Agilent
E4438C ESG Vector Signal Generator

Data Sheet

Notice

Please contact Agilent Technologies
for the latest information
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Agilent Technologies

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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. Flexible options provide test solutions that will evaluate the performance 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 *E4438C Configuration Guide* for complete ordering information. Literature number 5988-4085EN.

Definitions

Specifications (spec): Specifications describe the instrument's warranted performance and apply after a 45 minute warm-up. All specifications are valid over the signal generators 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.

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

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

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

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
- 1-year standard 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

- Internal baseband generator, 8 or 64 MSa (40 or 320 MB) memory with digital bus capability
- ESG digital input or output connectivity with N5102A Baseband Studio digital signal interface module
- 6 GB internal hard drive
- Internal bit error rate (BER) analyzer
- High-stability time-base
- Enhanced phase noise performance
- High output power with mechanical attenuator
- Move all front panel connectors to the rear panel
- 3GPP W-CDMA FDD personality
- cdma2000 and IS-95-A personality
- TDMA personality (GSM, EDGE, GPRS, EGPRS, NADC, PDC, PHS, DECT, TETRA)
- Calibrated noise (AWGN) personality
- GPS personality
- Signal Studio for 1xEV-DO
- Signal Studio for 1xEV-DV and cdma2000
- Signal Studio for 802.11 WLAN
- Signal Studio for *Bluetooth*™
- Signal Studio for enhanced multitone
- Signal Studio for HSDPA over W-CDMA
- Signal Studio for TD-SCDMA
- Signal Studio for noise power ratio (NPR)
- Signal Studio for S-DMB
- Signal Studio for pulse building
- Signal Studio for jitter injection
- Signal Studio toolkit
- Signal Studio for 802.16-2004 (WiMAX)
- Signal Studio for DVB

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 for Frequency and Power Characteristics

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[3]

	Option 501-504		*With Option UNJ*		*Option 506*	
	Freq.[4]	Freq./Amp.[5]	Freq.[4]	Freq./Amp.[5]	Freq.[4]	Freq./Amp.[5]
Digital modulation						
on	(< 35 ms)	(< 49 ms)	(< 35 ms)	(< 52 ms)	(< 41 ms)	(< 57 ms)
off	(< 9 ms)	(< 9 ms)	(< 9 ms	(< 9 ms)	(< 16 ms	(< 17 ms)
[For hops < 5 MHz within a band]						
Digital modulation						
on	(< 9 ms)	(< 9 ms)	(< 9 ms)	(< 9 ms)	(< 33 ms)	(< 53 ms)
off	(< 9 ms)	(< 9 ms)	(< 9 ms)	(< 9 ms)	(< 12 ms)	(< 14 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 65,535

Internal reference oscillator

Stability[3]

	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 ±.2 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 E4428C.
2. Performance below 250 kHz not guaranteed.
3. Parentheses denote typical performance.
4. To within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below 250 MHz.
5. Frequency switching time with the amplitude settled within ±0.1 dB.

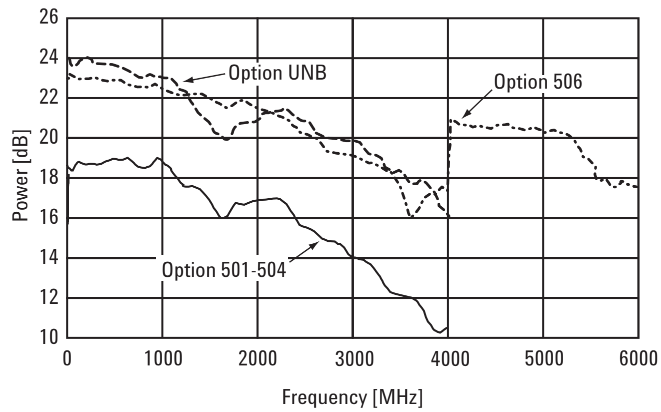
Specifications for Frequency and Power Characteristics

Output power

Power

	Option 501-504	*With Option UNB*	*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

	Option 501-504	*With Option UNB*	*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]

Option 501-504 [1,2]

	Power level			
	+7 to –50 dBm	–50 to –110 dBm	–110 to –127 dBm	< –127 dBm
250 kHz to 2.0 GHz	±0.5	±0.5	±0.7	(±1.5)
2.0 to 3 GHz	±0.6	±0.6	±0.8	(±2.5)
3 to 4 GHz	±0.7	±0.7	±0.9	(±2.5)

With Option UNB [2,3]

	Power level			
	+10 to –50 dBm	–50 to –110 dBm	–110 to –127 dBm	< –127 dBm
250 kHz to 2.0 GHz	±0.5	±0.7	±0.8	(±1.5)
2.0 to 3 GHz	±0.6	±0.8	±1.0	(±2.5)
3 to 4 GHz	±0.8	±0.9	±1.3	(±2.5)

Option 506 [2,4]

	Power level			
	+7 to –50 dBm	–50 to –110 dBm	–110 to –127 dBm	< –127 dBm
250 kHz to 2.0 GHz	±0.6	±0.8	±0.8	(±1.5)
2.0 to 3 GHz	±0.6	±0.8	±1.0	(±2.5)
3 to 4 GHz	±0.8	±0.9	±1.5	(±2.5)
4 to 6 GHz	±0.8	±0.9	(±1.5)	

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 0.03 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 for Frequency and Power Characteristics

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

π/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

Option 501-504	*Option 506*
±0.15 dB	±0.25 dB

Constant amplitude formats [FSK, GMSK, etc]

Option 501-504	*Option 506*
±0.1 dB	±0.15 dB

Level accuracy with ALC off[1, 2] (±0.15 dB) [relative to ALC on]

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

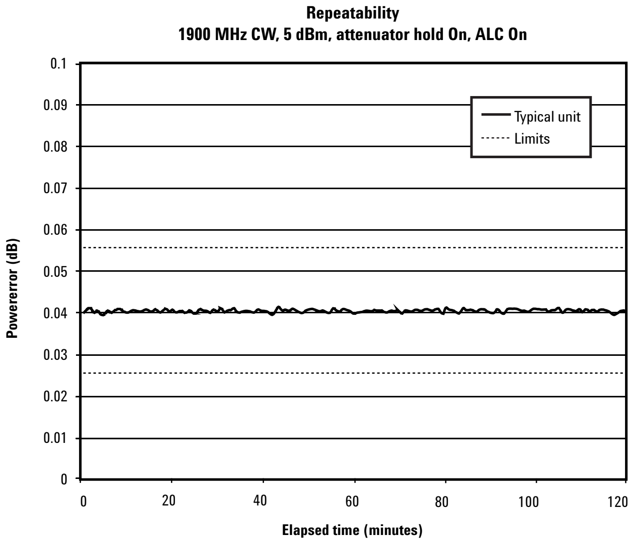
Level switching speed[1]

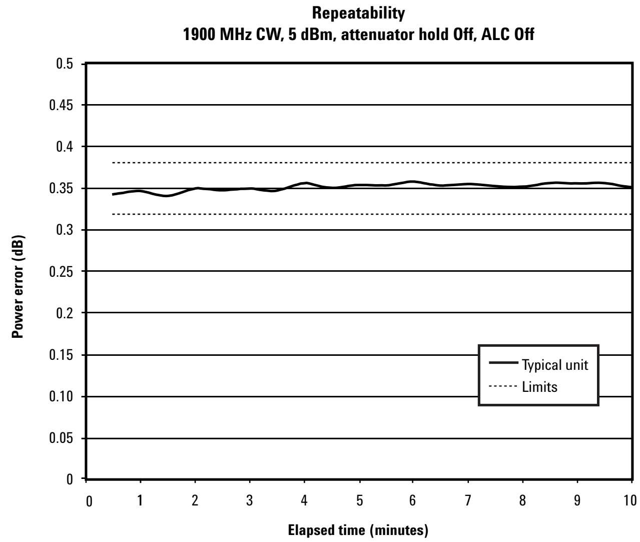
	Option 501-504	*With Option UNB*	*Option 506*
Normal operation [ALC on]	(< 15 ms)	(< 21 ms)	(< 21 ms)
When using power search manual	(< 83 ms)	(< 95 ms)	(< 95 ms)
When using power search auto	(< 103 ms)	(< 119 ms)	(< 119 ms)

1. Parentheses denote typical performance.
2. When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level.

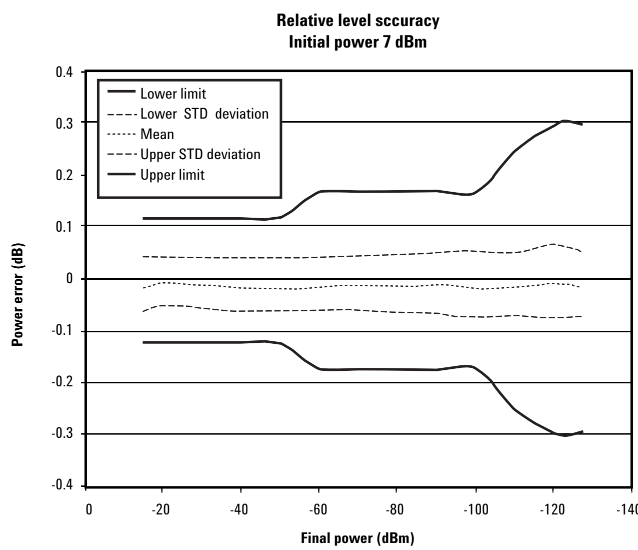
Specifications for Frequency and Power Characteristics

Repeatability and linearity





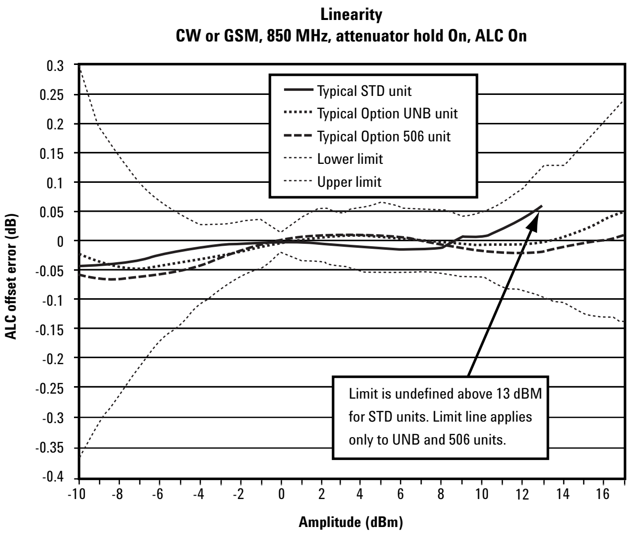
Repeatability measures the ability of the instrument to return to a given power setting after a random excursion to any other frequency and power setting. It is a relative measurement that reflects the difference in dB between the maximum and minimum power readings for a given setting over a specific time interval. It should not be confused with absolute power accuracy, which is measured in dBm.[1]



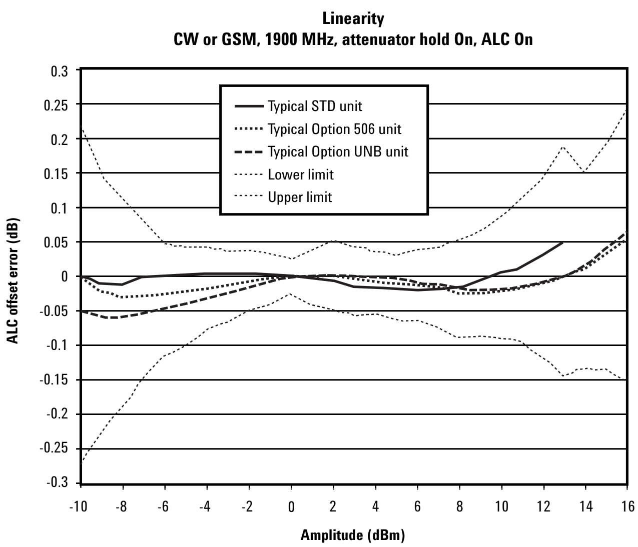
Relative level accuracy measures the accuracy of a step change from any power level to any other power level. This is useful for large changes (i.e. 5 dB steps).[1]

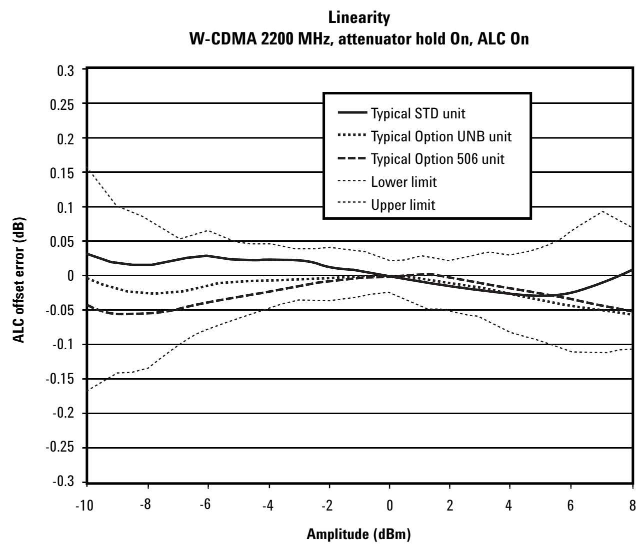
1. Repeatability and relative level accuracy are typical for all frequency ranges.

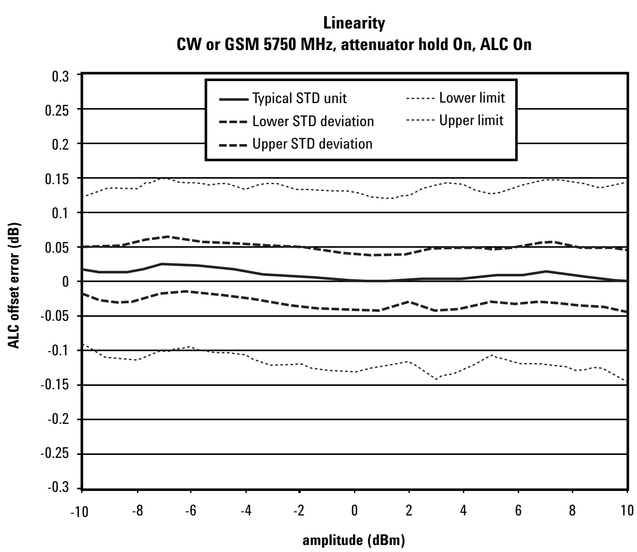
Specifications for Frequency and Power Characteristics

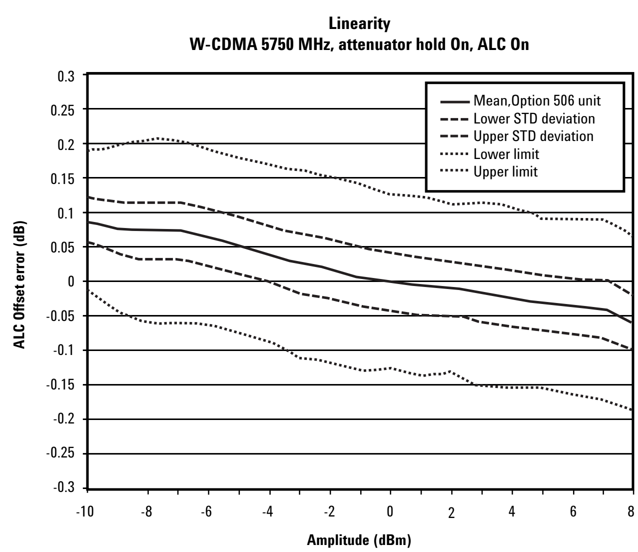


Linearity measures the accuracy of small changes while the attenuator is held in a steady state (to avoid power glitches). This is useful for fine resolution changes.[1]









1. Repeatability and relative level accuracy are typical for all frequency ranges.

Specifications for Frequency and Power Characteristics

Spectral purity

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

	Standard	*With Option UNJ*
at 500 MHz	(< –124 dBc/Hz)	< –135 dBc/Hz, (< –138 dBc/Hz)
at 1 GHz	(< –118 dBc/Hz)	< –130 dBc/Hz, (< –134 dBc/Hz)
at 2 GHz	(< –112 dBc/Hz)	< –124 dBc/Hz, (< –128 dBc/Hz)
at 3 GHz	(< –106 dBc/Hz)	< –121 dBc/Hz, (< –125 dBc/Hz)
at 4 GHz	(< –106 dBc/Hz)	< –118 dBc/Hz, (< –122 dBc/Hz)
at 6 GHz	N/A	< –113 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, 3] [output level ≤ +4 dBm, ≤ +7.5 dBm Option UNB, ≤ +4.5 dBm Option 506]
< –30 dBc above 1 GHz, (< –30 dBc 1 GHz and below)

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

	Standard[5]		*With Option UNJ*[6]	
	> 3 kHz offset	> 10 kHz offset	> 3 kHz < 10 kHz offset	> 10kHz offset
250 kHz to 250 MHz	< –53 dBc (< –68 dBc)	(< –58 dBc)	< –65 dBc	(< –58 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

Jitter in µUI[1, 7, 8]

Carrier frequency	*SONET/SDH data rates*	*rms jitter bandwidth*	*Standard (µUI rms)*	*With option UNJ (µUI rms)*
155 MHz	155 MB/s	100 Hz to 1.5 MHz	(359)	(78)
622 MHz	622 MB/s	1 kHz to 5 MHz	(158)	(46)
2.488 GHz	2488 MB/s	5 kHz to 15 MHz	(384)	(74)

Jitter in seconds[1, 7, 8]

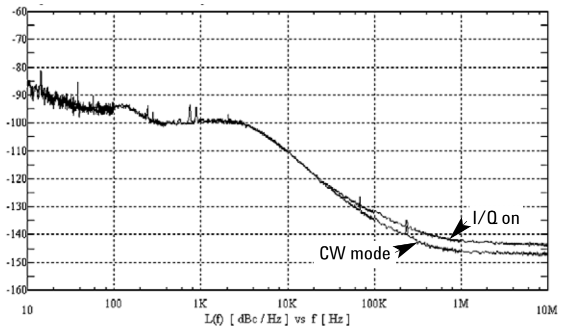
Carrier frequency	*SONET/SDH data rates*	*rms jitter bandwidth*	*Standard*	*With option UNJ*
155 MHz	155 MB/s	100 Hz to 1.5 MHz	(2.4 ps)	(0.6 ps)
622 MHz	622 MB/s	1 kHz to 5 MHz	(255 fs)	(74 fs)
2.488 GHz	2488 MB/s	5 kHz to 15 MHz	(155 fs)	(30 fs)

1. Parentheses denote typical performance.
2. Refer to frequency bands on page 12 for N values.
3. Harmonic performance outside the operating range of the instrument is typical.
4. Spurs outside the operating range of the instrument are not specified.
5. 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.
6. Specifications apply for CW mode only.
7. Calculated from phase noise performance in CW mode only at -2.5 dBm for standard instruments, -0.5 dBm with Option 506, and +2.5 dBm with Option UNB.
8. For other frequencies, data rates, or bandwidths, please contact your sales representative.

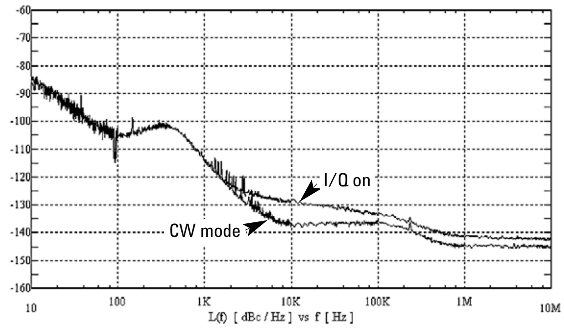
Specifications for Frequency and Power Characteristics

Characteristic SSB phase noise

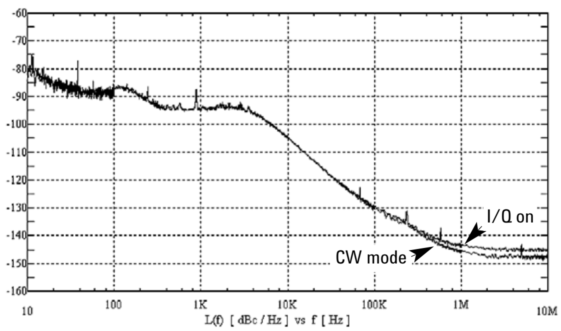
With Option 1E5 | *With Option UNJ*



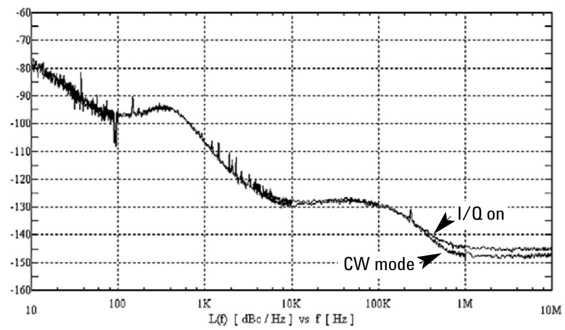
fc = 850 MHz



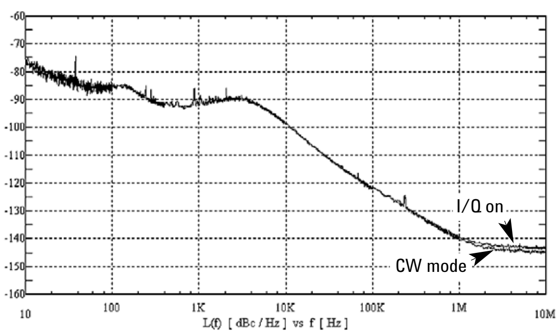
fc = 850 MHz



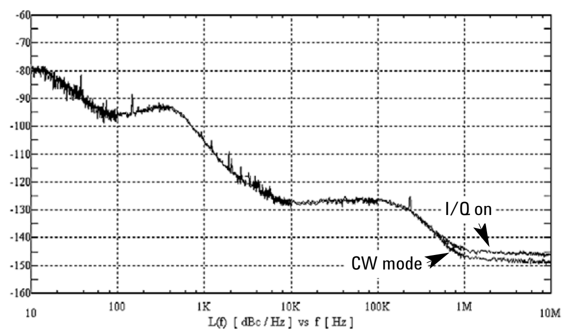
fc = 1900 MHz



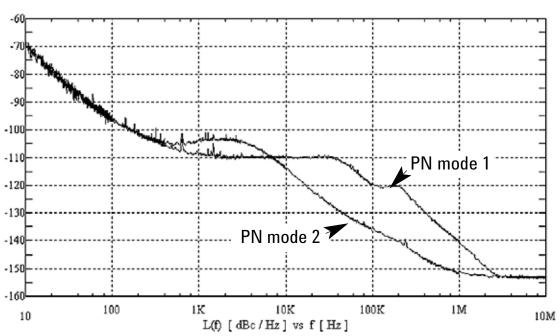
fc = 1900 MHz



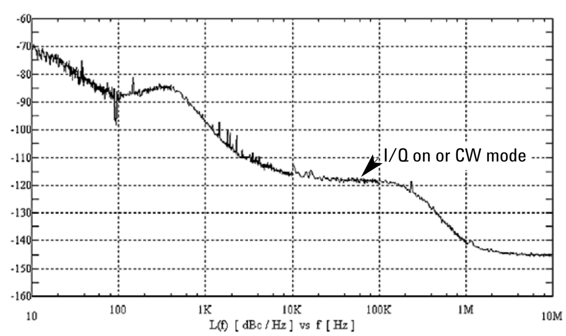
fc = 2200 MHz



fc = 2200 MHz



Phase noise modes 1 and 2 at fc = 900 MHz



fc = 5.7 GHz [Option 506]

Specifications for 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[1,2]

Maximum deviation[3]

Standard	*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[4] [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[3] [1 kHz rate, deviation < N x 100 kHz]

< ± 3.5% of FM deviation + 20 Hz

Carrier frequency accuracy relative to CW in DCFM[3, 5]

±0.1% of set deviation + (N x 1 Hz)

Distortion[3] [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.

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

Specifications for Analog Modulations

Phase modulation[1, 2]

Resolution 0.1% of set deviation

Modulation frequency response[3, 4]

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[3] [1 kHz rate, deviation < 80 radians on standard model, < 10 N 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, 6]

[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]

	Option 501-504/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.

1. All analog performance above 4 GHz is typical.
2. For non-Option UNJ units, specifications apply in phase noise mode 2 [default].
3. Refer to frequency bands on page 12 for N.
4. Parentheses denote typical performance.
5. Bandwidth is automatically selected based on deviation.
6. AM is typical above 3 GHz or if wideband AM or I/Q modulation is simultaneously enabled.
7. Peak envelope power of AM must be 3 dB less than maximum output power below 250 MHz.

Specifications for Analog Modulation

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]	
≤ 4 GHz	> 80 dB
> 4 GHz	(> 64 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

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 for Analog Modulation

Internal modulation source

Provides modulating signal for FM, AM, pulse and phase modulation signals, and provides LF output source for basic function generator capability.

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].

Specifications for Analog Modulation

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		
	≤ 4 GHz	> 75 dB
	> 4 GHz	(> 64 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	

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.

1. Parentheses denote typical performance.

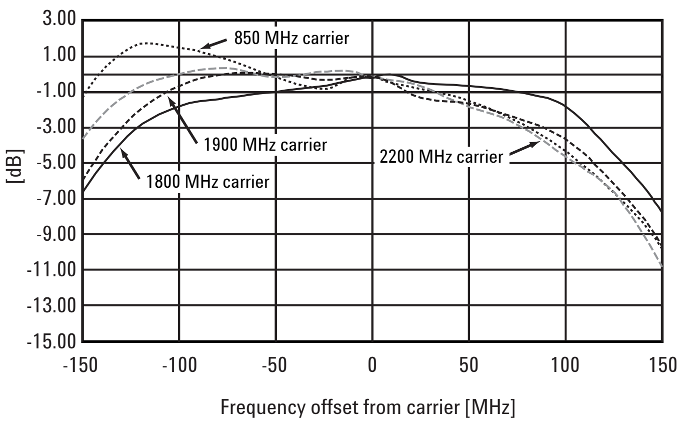
Specifications for I/Q Characteristics

I/Q modulation bandwidth

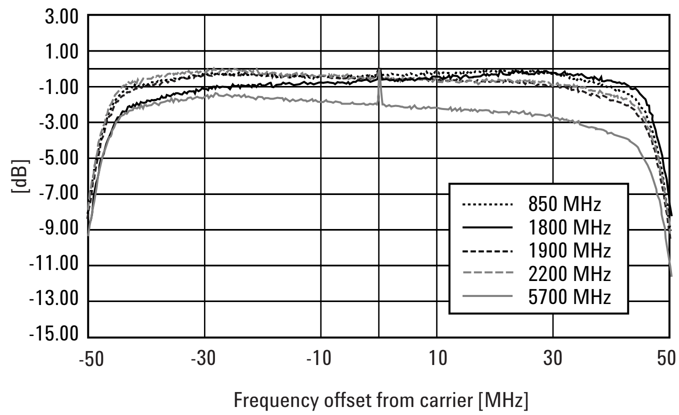
I/Q inputs

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

I/Q bandwidth using external I/Q source (ALC off)[2]



I/Q bandwidth using internal I/Q source (Options 001, 002, 601, 602)



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. Parentheses denote typical performance.

Specifications for I/Q Characteristics

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, through
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, through

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

Baseband generator

[arbitrary waveform mode]
[Option 601 or 602]

Channels	2 [I and Q]
Resolution	16 bits [1/65,536]
Arbitrary waveform memory	
Maximum playback capacity	8 megasamples (MSa)/channel [Option 601]
	64 MSa/channel [Option 602]
Maximum storage capacity	1.2 GSa [Option 005]
	2.8 MSa [Standard]
Waveform segments	
Segment length	60 samples to 8 or 64 MSa
Maximum number of segments	1,024 [8 MSa volatile memory]
	8,192 [64 MSa volatile memory]
Minimum memory allocation	256 samples or 1 KB blocks
Waveform sequences	
Maximum total number of segment files stored in the non-volatile file system	16,384
Sequencing	Continuously repeating
Maximum number of sequences	16,384 [shared with number of segments]
Maximum segments/sequence	32,768 [including nested segments]
Maximum segment repetitions	65,536

1. Parentheses denote typical performance.

Specifications for I/Q Characteristics

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
Multicarrier	
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, 128, 256
FSK	Selectable: 2, 4, 8, 16
MSK	
Data	Random ONLY
Multitone	
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

1. Parentheses denote typical performance.

Specifications for I/Q Characteristics

Baseband generator
[real-time mode]
[Option 601 or 602]

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, 128, 256
FSK	Selectable: 2, 4, 8, 16 level symmetric, C4FM 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, Apco 25 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 $\frac{\text{50 Mbits/sec}}{\text{\#bits/symbol}}$

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

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

Specifications for I/Q Characteristics

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 601	8 Mbits
	Option 602	64 Mbits [each bit uses an entire sample space]
Use	Non-standard framing	
User file		
Max size	Option 601	800 kB
	Option 602	6.4 MB
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

Specifications for Signal Personality Characteristics

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

Error vector magnitude[1]
[1.8 GHz < f_c < 2.2 GHz, root Nyquist filters, 40 MHz baseband filter, EVM optimization mode 3.84 Mcps chip rate, ≤ 4 dBm, ≤ 7 dBm with Option UNB]

1 DPCH	≤ 1.8%, (0.9%)

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, ≤ –2 dBm Option 506, ≤ –3 dBm standard in Optimize ADJ mode]

1 DPCH	–65 dBc (–67 dBc)
Test Model 1 + 64 DPCH	–63 dBc (–66 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	–71 dBc (–75 dBc)
Test Model 1 + 64 DPCH	–70 dBc (–73 dBc)

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

Specifications for Signal Personality Characteristics

IS-95 CDMA

[arbitrary waveform mode[1]]
[Option 401]

Spurious emissions
[dBc, IS-95 modified filter with equalizer and amplitude = ≤ -5 dBm standard, ≤ -3 dBm for Option 506, ≤ 0 dBm for Option UNB] [2]

	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)	(–77)	(–77)
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)	(–76)	(–76)
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

[arbitrary waveform mode]
[Option 401]

Spurious emissions
[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)	(–69)
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)	(–75)
700 – 1000 MHz	(–80)	(–83)	(–85)
>1000 – 2000 MHz	(–80)	(–83)	(–85)
Reverse 5 channel, SR3/DS[1, 3]			
30 – 200 MHz	(–78)	(–78)	(–75)
700 – 1000 MHz	(–82)	(–83)	(–85)
>1000 – 2000 MHz	(–82)	(–83)	(–85)

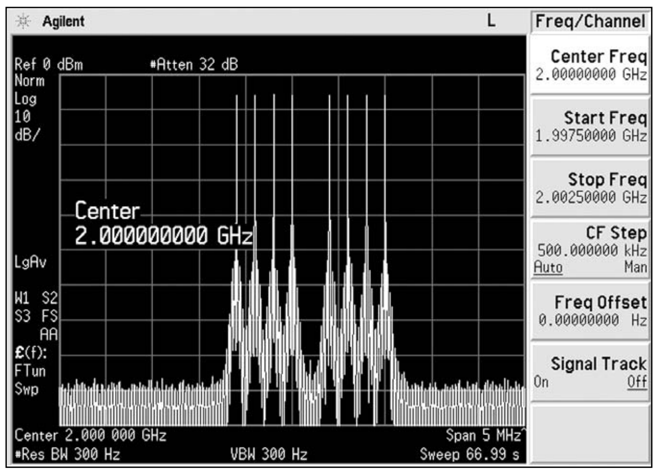
Error vector magnitude
[≤ 4 dBm standard and Option 506, ≤ 7 dBm for Option UNB]
[825 to 2100 MHz, SR3 pilot, IS-95 filter, which is optimized for EVM][1]
EVM ≤ 2.1%, (≤ 1.5%)

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

Specifications for Signal Personality Characteristics

Enhanced multitone[1]
[arbitrary waveform mode]
[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

AWGN
[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 error ≤ 0.2 dB at baseband I/Q outputs.

1. All values typical.

Specifications for Signal Personality Characteristics

802.11 WLAN

[arbitrary waveform mode]
[Option 417][1]

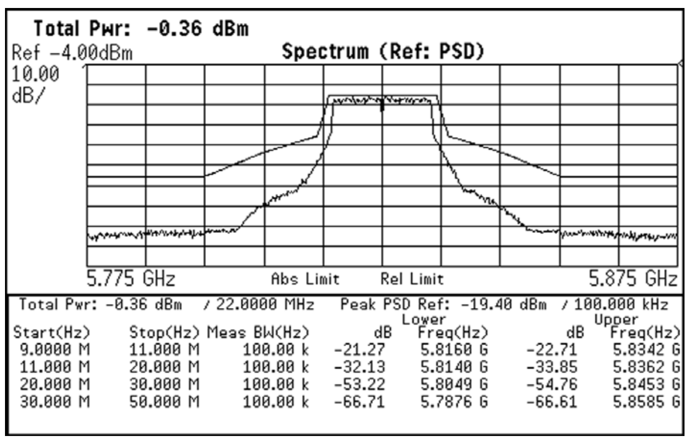
EVM	(< 1%, –40 dB)

The EVM was measured with an 89641A vector signal analyzer with Option B7R.

Instrument and software settings listed below.

Software settings		**Source settings**	
Data rate	54 Mbps	Frequency	5.8/2.4/0.9 GHz
Modulation	64 QAM	Output power	≤ –1 dBm
Encoder	3/4 rate	Reconstruction filter	thru
Scrambler	active	ALC	On
interleaver	active	RF blanking	Off
Scrambler initialization	5D	Modulator Atten	8 to 10 dB
Support carrier setup	All channels active		
Idle interval	100 µS	**89641A settings**	
OSR	≥ 2	Frequency	5.8/2.4/0.9 GHz
Window length	≥ 8	Span	20 MHz
Data type	PN15	Range	optimal
Data length	1024	RMS video average	20

802.11a spectral mask typical performance
(0 dbm, at 5.805 GHz, OSR: 4, window length: 16)



1. All values typical.

Specifications for Signal Personality Characteristics

Custom modulation

[real-time mode]

Custom digitally modulated signals [real-time mode][1, 2]

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[3, 4] [% rms]			**Shift error[3, 4]** [% rms]	**Global phase error[3, 4]** [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)	1.5 (0.9)	1.8 (1.0)	0.7 (0.4)
fc = 4 GHz	2.5 (1.4)	2.5 (1.3)	3.3 (1.9)	3.3 (2.0)	1.0 (0.6)
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][2]

	NADC		PDC		PHS		TETRA[4]		DECT	GSM DCS, PCS		EDGE
Error vector magnitude[6, 4] [% rms]												
Low EVM mode	1.2 (0.7)		1.2 (0.7)		0.9 (0.5)		0.8 (0.5)					1.2 (0.6)
Low ACP mode	(1.2)		(0.9)		(0.6)		(1.0)					
Global phase error[2]												
rms	N/A		N/A		N/A		N/A		N/A	0.6 (0.3)		N/A
pk										1.9 (1.0)		
Deviation accuracy[2] [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[2] [ACP]	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst	N/A	Cont.	Burst	N/A
(Low ACP mode, dBc)												
at adjacent channel [7]	(–35)	(–34)	–	–	–	–	(–70)	(–63)		(–37)	(–37)	
at 1st alternate channel [7]	(–80)	(–79)	(–74)	(–74)	(–81)	(–76)	(–81)	(–80)		(–71)	(–70)	
at 2nd alternate channel [7]	(–84)	(–83)	–	–	(–82)	(–79)	(–82)	(–82)		(–84)	(–81)	
at 3rd alternate channel[7]	(–85)	(–84)	(–82)	(–82)	–	–	(–83)	(–83)		(–85)	(–81)	
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					

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. Parentheses denote typical performance.
3. 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.
4. Valid after executing I/Q calibration and maintained within +/- 5 °C of the calibration temperature.
5. ACP for TETRA is measured over a 25 kHz bandwidth, 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].
6. 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].
7. 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.

Specifications for Signal Personality Characteristics

GSM/GPRS
[real-time mode]
[Option 402]

Multiframe output data generation	
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].

Multiframe 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

1. Measurements also require Option 300.

Specifications for Signal Personality Characteristics

EDGE/EGPRS
[real-time mode]
[Option 402]

Multiframe output data generation	
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.
Multiframe 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

1. Measurements also require Option 300.

Specifications for Signal Personality Characteristics

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 601 or 602, 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 for Signal Personality Characteristics

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 Hz use.[1]
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, non-volatile waveforms, sweep list files and waveform sequences. There is 14 MB of flash memory standard in the ESG. With Option 005, there is 6 GB of storage. Depending on available memory, a maximum of 1000 instrument states can be saved.
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[3]	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.

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[4]

	Standard	*Option UNB*	*Option 506*
250 kHz to 2.2 GHz	(< 1.5:1)	(< 1.5:1)	(< 1.6:1)
> 2.2 GHz to 3 GHz	(< 1.4:1)	(< 1.5:1)	(< 1.4:1)
> 3 GHz to 4 GHz	(< 1.5:1)	(< 1.7:1)	(< 1.7:1)
> 4 GHz to 6 GHz	N/A	N/A	(< 1.8:1)

Output impedance	50 Ω nominal

1. For 400 Hz systems, order transformer 70001-60066.
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. ESG series does not implement 8657A/B "Standby" or "On" [R0 or R1, respectively] mnemonics.
4. Parentheses denote typical performance.

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 601 or 602. 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[2]	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.

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.
2. Coherent carrier is modulated by FM or ΦM when enabled.

General Characteristics

	[SMA, rear panel]
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 601 or 602. 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 601 or 602. 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

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

	connector, rear panel]
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 annunciator 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 annunciator 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. • (0.7 V_{peak}), for peaks for $\pi/4$ DQPSK. • (1.6 V_{p-p}) maximum [Options 601, 602, 001, 002 only]. These female BNC connectors are provided on signal generators with Option 601 or 602. On signal generators with Option 1EM, these inputs are relocated to rear panel SMB connectors.

1. Parentheses denote typical performance.

General Characteristics

$\overline{I}$ and $\overline{Q}$ out

$\overline{I}$ and $\overline{Q}$ 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 601 or 602. 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 601 or 602. 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*.

Data transfer speeds[2]

LAN [FTP]	file transfer to volatile memory	(700 KB/sec)
	to hard drive	(500 KB/sec)
LAN [SCPI]	command transfer to volatile memory	(146 KB/sec)
	to hard drive	(128 KB/sec)
Internal file transfer from hard drive to volatile memory		(1280 KB/sec)

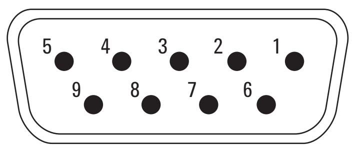
Agilent's IO Libraries Suite ships with the E4438C to help you quickly establish an error-free connection between your PC and instruments – regardless of the vendor. It provides robust instrument control and works with the software development environment you choose.

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.
2. Parentheses denote typical performance.

General Characteristics

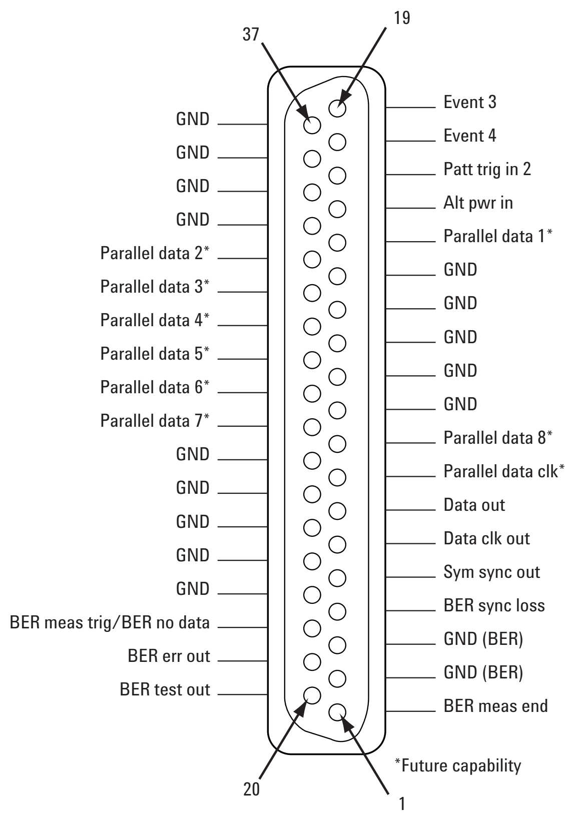
RS-232 connector
This male DB-9 connector is an RS-232 serial port that can be used for controlling the signal generator remotely. It is functionally equivalent to the GPIB connector. The following table shows the description of the pinouts. The pin configuration is shown below.

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

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[1]

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]

Performance enhancement 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
- 003[2] ESG digital output connectivity with N5102A Baseband Studio digital interface module
- 004[2] ESG digital input connectivity with N5102A Baseband Studio digital interface module
- 601 Internal baseband generator with 8 MSa and digital bus capability [40 MB] of memory
- 602 Internal baseband generator with 64 MSa and digital bus capability [320 MB] of memory
- 005[3] 6 GB internal hard drive
- UN7 Internal bit-error-rate analyzer
- 300 GSM/EDGE base station loopback BERT

Signal creation software[3]

- 3GPP W-CDMA FDD personality
- cdma2000 and IS-95-A personality
- TDMA personality (GSM, EDGE, GPRS, EGPRS, NADC, PDC, PHS, DECT, TETRA)
- Calibrated noise (AWGN) personality
- GPS personality
- Signal Studio for 1xEV-DO
- Signal Studio for 1xEV-DV and cdma2000
- Signal Studio for 802.11 WLAN
- Signal Studio for Bluetooth™
- Signal Studio for enhanced multitone
- Signal Studio for HSDPA over W-CDMA
- Signal Studio for TD-SCDMA
- Signal Studio for noise power ratio (NPR)
- Signal Studio for S-DMB
- Signal Studio for pulse building
- Signal Studio for jitter injection
- Signal Studio toolkit
- Signal Studio for 802.16-2004 (WiMAX)
- Signal Studio for DVB

Baseband Studio products[4]

- N5102A Baseband Studio digital signal interface module
- N5110B Baseband Studio for waveform capture and playback[5]
- N5115A Baseband Studio for fading[5]
- N5101A Baseband Studio PCI card[5]

System accessories

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

1. All options should be ordered using E4438C-xxx, where the xxx represents the option number. For more information, please refer to the configuration guide publication number 5988-4085EN.
2. Requires either Option 601 or 602 (baseband generator) to function.
3. Requuires Option 001, 002, 601, or 602.
4. For details visit **www.agilent.com/find/basebandstudio**.
5. Baseband Studio for waveform capture and playback and for fading both require a PC equipped with the Agilent N5101A Baseband Studio PCI card. The PCI card is not functional as a stand-alone product.

Related Literature

Application literature

- *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/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and Their Components,* 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 - Vector, Analog, and CW Models,* Selection Guide, literature number 5965-3094E.

Product literature

- *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.

E4438C ESG signal generation firmware personalities

- *3GPP W-CDMA (FDD) Personalities - Option 400*, Technical Overview, literature number 5988-4449EN
- *cdma2000 and IS-95A Personalities - Option 401*, Technical Overview, literature number 5988-4430EN
- G*PS Personality - Option 409*, Technical Overview, literature number 5988-6256EN
- *TDMA Personalities (GSM/EDGE/NADC/PDC/PHS/TETRA/DECT) - Option 402*, Technical Overview, literature number 5988-4431EN

E4438C ESG Signal Studio software personalities

- *Signal Studio for 1xEV-DO - Option 404*, Technical Overview, literature number 5988-5459EN
- *Signal Studio for 1xEV-DV and cdma2000 - Option 414*, Technical Overview, literature number 5988-9123EN
- *Signal Studio for 802.11 WLAN - Option 417*, Technical Overview, literature number 5988-8618EN
- *Signal Studio for Bluetooth - Option 406*, Technical Overview, literature number 5988-5458EN
- *Signal Studio for Enhanced Multitone - Option 408*, Technical Overview, literature number 5988-5639EN
- *Signal Studio for Noise Power Ratio - Option 421*, Technical Overview, literature number 5988-6552EN
- *Signal Studio for TD-SCDMA (TSM) - Option 411*, Technical Overview, literature number 5988-6552EN

See the ESG Web page for the latest information

Get the latest news, product and support information, application literature, firmware upgrades and more. Agilent's Internet address for the ESG is:

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