search manual	(< 82 ms)	(< 106 ms)	(< 106 ms)
When using power search auto	(< 67 ms)	(< 69 ms)	(< 69 ms)

RF output

Reverse power protection

	Standard	*With Option 506*
250 kHz to 2 GHz	47 dBm	30 dBm
> 2 to 4 GHz	44 dBm	30 dBm
> 4 to 6 GHz	N/A	30 dBm
Max DC voltage	50 V	

SWR[1]

	Standard	*Option UNB*	*Option 506*
250 kHz to 2.2 GHz	(< 1.4:1)	(< 1.4:1)	(< 1.5:1)
> 2.2 GHz to 3 GHz	(< 1.4:1)	(< 1.5:1)	(< 1.7:1)
> 3 GHz to 4 GHz	(< 1.4:1)	(< 1.8:1)	(< 2.1:1)
> 4 GHz to 6 GHz	N/A	N/A	(< 2.0:1)

Output impedance 50 Ω nominal

1. Parentheses denote typical performance.

Specifications

Spectral purity

SSB Phase noise [at 20 kHz offset][1]

	Standard	*With Option UNJ*
at 500 MHz	(< –124 dBc/Hz)	< –136 dBc/Hz, (< –139 dBc/Hz)
at 1 GHz	(< –118 dBc/Hz)	< –130 dBc/Hz, (< –133 dBc/Hz)
at 2 GHz	(< –112 dBc/Hz)	< –124 dBc/Hz, (< –127 dBc/Hz)
at 3 GHz	(< –106 dBc/Hz)	< –120 dBc/Hz, (< –123 dBc/Hz)
at 4 GHz	(< –106 dBc/Hz)	< –118 dBc/Hz, (< –121 dBc/Hz)
at 6 GHz	N/A	< –114 dBc/Hz, (< –117 dBc/Hz)

Residual FM[1] [CW mode, 0.3 to 3 kHz BW, CCITT, rms]

Option UNJ < N x 1 Hz (< N x 0.5 Hz)[2]

Standard

Phase noise mode 1 < N x 2 Hz

Phase noise mode 2 < N x 4 Hz

Harmonics[1, 6] [output level ≤+4 dBm, ≤+7.5 dBm Option UNB, ≤ +4.5 dBm Option 506]

< –32 dBc above 1 GHz, (< –30 dBc below 1 GHz)

Nonharmonics[1, 3] [≤+7 dBm output level, ≤ +4 dBm Option 506]

	Standard[4]		*With Option UNJ*[5]	
	> 3 kHz offset	> 10 kHz offset	> 3 kHz offset	> 10kHz offset
250 kHz to 250 MHz	< –53 dBc (< –68 dBc)	(< –70 dBc)	< –65 dBc	(< –70 dBc)
250 MHz to 500 MHz	< –59 dBc (< –74 dBc)	(< –81 dBc)	< –80 dBc	< –80 dBc
500 MHz to 1 GHz	< –53 dBc (< –68 dBc)	(< –75 dBc)	< –80 dBc	< –80 dBc
1 to 2 GHz	< –47 dBc (< –62 dBc)	(< –69 dBc)	< –74 dBc	< –74 dBc
2 to 4 GHz	< –41 dBc (< –56 dBc)	(< –63 dBc)	< –68 dBc	< –68 dBc
4 to 6 GHz	N/A N/A	N/A	< –62 dBc	< –62 dBc

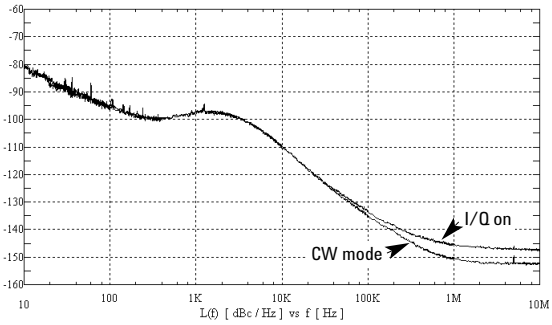
Subharmonics

	Standard	*With Option UNJ*
≤ 1 GHz	None	None
>1 GHz	< –40 dBc	None

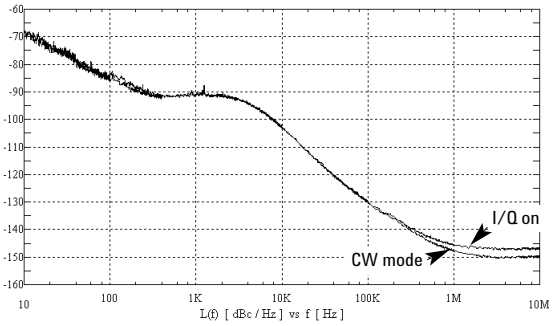
1. Parentheses denote typical performance.
2. Refer to frequency bands on page 10 for N values.
3. Spurs outside the operating range of the instrument are not specified.
4. Specifications apply for FM deviations < 100 kHz and are not valid on ΦM. For non-constant amplitude formats, unspecified spur levels occur up to the second harmonic of the baseband rate.
5. Specifications apply for CW mode only.
6. Harmonic performance outside the operating range of the instrument is typical.

Characteristic SSB phase noise

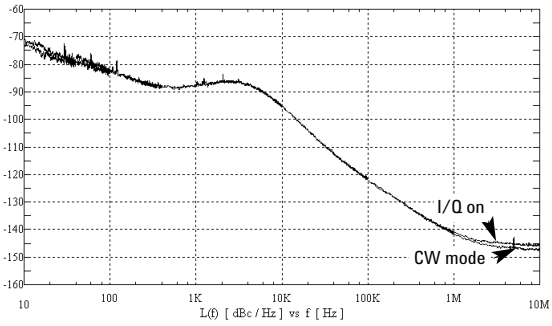
With Option 1E5



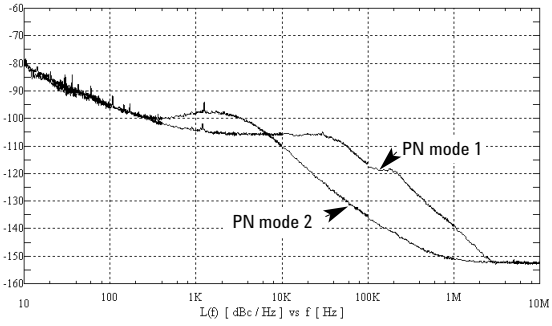
fc = 850 MHz



fc = 1900 MHz

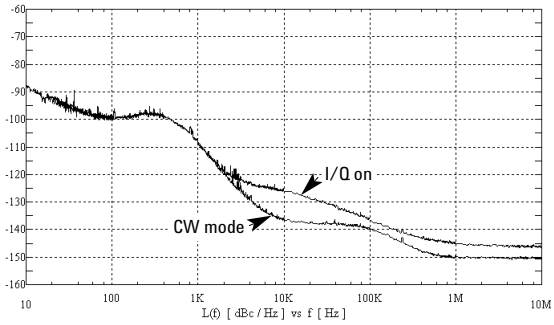


fc = 2200 MHz

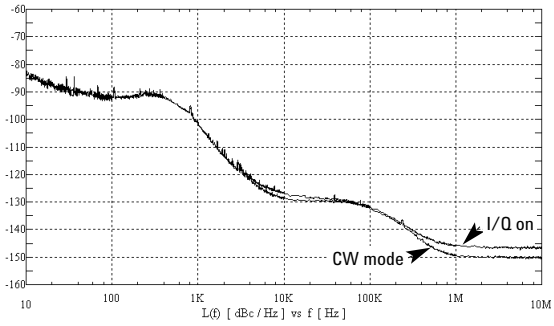


Phase noise modes 1 and 2 at fc = 900 MHz

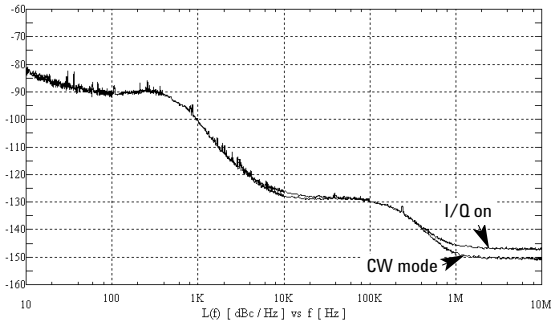
With Option UNJ



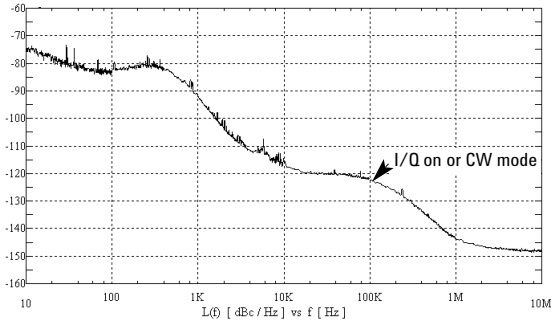
fc = 850 MHz



fc = 1900 MHz



fc = 2200 MHz



fc = 5.7 GHz [Option 506]

Specifications

Analog modulation

Frequency bands

Band	*Frequency range*	*N number*
1	250 kHz to ≤ 250 MHz	1
2	> 250 MHz to ≤ 500 MHz	0.5
3	> 500 MHz to ≤ 1GHz	1
4	> 1 to ≤ 2 GHz	2
5	> 2 to ≤ 4 GHz	4
6	> 4 to ≤ 6 GHz	8

Frequency modulation[1,4]

Maximum deviation

Standard[2]	*With Option UNJ*
N x 8 MHz	N x 1 MHz

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

Modulation frequency rate[5] [deviation = 100 kHz]

Coupling	*1 dB bandwidth*	*3 dB bandwidth*
FM path 1[DC]	DC to 100 kHz	(DC to 10 MHz)
FM path 2 [DC]	DC to 100 kHz	(DC to 0.9 MHz)
FM path 1 [AC]	20 Hz to 100 kHz	(5 Hz to 10 MHz)
FM path 2 [AC]	20 Hz to 100 kHz	(5 Hz to 0.9 MHz)

Deviation accuracy[2] [1 kHz rate, deviation < N x 100 kHz]
< ± 3.5% of FM deviation + 20 Hz

Carrier frequency accuracy relative to CW in DCFM[2, 3]
±0.1% of set deviation + (N x 1 Hz)

Distortion[2] [1 kHz rate, dev.= N x 100 kHz]
< 1%

FM using external inputs 1 or 2

Sensitivity 1 V_{peak} for indicated deviation

Input impedance 50 Ω, nominal

FM path 1 and FM path 2 are summed internally for composite modulation. 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 path.

Analog modulation specifications continued on page 11

1. All analog performance above 4 GHz is typical.
2. Refer to frequency bands on this page to compute specifications.
3. At the calibrated deviation and carrier frequency, within 5 °C of ambient temperature at time of calibration.
4. For non-Option UNJ units, specifications apply in phase noise mode 2 [default].
5. Parentheses denote typical performance.

Specifications

Analog modulation specifications

continued from page 10

Phase modulation [1, 5]

Resolution 0.1% of set deviation

Modulation frequency response [2, 7]

Standard

Mode	*Maximum deviation*	*Allowable rates [3 dB BW] ΦM path 1*	*ΦM path 2*
Normal BW	N x 80 rad	DC to 100 kHz	DC to 100 kHz
High BW[6]	N x 8 rad	(DC to 1 MHz)	(DC to 0.9 MHz)
	N x 1.6 rad	(DC to 10 MHz)	(DC to 0.9 MHz)

With Option UNJ

Mode	*Maximum deviation*	*Allowable rates [3 dB BW] ΦM path 1*	*ΦM path 2*
Normal BW	N x 10 radians	DC to 100 kHz	DC to 100 kHz
High BW	N x 1 radians	(DC to 1 MHz)	(DC to 0.9 MHz)

Deviation accuracy [1 kHz rate, Normal BW mode]
< ±5% of deviation + 0.01 radians

Distortion[2] [1 kHz rate, deviation < 80 radians on standard model, < 10N radians on Option UNJ models, Normal BW mode]
< 1%

ΦM using external inputs 1 or 2

Sensitivity 1 V_{peak} for indicated deviation

Input impedance 50 Ω, nominal

Paths ΦM path 1 and ΦM path 2 are summed internally for composite modulation. The ΦM 2 path is limited to a maximum rate of 1 MHz. ΦM path 2 must be set to a deviation less than the ΦM path 1.

Amplitude modulation [1, 3] [fc > 500 kHz]

Range 0 to 100%

Resolution 0.1%

Rates [3 dB bandwidth]
DC coupled 0 to 10 kHz
AC coupled 10 Hz to 10 kHz

Accuracy [4, 7] 1 kHz rate <±(6% of setting +1%)

Distortion [4, 7] [1 kHz rate, THD]

	Standard/Option UNJ	*Option 506*
30% AM	< 1.5%	< 1.5%
90% AM	(< 4%)	(< 5%)

AM using external inputs 1 or 2

Sensitivity 1 V_{peak} to achieve indicated depth

Input impedance 50 Ω, nominal

Paths AM path 1 and AM path 2 are summed internally for composite modulation.

Analog modulation specifications continued on page 12

1. All analog performance above 4 GHz is typical.
2. Refer to frequency bands on page 10 for N.
3. AM is typical above 3 GHz or if wideband AM or I/Q modulation is simultaneously enabled.
4. Peak envelope power of AM must be 3 dB less than maximum output power below 250 MHz.
5. For non-Option UNJ units, specifications apply in phase noise mode 2 [default].
6. Bandwidth is automatically selected based on deviation.
7. Parentheses denote typical performance.

Specifications

Analog modulation specifications

continued from page 11

Wideband AM

Rates [1 dB bandwidth][1]

ALC on	(400 Hz to 40 MHz)
ALC off	(DC to 40 MHz)

Wideband AM using external I input only

Sensitivity	0.5 V = 100%
Input impedance	50 Ω, nominal

Pulse modulation

On/off ratio[1]

< 2.8 GHz	> 80 dB
≥ 2.8 GHz	(> 65 dB)

Rise/fall times[1] (150 ns)

Minimum width[1]

ALC on	(2 µs)
ALC off	(0.4 µs)

Pulse repetition frequency[1]

ALC on	(10 Hz to 250 kHz)
ALC off	(DC to 1.0 MHz)

Level accuracy[1, 2] [relative to CW at ≤ 4 dBm standard, ≤ 7.5 dBm Option UNB, ≤ 4.5 dBm Option 506]
(< ±1 dB)

Pulse modulation using external inputs

Input voltage	
RF on	> +0.5 V, nominal
RF off	< +0.5 V, nominal
Input impedance	50 Ω, nominal

Internal pulse generator

Square wave rate	0.1 Hz to 20 kHz
Pulse	
Period	8 µs to 30 seconds
Width	4 µs to 30 seconds
Resolution	2 µs

Analog modulation specifications continued on page 13

1. Parentheses denote typical performance.
2. With ALC off, specifications apply after the execution of power search. With ALC on, specifications apply for pulse repetition rates ≤10 kHz and pulse widths ≥5 µs.

Specifications

Analog modulation specifications

continued from page 12

Internal analog modulation source

[Provides FM, AM, pulse, and phase modulation signals and LF audio out]

Waveforms	sine, square, ramp, triangle, pulse, noise
Rate range	
Sine	0.1 Hz to 100 kHz
Square, ramp, triangle	0.1 Hz to 20 kHz
Resolution	0.1 Hz
Frequency accuracy	same as RF reference source
Swept sine mode [frequency, phase continuous]	
Operating modes	Triggered or continuous sweeps
Frequency range	0.1 Hz to 100 kHz
Sweep time	1 ms to 65 sec
Resolution	1 ms
Dual sinewave mode	
Frequency range	0.1 Hz to 100 kHz
Amplitude ratio	0 to 100%
Amplitude ratio resolution	0.1%
LF audio out mode	
Amplitude	0 to 2.5 V_{peak} into 50 Ω
Output impedance	50 Ω nominal

External modulation inputs

Modulation types	
Ext 1	FM, ΦM, AM, pulse, and burst envelope
Ext 2	FM, ΦM, AM, and pulse

High/Low Indicator [100 Hz to 10 MHz BW, AC coupled inputs only]. Activated when input level error exceeds 3% [nominal].

Composite modulation

AM, FM, and ΦM each consist of two modulation paths which are summed internally for composite modulation. The modulation sources may be any two of the following: Internal, External 1, External 2.

Simultaneous modulation

Multiple modulation types may be simultaneously enabled. For example, W-CDMA, AM, and FM can run concurrently and all will affect the output RF. This is useful for simulating signal impairments. There are some exceptions: FM and ΦM cannot be combined; AM and Burst envelope cannot be combined; Wideband AM and internal I/Q cannot be combined. Two modulation types cannot be generated simultaneously by the same modulation source.

Level accuracy with digital modulation turned on [relative to CW]

Conditions: [with PRBS modulated data;
if using I/Q inputs, $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$, nominal][1]

Level accuracy with ALC on

$\pi/4$ DQPSK or QPSK formats

Conditions: With raised cosine or root-raised cosine filter and $\alpha \geq 0.35$;
with 10 kHz ≤ symbol rate ≤ 1 MHz; at RF freq ≥ 25 MHz;
power ≤ max specified –3 dB

±0.25 dB

Constant amplitude formats [FSK, GMSK, etc]

Standard	*With Option 506*
±0.15 dB	±0.20 dB

Level accuracy with ALC off[2, 3] (±0.20 dB) [relative to ALC on]

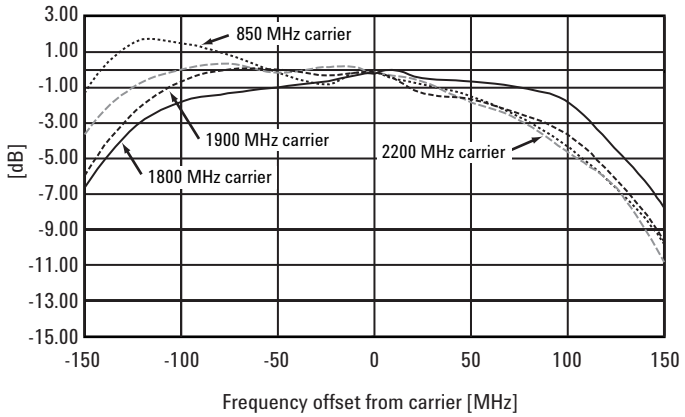
Conditions: After power search is executed, with burst off.

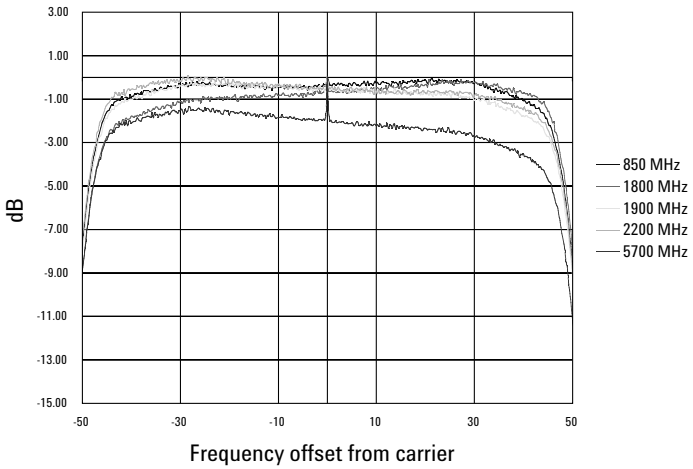
I/Q modulation using external I/Q inputs

I/Q inputs

Input impedance	50 Ω or 600 Ω
Full scale input[1]	$\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$

I/Q Bandwidth (ALC off)[3]





1. The optimum I/Q input level is $\sqrt{I^2+Q^2} = 0.5\ V_{rms}$, I/Q drive level 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}.
2. When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level.
3. Parentheses denote typical performance.

Specifications

I/Q Adjustments

Source	*Parameter*	*Range*
I/Q baseband inputs	Impedance	50 or 600 Ω
	I offset [600 Ω only]	± 5 V
	Q offset [600 Ω only]	± 5 V
I/Q baseband outputs	I/Q offset adjustment	± 3 V
	I/Q offset resolution	1 mV
	I/Q gain balance	± 4 dB
	I/Q attenuation	0 to 40 dB
	I/Q low pass filter	40 MHz, thru
RF output	I/Q offset adjustment	+/- 50%
	I/Q gain balance	± 4 dB
	I/Q attenuation	0 to 40 dB
	I/Q quad skew	
	[≤ 3.3 GHz]	± 10°
	[> 3.3 GHz]	± 5°
	I/Q low pass filter	2.1 MHz, 40 MHz, thru

I/Q baseband outputs[1]	
Differential outputs	I, $\overline{I}$, Q, $\overline{Q}$
Single ended	I, Q
Frequency range	DC to 40 MHz [with sinewave]
Output voltage into 50 Ω	(1.5 V P-P) [with sinewave]
Output impedance	50 Ω nominal

External burst envelope

Input voltage

RF On	0 V
RF Off	–1.0 V
Linear control range	0 to –1 V

On/off ratio[1]

Condition: V_{in} below –1.05 V

< 2.3 GHz	> 75 dB
≥ 2.3 GHz	(> 65 dB)

Rise/fall time[1]

Condition: With rectangular input

(< 2 µs)

Minimum burst repetition frequency[1]

ALC on	(10 Hz)
ALC off	DC

Input port	External 1
Input impedance	50 Ω, nominal

Coherent carrier out

Range	250 MHz to 4 GHz
Level[1]	**(**–2 dBm ±5 dB)[2]
Impedance	50 Ω

1. Parentheses denote typical performance.
2. Not available above 4 GHz.
3. Coherent carrier is modulated by FM or ΦM when enabled.

Specifications

I/Q baseband generator [arbitrary waveform mode]
[Option 001 or 002]

Channels	2 [I and Q]
Resolution	16 bits [1/65,536]
Baseband waveform memory	
Maximum playback capacity	8 Msamples/channel [Option 001] 32 Msamples/channel [Option 002]
Maximum storage capacity	1 Gsamples on 6 Gbyte non-volatile storage
Waveform segments	
Segment length	60 samples to 8 Msamples or 32 Msamples
Maximum number of segments	1,024 [8 Msamples memory] 4,096 [32 Msamples memory]
Minimum memory allocation	256 samples or 1 kbyte blocks
Waveform sequences	
Maximum total number of segment files stored in the instrument file system	16,384
Sequencing	Continuously repeating
Maximum number of sequences	16,384
Maximum segments/sequence	32,768
Maximum segment repetitions	65,536
Clock	
Sample rate	1 Hz to 100 MHz
Resolution	0.001 Hz
Accuracy	Same as timebase $+2^{-42}$ [in non-integer applications]
Baseband filters	
40 MHz	used for spur reduction
2.1 MHz	used for ACPR reduction
Through	used for maximum bandwidth
Reconstruction filter: [fixed]	
50 MHz	[used for all symbol rates]
Baseband spectral purity[1]	
[full scale sinewave]	
Harmonic distortion	
100 kHz to 2 MHz	(< –65 dBc)
Phase noise	(< –127 dBc/Hz)
[baseband output of 10 MHz sinewave at 20 kHz offset]	
IM performance	(< –74 dB)
[two sinewaves at 950 kHz and 1050 kHz at baseband]	
Triggers	
Types	Continuous, single, gated, segment advance
Source	Trigger key, external, remote [LAN, GPIB, RS-232]
External polarity	Negative, positive
External delay time	10 ns to 40 sec plus latency
External delay resolution	10 ns
Markers	
[Markers are defined in a segment during the waveform generation process, or from the ESG front panel. A marker can also be tied to the RF blanking feature of the ESG.]	
Marker polarity	Negative, positive
Number of markers	4

1. Parentheses denote typical performance.

I/Q baseband generator arbitrary waveform mode specifications continued on page 17

Specifications

I/Q baseband generator
arbitrary waveform mode specifications
continued from page 16

Multi-carrier	
Number of carriers	Up to 100 [limited by a max bandwidth of 80 MHz depending on symbol rate and modulation type]
Frequency offset [per carrier]	–40 MHz to +40 MHz
Power offset [per carrier]	0 dB to –40 dB
Modulation	
PSK	BPSK, QPSK, OQPSK, π/4DQPSK, 8PSK, 16PSK, D8PSK
QAM	4, 16, 32, 64, 256
FSK	Selectable: 2, 4, 8, 16
MSK	
Data	Random ONLY
Multi-tone	
Number of tones	2 to 64, with selectable on/off state per tone
Frequency spacing	100 Hz to 80 MHz
Phase [per tone]	Fixed or random

3GPP W-CDMA [arbitrary waveform mode[2]]
[Option 400]

Error vector magnitude[1]
[1.8 GHz < f_c < 2.2 GHz, default W-CDMA filters, 2.1 MHz baseband filter, 3.84 Mcps chip rate, ≤ 4 dBm, ≤ 7 dBm with Option UNB]
1 DPCH ≤ 2.3%, (< 1.3%)

Level accuracy [relative to CW at 800, 900, 1800, 1900, 2200 MHz][1]
[≤ 2.5 dBm standard, 7.5 dBm for Option UNB, and 4.5 dBm for Option 506]
±0.7 dB (±0.35 dB)

Adjacent channel leakage ratio[1]
[1.8 GHz < f_c < 2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤ 0 dBm Option UNB, ≤ –3dBm Option 506, ≤ –5 dBm standard in Optimize ADJ mode]
1 DPCH –65 dBc (–67 dBc)
Test Model 1 + 64 DPCH –63 dBc (–65 dBc)

Alternate channel leakage ratio[1]
[1.8 GHz < f_c < 2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤ 2.5 dBm standard, ≤ 4.5 dBm Option 506, ≤ 7.5 dBm Option UNB, in Optimize ALT mode]
1 DPCH –70 dBc (–73 dBc)
Test Model 1 + 64 DPCH –68 dBc (–70 dBc)

I/Q baseband generator arbitrary waveform mode specifications continued on page 18

1. Parentheses denote typical performance.
2. Valid for 23° ±5° C.

Specifications

I/Q baseband generator

arbitrary waveform mode specifications

continued from page 17

IS-95 CDMA spurious emissions [arbitrary waveform mode[2]]
[Option 401]

[dBc, IS-95 modified filter with equalizer and amplitude = ≤ -5 dBm standard, ≤ -3 dBm for Option 506, ≤ 0 dBm for Option UNB][1]

	0.885 to 1.25 MHz		*1.25 to 1.98 MHz*		*1.98 to 5 MHz*	
Frequencies/offsets	Standard	Option 506	Standard	Option 506	Standard	Option 506
Reverse						
30 – 200 MHz	(–74)	(–74)	(–77)	(–77)	(–80)	(–80)
700 – 1000 MHz	–73 (–77)	–73 (–77)	(–81)	(–81)	(–85)	(–85)
>1000 – 2000 MHz	–76 (–79)	–75 (–79)	(–83)	(–83)	(–85)	(–85)
9/64 channels						
30 – 200 MHz	(–70)	(–70)	(–73)	(–73)	(–79)	(–79)
700 – 1000 MHz	–73 (–76)	–73 (–76)	(–79)	(–79)	(–82)	(–82)
>1000 – 2000 MHz	–72 (–76)	–71 (–76)	(–79)	(–79)	(–82)	(–82)

Rho[1] [≤ 4 dBm standard and Option 506, or ≤ 7 dBm Option UNB, IS-95 filter, ≤ 2 GHz]
$\rho \geq 0.9992$ (.9998)

cdma2000 spurious emissions [arbitrary waveform mode]
[Option 401]

[dBc, IS-95 modified filter with equalizer and amplitude = ≤ -5 dBm standard,
≤ -3 dBm for Option 506, ≤ 0 dBm for Option UNB]

	Offsets from center of carrier		
Frequencies/offsets	2.135 to 2.50 MHz	2.50 to 3.23 MHz	3.23 to 10 MHz
Forward 9 channel, SR3/multi-carrier[1, 3]			
30 – 200 MHz	(–70)	(–69)	(–72)
700 – 1000 MHz	(–75)	(–74)	(–77)
>1000 – 2000 MHz	(–75)	(–74)	(–77)

	Offsets from center of carrier		
Frequencies/offsets	2.655 to 3.75 MHz	3.75 to 5.94 MHz	5.94 to 10 MHz
Forward 9 channel, SR3/DS[1, 4]			
30 – 200 MHz	(–76)	(–78)	(–78)
700 – 1000 MHz	(–80)	(–83)	(–85)
>1000 – 2000 MHz	(–80)	(–83)	(–85)
Reverse 5 channel, SR3/DS[1, 3]			
30 – 200 MHz	(–78)	(–78)	(–78)
700 – 1000 MHz	(–82)	(–83)	(–85)
>1000 – 2000 MHz	(–82)	(–83)	(–85)

cdma2000 error vector magnitude [arbitrary waveform mode]
[Option 401]

[≤ 4 dBm standard and Option 506, ≤ 7 dBm for Option UNB]
[825 to 2100 MHz, SR3 pilot, IS-95 filter, which is optimized for EVM][1]

EVM ≤ 2.1%, (≤ 1.5%)

1. Parentheses denote typical performance.
2. Valid for 23° ±5° C.
3. Measurements performed with 30 kHz BW, relative to power in one carrier.
4. Measurements performed with 30 kHz BW, relative to total power.

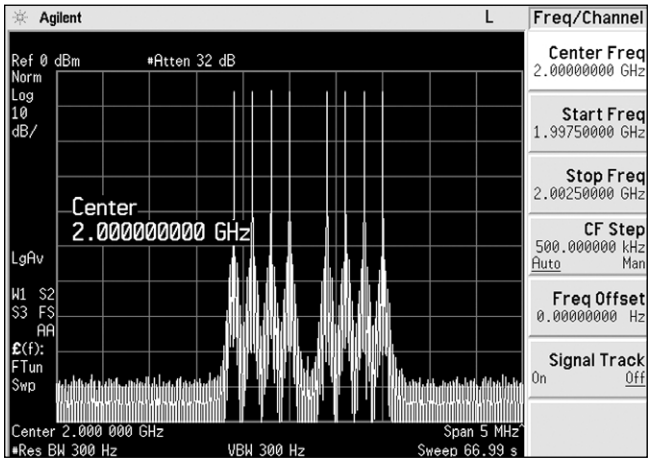
I/Q baseband generator arbitrary waveform mode specifications continued on page 19

Specifications

I/Q baseband generator
arbitrary waveform mode specifications
continued from page 18

Enhanced Multitone Signal Studio software[1] [Option 408]

Number of tones	2 to 1024
Tone spacing	1 kHz to 50 MHz, limited by 80 MHz I/Q bandwidth
Tone power (relative)	0 to -50 dB
Phase distribution	Fixed, random or parabolic
Suppression level	-50 to -90 dBc, depending on number of tones and available calibration time. Expected suppression = 80 dBc -10 log [N/8], where N is the number of tones
Calibration interval	8 hours
Calibration time	10 minutes (8 tones, -80 dBc suppression)
Temperature stability	1 dB/°C (typical for IMD products) 5 dB/°C (worst case for LO feedthrough and unbalanced images)



Enhanced multitone signal with correction applied

I/Q baseband generator arbitrary waveform mode specifications continued on page 20

1. All values typical.

continued from page 19

802.11a EVM [Option 410][1]

The EVM was measured with an 89640A vector signal analyzer with Option B7R. The E4440A spectrum analyzer was used as the down converter. Instrument and software settings listed below.

Software settings

Data rate	54 Mbps
Modulation	64 QAM
Encoder	3/4 rate
Scrambler	active
interlever	active
Scrambler initialization	5D
Support carrier setup	All channels active
Idle interval	100 µS
OSR	4
Window length	16
Data type	PN15
Data length	1024

Source settings

Frequency	5.825 GHz
Output power	0 dBm
Reconstruction filter	40 MHz
ALC	On
RF blanking	Off
Modulator Atten	4 to 10 dB

89640A settings

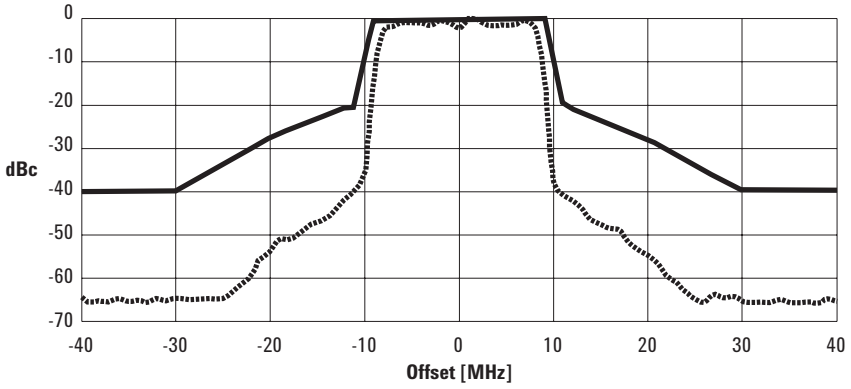
Frequency	321.4 MHz
Span	22 MHz
Range	-10 dBm
RMS video average	20

E4440A settings

Frequency	5.825 GHz
Span	0 span
Attenuation	12 to 16 dB
Phase noise option:	
Optimize L (f) for f > 50 kHz	

EVM (≤1.2%, 38.42 dB)

802.11a Spectral mask typical performance
(0 dbm, at 5805 MHz, OSR: 4, window length: 16



1. All values typical.

Specifications

I/Q baseband generator [real-time mode]
[Option 001 or 002]

Basic modulation types [custom format]

PSK	BPSK, QPSK, OQPSK, π/4DQPSK, 8PSK, 16PSK, D8PSK
MSK	User-defined phase offset from 0 to 100°
QAM	4, 16, 32, 64, 256
FSK	Selectable: 2, 4, 8, 16 level symmetric User defined: Custom map of up to 16 deviation levels

Symbol rate	*Maximum deviation*
< 5 MHz	4 times symbol rate
> 5 MHz, < 50 MHz	20 MHz

Resolution: 0.1 Hz

I/Q Custom map of 256 unique values

FIR Filter

Selectable	Nyquist, root Nyquist, Gaussian, rectangular α: 0 to 1, B_bT: 0.1 to 1
Custom FIR	16-bit resolution, up to 64 symbols long, automatically resampled to 1024 coefficients [max] > 32 to 64 symbol filter: symbol rate ≤ 12.5 MHz > 16 to 32 symbol filter: symbol rate ≤ 25 MHz Internal filters switch to 16 tap when symbol rate is between 25 and 50 MHz

Symbol rate

For external serial data, symbol rate is adjustable from 1000 symbols/sec to a maximum symbol rate of $\frac{50\ \text{Mbits/sec}}{\#\text{bits/symbol}}$

For internally generated data, symbol rate is adjustable from 1000 symbols/sec to 50 Msymbols/sec. and a maximum of 8 bits per symbol. Modulation quality may be degraded at high symbol rates.

Baseband reference frequency

	Data clock can be phase locked to an external reference. 13 MHz for GSM, 250 kHz to 100 MHz in W-CDMA and cdma2000[1, 2]
Input	ECL, CMOS, TTL compatible, 50 Ω AC coupled

Frame trigger delay control

Range	0 to 1,048,575 bits
Resolution	1 bit

I/Q baseband generator real-time mode specifications continued on page 22

1. Performance below 1 MHz not specified.
2. When used, this baseband reference is independent of the 10 MHz RF reference.

Specifications

I/Q baseband generator (Option 001 or 002) real-time mode specifications

continued from page 21

Data types		
Internally generated data		
Pseudo-random patterns		PN9, PN11, PN15, PN20, PN23
Repeating sequence		Any 4-bit sequence
		Other fixed patterns
Direct-pattern RAM [PRAM]		
Max size	Option 001	8 Mbits
	Option 002	32 Mbits
		[each bit uses an entire sample space]
Use	Non-standard framing	
User file		
Max size	Option 001	800 kbytes
	Option 002	3.2 Mbytes
Use	Continuous modulation or internally generated TDMA standard	
Externally generated data		
Type	Serial data	
Inputs	Data, bit clock, symbol sync	
	Accepts data rates ±5% of specified data rate	
Internal burst shape control		
Varies with standards and bit rates		
Rise/fall time range		Up to 30 bits
Rise/fall delay range		0 to 63.5 bits

AWGN personality [real-time mode] [Option 403]

Crest factor [output power set at least 16 dB below maximum power]	> 16 db
Randomness	89 bit pseudo-random generation, repetition period 3 x 10^9 years
Carrier to noise ratio	Magnitude accuracy better than 0.2 dB at baseband I/Q outputs.

I/Q baseband generator real-time mode specifications continued on page 23

Specifications

I/Q baseband generator (Option 001 or 002)
real-time mode specifications
continued from page 22

Custom digitally modulated signals [real-time mode][1, 7]

Modulation	**QPSK**	**π/4DQPSK**	**16QAM**	**2FSK**	**GMSK**
Filter	**Root Nyquist**			**Gaussian**	
Filter factor [α or B_bT]	0.25	0.25	0.25	0.5	0.5
Modulation index	N/A	N/A	N/A	0.5	N/A
Symbol rate [Msym/s]	4	4	4	1	1
	Error vector magnitude[2, 6] [% rms]			**Shift error**[2, 6] [% rms]	**Global phase error**[2, 6] [degrees rms]
fc = 1 GHz	1.1 (0.7)	1.1 (0.7)	1.0 (0.6)	1.3 (0.8)	0.4 (0.2)
fc = 2 GHz	1.2 (0.8)	1.2 (0.8)	1.0 (0.6)	1.4 (0.9)	0.5 (0.3)
fc = 3 GHz	1.6 (1.0)	1.6 (1.0)	1.4 (0.8)	1.5 (1.0)	0.6 (0.3)
fc = 4 GHz	2.5 (1.3)	2.5 (1.2)	2.8 (1.4)	3.0 (1.8)	0.8 (0.5)
fc = 5 GHz	1.5 (1.0)	1.5 (1.0)	1.2 (0.8)	1.8 (1.2)	0.6 (0.3)
fc = 6 GHz	1.8 (1.2)	1.8 (1.2)	1.4 (1.0)	2.0 (1.4)	0.8 (0.4)

Internal modulation using real-time TDMA personalities [Option 402][7]

	NADC		**PDC**		**PHS**		**TETRA**[4]		**DECT**	**GSM DCS, PCS**		**EDGE**
Error vector magnitude[3, 6] [% rms]												
Low EVM mode	0.9 (0.6)		0.9 (0.7)		0.8 (0.5)		0.8 (0.5)					1.2 (0.6)
Low ACP mode	(1.1)		(0.9)		(0.6)		(1.0)					
Global phase error[3]												
rms	N/A		N/A		N/A		N/A		N/A	0.6 (0.3)		N/A
pk										1.9 (1.0)		
Deviation accuracy[3] [kHz, rms]	N/A		N/A		N/A		N/A		2.5 (1.1)	N/A		N/A
Channel spacing [kHz]	30		25		300		25		1728	200		200
Adjacent channel power[3] [ACP]	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst	N/A	Cont.	Burst	N/A
(Low ACP mode, dBc)												
at adjacent channel[5]	(-35)	(-34)	–	–	–	–	(-70)	(-64)		(-37)	(-37)	
at 1st alternate channel[5]	(-80)	(-79)	(-74)	(-74)	(-83)	(-79)	(-81)	(-80)		(-71)	(-71)	
at 2nd alternate channel[5]	(-84)	(-84)	–	–	(-85)	(-82)	(-82)	(-82)		(-87)	(-84)	
at 3rd alternate channel[5]	(-86)	(-85)	(-82)	(-82)	–	–	(-84)	(-84)		(-88)	(-85)	
Support burst types	Custom up/down TCH		Custom up/down TCH up Vox		Custom TCH, sync		Custom up control 1 & 2, up normal, down normal,		Custom dummy B 1 & 2, traffic B, low capacity	Custom, normal Fcorr, sync, dummy, access		
Scramble capability					Yes		Yes					

I/Q baseband generator real-time mode specifications continued on page 24

1. This level of performance can be attained using the external I/Q inputs, provided the quality of the baseband signal meets or exceeds that of the ESG baseband generator.
2. Specifications apply at power levels ≤ +4 dBm [≤ +5 dBm for Option 506, and ≤ +8 dBm for Option UNB] with default scale factor of I/Q outputs.
3. Specifications apply for the symbol rates, filter, filter factors [α or BbT] and default scaling factor specified for each standard, and at power levels ≤ +7 dBm [≤ +10 dBm for Option UNB].
4. ACP for TETRA is measured over a 25 kHz band width, with an 18 kHz root raised cosine filter. Low ACP mode is valid at power levels ≤ –1 dBm [≤ 1 dBm for Option 506 and ≤ +4 dBm for Option UNB].
5. 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.
6. Valid after executing I/Q calibration and maintained within +/- 5 °C of the calibration temperature.
7. Parentheses denote typical performance.

Specifications

I/Q baseband generator (Option 001 or 002)
real-time mode specifications
continued from page 23

GSM/GPRS Multi-frame output data generation [real-time mode] [Option 402]

Coding scheme	Full-rate speech [TCH/FS] CS-1, CS-4
Data	PN9 or PN15 The selected data sequence is coded continuously across the RLC data block as per ETSI TS 100 909, 3GPP TS 05.03, V8.9.0, 2000-11 [release 1999] An independent version of the selected data sequence is coded across the MAC header.
Frame structure	26-frame multi-frame structure as per ETSI GSM, 05.01 version 6.1.1 [1998-07]. [Coding is done on frames 0-11, 13-24, of the multi-frame. Frame 25 is idle [RF blanked].]
Adjacent timeslots	
Data	PN9, PN15 coded as per ETSI TS 100 909, 3GPP TS 05.03, V8.9.0, 2000-11 [release 1999].
Frame structure	26-frame multi-frame structure as per ETSI GSM, 5.01 version 6.1.1 [1998-07].

GSM Multi-frame measurements[1]

GSM measurement modes	
Static sensitivity	RBER at user-specified power level measured. [This is the complete conformance test as defined in pri-ETS 300 609-1 [GSM 11.21] version 4.12.0 [Dec 98], section 7.3.4.]
Sensitivity search	Automatically finds the input level [sensitivity] that causes a user-specified RBER [normally 2%] for class II bits.
Maximum frame count	6,000,000 speech frames
GSM measurement results	Class Ib bit-error ratio [RBER for TCH/FS] Class II bit-error ratio [RBER for TCH/FS] Frame erasure ratio [FER] Downlink error frame count Class Ib bit-error count Class II bit-error count Erased frame count Total frame count
Maximum RBER	50%
Maximum FER	100%

Alternate time slot power level control

[Valid for standard attenuator only. Not applicable to Option UNB or Option 506]

Amplitude is settled within 0.5 dB in 20 µsecs, +4 to –136 dBm at 23 ±5 °C

I/Q baseband generator real-time mode specifications continued on page 25

1. Measurements also require Option 300.

continued from page 24

EDGE/EGPRS Multi-frame output data generation [real-time mode] [Option 402]

Coding scheme	MCS-1: uplink and downlink, MCS-5: uplink and downlink, MCS-9: uplink and downlink, E-TCH/F43.2
Data	PN9 or PN15 The selected data sequence is fully coded continuously across the RLC data blocks according to MCS-1, MCS-5, MCS-9 or E-TCH/F43.2. An independent version of the selected data sequence is coded across the unused RLC/MAC header fields [The CPS header field is as defined in GSM 04.60 V8.50].
Frame structure	52-frame multi-frame structure for EDGE/EGPRS channel as per ETSI TS 100 909, 3GPP TS 05.03, V8.9.0, 2000-11 [release 1999]. [Coding is done on frames 0-11, 13-24, 26-37, 39-50 on a 52 PDCH multi-frame. Frame 25 and 51 are idle [RF blanked].]
Adjacent timeslots	
Data	Coded MCS-1, MCS-5 or MCS-9 with continuous PN9 or PN15 sequence data payload. Uncoded PN9, PN15. Note: Maximum of 4 timeslots can be turned on with EDGE/EGPRS multi-frame coded data.
Frame structure	EDGE/EGPRS PDCH multi-frame. Repeating EDGE frame.

EDGE Multi-frame measurements[1]

EDGE Measurement modes	
Static sensitivity	BER/BLER at user-specified power level measured; based on bit errors in total unencoded data, and block errors in coded channels.
Sensitivity search BER/BLER	Automatically finds the input level [sensitivity] that causes user-specified BER [uncoded] or BER [coded].
EDGE Measurement results	Erased data block count/rate for coded channel [MCS-1, MCS-5 or MCS-9]. Total data block count for coded channel [MCS-1, MCS-5 or MCS-9]. Payload bit error count/rate for raw BER. Total burst count for raw BER. Data block count which contains residual bit errors and bit error count. Downlink error reporting

I/Q baseband generator real-time mode specifications continued on page 26

1. Measurements also require Option 300.

Specifications

I/Q baseband generator (Option 001 or 002)
real-time mode specifications
continued from page 25

GSM/EDGE base station Bit Error Rate Test [BERT] [Option 300]

This is a system of two instruments; an ESG with Option 300, and a VSA with Option 300. Both are required. Option 300 for the ESG requires Option 001 or 002, the TDMA personalities [Option 402], and the UN7 BER board. The VSA functions as an IF downconverter. It may be used simultaneously to make transmitter measurements on the loop back signal.

GSM BTS test only

E4406A VSA-series transmitter tester with Options BAH [GSM measurement personality] and Option 300 [321.4 MHz output].

GSM/EDGE BTS test

E4406A VSA-series transmitter tester with Option 202 [GSM and EDGE measurement personality] and Option 300 [321.4 MHz output].

Test technique	RF loopback
Supported systems GSM 400 GSM 850 GSM 900 [P-GSM] DCS 1800 PCS 1900 E-GSM [extended]	
Minimum power level	–136 dBm [ESG minimum]
Maximum power level	+13 dBm [option dependent]
Power level accuracy	±0.5 dB [23° ± 5 °C] [power and frequency dependent]
Relative power level	0 to ±130 dB relative to timeslot under test. [Limited only by output power range of the ESG.]
Timeslot under test	
Timeslots tested	0 to 7 A single timeslot is tested at one time. [No frequency hopping.]
Encryption	None
Measurement triggers	Immediate, trigger key, external, remote [LAN, GPIB, RS-232]
Measurement indication	Pass/fail
BCH sync	BCH signal from the BTS is used to determine TCH frame and multi-frame location.
TCH sync	The idle frame [no RF] in the TCH signal itself is used to determine the TCH multi-frame location and so generate the multi-frame sync signal.
Threshold	Termination of measurement when error count exceeds user-specified threshold.

Specifications

Bit Error Rate [BER] analyzer
[Option UN7]

Clock rate	100 Hz to 60 MHz
Supported data patterns	PN9, 11, 15, 20, 23
Resolution	10 digits
Bit sequence length	100 bits to 4.294 Gbits after synchronization

Features

Input clock phase adjustment and gate delay
Adjustable input threshold
Hi/lo threshold selectable from 0.7 V [TTL], 1.4 V [TTL]
1.65 V [CMOS 3.3], 2.5 V [CMOS 5.0]
Direct measurement triggering
Data and reference signal outputs
Real-time display
Bit count
Error-bit-count
Bit error rate
Pass/fail indication
Valid data and clock detection
Automatic re-synchronization
Special pattern ignore

General characteristics

Operating characteristics

Power requirements	90 to 254 V; 50, or 60 Hz; 300 W maximum, power factor corrected. Not for 400 MHz use.[3]
Operating temperature range[2]	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-461C CE02 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	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 100 storage registers and 1000 register sequences [10 per register] are available.
Weight	< 16 kg [35 lb.] net, < 23 kg [50 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]
Remote programming	
Interface	GPIB [IEEE-488.2-1987] with listen and talk, RS-232, LAN [10BaseT].
Control languages[1]	SCPI version 1996.0, also compatible with 8656B and 8657A/B/C/D/J1 mnemonics.
Functions controlled	All front panel functions except power switch and knob.
ISO compliant	The E4438C ESG is manufactured in an ISO-9001 registered facility in concurrence with Agilent Technologies commitment to quality.

1. ESG series does not implement 8657A/B "Standby" or "On" [R0 or R1, respectively] mnemonics.
2. Save and recall of user files and instrument states from non-volatile storage is guaranteed only over the range 0 to 40 °C.
3. For 400 MHz systems, order transformer 70001-60066.

General characteristics

Accessories

Transit case	Part number 9211-1296

Inputs and outputs

All front panel connectors can be moved to rear with Option 1EM.

10 MHz input	Accepts a 1, 2, 5, or 10 MHz ±10 ppm [standard timebase] or ±1 ppm [high-stability timebase] reference signal for operation with an external timebase. Nominal input level –3.5 to +20 dBm, impedance 50 ohms. [BNC, rear panel]
10 MHz output	Outputs the 10 MHz reference signal. Level nominally +3.9 dBm ±2 dB. Nominal output impedance 50 ohms. [BNC, rear panel]
Alternate power input	Accepts CMOS[1] signal for synchronization of external data and alternate power signal timing. The damage levels are –0.5 to +5.5 V. [Auxiliary I/O connector, rear panel]
Baseband generator reference input	Accepts 0 to +20 dBm sinewave, or TTL squarewave, to use as reference clock for the baseband generator. Phase locks the internal data generator to the external reference; the RF frequency is still locked to the 10 MHz reference. Rate is 250 kHz to 100 MHz, 50 ohms nominal, AC coupled. [BNC, rear panel]
Burst gate input	The burst gate in connector accepts a CMOS[1] signal for gating burst power in digital modulation applications. The burst gating is used when you are externally supplying data and clock information. The input signal must be synchronized with the external data input that will be output during the burst. The burst power envelope and modulated data are internally delayed and re-synchronized. The input signal must be CMOS high for normal burst RF power or CW RF output power and CMOS low for RF off. The damage levels are –0.5 to +5.5 V. This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector. With Option 401, this connector is used for the even second synchronization input.
Coherent carrier output	Outputs RF modulated with FM or ΦM, but not IQ, pulse or AM. Nominal power –2 dBm ±5 dB. Nominal impedance 50 ohms. Frequency range from > 250 MHz to 4 GHz. For RF carriers below this range, output frequency = 1 GHz – frequency of RF output. Damage levels 20 VDC and 13 dBm reverse RF power. [SMA, rear panel]

1. Rear panel inputs and outputs are 3.3 V CMOS, unless indicated otherwise. CMOS inputs will accept 5 V CMOS, 3 V CMOS, or TTL voltage levels.

General characteristics

Data clock input	The CMOS[1] compatible data clock connector accepts an externally supplied data-clock input for digital modulation applications. The expected input is a bit clock signal where the falling edge is used to clock the data and symbol sync signals. The maximum clock rate is 50 MHz. The damage levels are –0.5 to +5.5 V. This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector.
Data clock output	Relays a CMOS[1] bit clock signal for synchronizing serial data. [Auxiliary I/O connector, rear panel]
Data input	The CMOS[1] compatible data connector accepts an externally supplied data input for digital modulation applications. CMOS high is equivalent to a data 1 and a CMOS low is equivalent to a data 0. The maximum data rate is 50 Mb/s. The data must be valid on the data clock falling edges [normal mode] or the symbol sync falling edges [symbol mode]. The damage levels are –0.5 to +5.5 V. This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector.
Data output	Outputs serial data from the internal data generator or the externally supplied signal at the data input. CMOS[1] signal. [Auxiliary I/O connector, rear panel]
Event 1 output	In real-time mode, outputs pattern or frame synchronization pulse for triggering or gating external equipment. May be set to start at the beginning of a pattern, frame, or timeslot and is adjustable to within ± one timeslot with one bit resolution. In arbitrary waveform mode, this connector outputs the timing signal generated by marker 1. [BNC, rear panel]
Event 2 output	In real-time mode, outputs data enable signal for gating external equipment. Applicable when external data is clocked into internally generated timeslots. Data is enabled when signal is low. In arbitrary waveform mode, this connector outputs the timing signal generated by marker 2. [BNC, rear panel]
Event 3 output	In arbitrary waveform mode, this connector outputs the timing signal generated by marker 3. [Auxiliary I/O connector, rear panel]
Event 4 output	In arbitrary waveform mode, this connector outputs the timing signal generated by marker 4. [Auxiliary I/O connector, rear panel]

1. Rear panel inputs and outputs are 3.3 V CMOS, unless indicated otherwise. CMOS inputs will accept 5 V CMOS, 3 V CMOS, or TTL voltage levels.

General characteristics

External 1 input

This BNC input connector accepts a ±1 V_{peak} signal for AM, FM, pulse, burst, and phase modulation. For all these modulations, ±1 V_{peak} produces the indicated deviation or depth. When ac-coupled inputs are selected for AM, FM, or phase modulation and the peak input voltage differs from 1 V_{peak} by more than 3%, the hi/lo annunciators light on the display. The input impedance is 50 ohms and the damage levels are 5 V_{rms} and 10 V_{peak}.

If you configure your signal generator with Option 1EM, this input is relocated to a female BNC connector on the rear panel.

External 2 input

This BNC input connector accepts a ±1 V_{peak} signal for AM, FM, phase modulation, and pulse modulation. With AM, FM, or phase modulation, ±1 V_{peak} produces the indicated deviation or depth. With pulse modulation, +1 V is on and 0 V is off. When ac-coupled inputs are selected for AM, FM, or phase modulation, and the peak voltage differs from 1 V_{peak} by more than 3%, the hi/lo annunciators light on the display. The input impedance is 50 ohms and the damage levels are 5 V_{rms} and 10 V_{peak}.

If you configure your signal generator with Option 1EM, this input is relocated to a female BNC connector on the rear panel.

GPIB

Allows communication with compatible devices. [rear panel]

I input

Accepts an I input either for I/Q modulation or for wideband AM. Nominal input impedance 50 or 600 ohms. Damage levels are 1 V_{rms} and 10 V_{peak}. [BNC, front panel]

I out and Q out[1]

The I out and Q out connectors output the analog components of I/Q modulation from the internal baseband generator. The nominal output impedance of these connectors are 50 Ω, DC-coupled. The damage levels are > +3.5 V and < –3.5 V. The output signal levels into a 50 Ω load are as follows:

- (0.5 V_{peak},), corresponds to one unit length of the I/Q vector.
- (0.69 V_{peak})[2.84 dB], maximum crest factor for peaks for $\pi/4$ DQPSK with α=0.5.
- (0.71 V_{peak})[3.08 dB), maximum crest factor for peaks for $\pi/4$ DQPSK with α=0.35.
- (1 V_{p-p}) maximum [Option 001 or 002 only].

These female BNC connectors are provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, these inputs are relocated to rear panel SMB connectors.

1. Parentheses denote typical performance.

General characteristics

I-bar and Q-bar out	I-bar and Q-bar are used in conjunction with I and Q to provide a balanced baseband stimulus. Balanced signals are signals present in two separate conductors that are symmetrical about the common mode offset, and are opposite in polarity [180 degrees out of phase]. These female BNC connectors are provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, these inputs are relocated to rear panel SMB connectors.
LF output	Outputs the internally-generated LF source. Outputs 0 to 2.5 V_{peak} into 50 ohms, or 0 to 5 V_{peak} into high impedance. [BNC, front panel]
Pattern trigger input	Accepts CMOS[1] signal to trigger internal pattern or frame generator to start single pattern output. Minimum pulse width 100 ns. The damage levels are –0.5 to +5.5 V. [BNC, rear panel]
Q input	Accepts a Q input for I/Q modulation. Nominal input impedance 50 or 600 ohms, damage levels are 1 V_{rms} and 10 V_{peak}. [BNC, front panel]
RF output	Nominal output impedance 50 ohms. [type-N female, front panel]
Sweep output	Generates output voltage, 0 to +10 V when signal generator is sweeping. Output impedance < 1 ohm, can drive 2000 ohms. [BNC, rear panel]
Symbol sync input	The CMOS[1] compatible symbol sync connector accepts an externally supplied symbol sync for digital modulation applications. The expected input is a symbol clock signal. It may be used in two modes. When used as a symbol sync in conjunction with a data clock, the signal must be high during the first data bit of the symbol. The signal must be valid during the falling edge of the data clock signal and may be a single pulse or continuous. When the symbol sync itself is used as the [symbol] clock, the falling edge is used to clock the data signal. The maximum clock rate is 50 MHz. The damage levels are –0.5 to +5.5 V. [BNC, front panel] This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector.
Symbol sync output	Outputs CMOS[1] symbol clock for symbol synchronization, one data clock period wide. [Auxiliary I/O connector, rear panel]
Trigger input	Accepts CMOS[1] signal for triggering point-to-point in manual sweep mode, or to trigger start of LF sweep. the damage levels are –0.5 to +5.5 V. [BNC, rear panel]
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 2 µs pulse at start of LF sweep. [BNC, rear panel]

1. Rear panel inputs and outputs are 3.3 V CMOS, unless indicated otherwise. CMOS inputs will accept 5 V CMOS, 3 V CMOS, or TTL voltage levels.

General characteristics

With Option UN7

BER data, BER clock BER gate	Accepts CMOS[1] or 75 Ω input. Polarity is selected. Clock duty and inputs cycle is 30% to 70%. [SMB, rear panel]
BER sync loss output	Outputs a CMOS[1] signal that is low when sync is lost. Valid only when measure end signal is high. [Auxiliary I/O connector, rear panel]
BER no data output	Outputs a CMOS[1] signal that is low when no data is detected. Valid only when measure end is high. [Auxiliary I/O connector, rear panel]
BER error-bit-output	Outputs CMOS[1] signal when error bit is detected. Pulse width matches the input clock. [Auxiliary I/O connector, rear panel]
BER test result output	Outputs a CMOS[1] signal that is high for fail and low for pass. Valid only on measure end signal falling edge. [Auxiliary I/O connector, rear panel]
BER measure end output	Outputs a CMOS[1] signal that is high during measurement. Trigger events are ignored while high. [Auxiliary I/O connector, rear panel]
BER measure trigger	Accepts CMOS[1] signal to initiate BER measurement. Polarity is selectable; available when trigger source is selected as "AUX I/O". Damage levels are The damage levels are –0.5 to +5.5 V. [Auxiliary I/O connector, rear panel]

With Option 300

321.4 MHz input	Accepts a 321.4 MHz IF signal for GSM/EDGE/loopback testing. Input amplitude range -7 dBm to -22 dBm. Nominal input impedance 50 ohms. [SMB, rear panel]

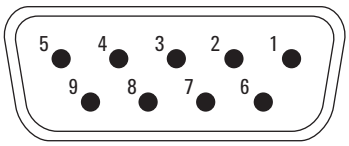
LAN connector

LAN communication is supported by the signal generator via the LAN connector. It is functionally equivalent to the GPIB connector. The LAN connector enables the signal generator to be remotely programmed by a LAN-connected computer. The distance between a computer and the signal generator is limited to 100 meters [10BaseT]. For more information about the LAN, refer to the *Getting Started* chapter in the *Programming Guide*.

RS-232 connector

This male DB-9 connector is an RS-232 serial port that can be used for controlling the signal generator remotely. It is functionally equivalent to the GPIB connector. The following table shows the description of the pinouts. The pin configuration is shown below.

Pin number	*Signal description*	*Signal name*
1	No connection	
2	Receive data	RECV
3	Transmit data	XMIT
4	+5 V	
5	Ground, 0 V	
6	No connection	
7	Request to send	RTS
8	Clear to send	CTS
9	No connection	



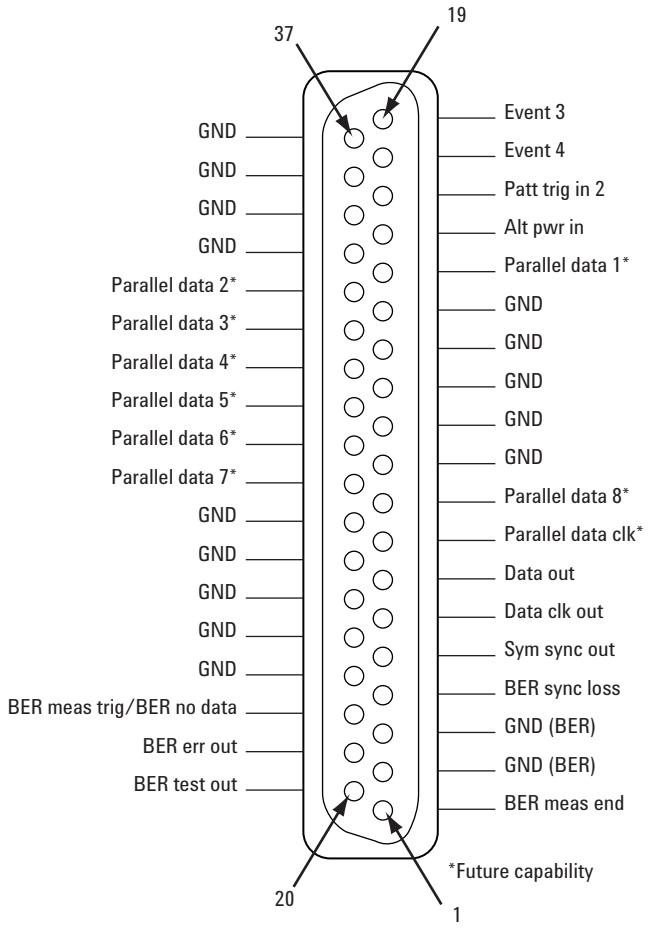
View looking into rear panel connector

1. Rear panel inputs and outputs are 3.3 V CMOS, unless indicated otherwise. CMOS inputs will accept 5 V CMOS, 3 V CMOS, or TTL voltage levels.

General characteristics

Auxiliary I/O connector

This connector enables you to access the inputs and outputs of the baseband generator. The figure below shows the Auxiliary I/O pin connector configuration.



View looking into rear panel connector

Mating connector	37 pin male D-subminiature, available from AMP, 3M, others.

Ordering Information

E4438C ESG vector signal generator

Frequency options

- 501 1 GHz frequency range
- 502 2 GHz frequency range
- 503 3 GHz frequency range
- 504 4 GHz frequency range
- 506 6 GHz frequency range [requires option UNJ, includes mechanical attenuator]

Hardware options

- UNB High output power with mechanical attenuator [included with 506]
- UNJ Enhanced phase noise performance [includes 1E5]
- 1E5 High-stability time base
- 1EM Moves all front panel connectors to rear
- 001 Internal baseband generator with 8 Msamples [40 Mbytes] of memory
- 002 Internal baseband generator with 32 Msamples [160 Mbytes] of memory
- 005 6 Gbyte non-volatile waveform storage, requires option 001 or 002
- UN7 Internal bit-error-rate analyzer
- 300 GSM/EDGE basestation loopback BER test capability

Signal generation personalities[1]

- 400 3GPP W-CDMA FDD personalities
- 401 cdma2000 and IS-95A personalities
- 402 TDMA personalities [includes GSM, EDGE, NADC and others]
- 403 Calibrated AWG noise personality
- 409 GPS personality

Signal Studio software personalities[1]

- 404 1xEV-DO
- 405 Wireless LAN (802.11b)
- 406 Bluetooth
- 408 Enhanced Multitone
- 410 Wireless LAN (802.11a)

System accessories

- 1CP Rack mount kit with handles
- 1CN Front handle kit

1. Requires either Option 001 or 002 (baseband generator) to function.

ESG family application literature and information

- *RF Source Basics,* a self-paced tutorial (CD ROM), literature number 5980-2060E.
- *Digital Modulation in Communications Systems—An Introduction*, Application Note 1298, literature number 5965-7160E.
- *Using Vector Modulation Analysis in the Integration, Troubleshooting and Design of Digital Communications Systems*, Product Note, literature number 5091-8687E.
- *Testing CDMA Base Station Amplifiers*, Application Note 1307, literature number 5967-5486E.
- *Understanding GSM Transmitter Measurements for Base Transceiver Stations and Mobile Stations,* Application Note 1312, literature number 5968-2320E.
- *Understanding CDMA Measurements for Base Stations and their Components,* Application Note 1311, literature number 5968-0953E.
- *Testing and Troubleshooting Digital RF Communications Receiver Designs,* Application Note 1314, literature number 5968-3579E.
- *Signal Generators RF and Microwave Models,* Catalog, literature number 5965-3094E.

ESG family product literature and information

- *Agilent E4438C ESG Vector Signal Generator,* Brochure, literature number 5988-3935EN.
- *E4438C ESG Vector Signal Generator,* Configuration Guide, literature number 5988-4085EN.
- *IntuiLink Software,* Data Sheet, literature number 5980-3115EN.
- *3GPP W-CDMA Firmware Option for the E4438C ESG Vector Signal Generator - Option 400*, literature number 5988-4449EN
- cdma2000 and IS-95A Personalities *for the E4438C ESG Vector Signal Generator - Option 401*, literature number 5988-4430EN
- *Real time TDMA Firmware for the E4438C ESG Vector Signal Generator - Option 402*, literature number 5988-4431EN
- 1*xEV-DO Signal Studio software for the E4438C ESG Vector Signal Generator - Option 404*, literature number 5988-5459EN
- *802.11b WLAN Signal Studio Software for the E4438C ESG Vector Signal Generator - Option 405*, literature number 5988-5766EN
- Bluetooth *Signal Studio Software for the E4438C ESG Vector Signal Generator - Option 406*, literature number 5988-5458EN
- *Enhanced Multi-tone Signal Studio Software for the E4438C ESG Vector Signal Generator - Option 408,* literature number 5988-5639EN
- *GPS Personality for the E4438C ESG Vector Signal Generator - Option 409* literature number 5988-6256EN
- *802.11a WLAN Signal Studio Software for the E4438C ESG Vector Signal Generator - Option 410*, literature number 5988-5765EN

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