Agilent Technologies
ESG Family/RF Signal Generators

Technical Specifications

	Analog only		Digital and analog	
	ESG-A series	ESG-AP series (high spectral purity)	ESG-D series	ESG-DP series (high spectral purity)
250 kHz – 1 GHz	E4400B	E4423B	E4430B	E4434B
250 kHz – 2 GHz	E4420B	E4424B	E4431B	E4435B
250 kHz – 3 GHz	E4421B	E4425B	E4432B	E4436B
250 kHz – 4 GHz	E4422B	E4426B	E4433B	E4437B

Notice

This document is updated as often as once a month. Please contact Agilent Technologies for the latest information or check the ESG web site at **http://www.agilent.com/find/esg**

Agilent Technologies
Innovating the HP Way

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Introduction

Standard Agilent Technologies ESG family RF signal generators incorporate a broad array of capabilities for testing both analog and digital communications systems. Adding flexible options provides a test solution 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 ESG family an excellent choice for wireless communications system testing now and in the future.

ESG family of RF signal generators

The family consists of four series:

ESG-A series: analog instruments
E4400B, E4420B, E4421B, E4422B

ESG-AP series: analog instruments with high spectral purity
E4423B, E4424B, E4425B, E4426B

ESG-D series: digital and analog instruments
E4430B, E4431B, E4432B, E4433B

ESG-DP series: digital and analog instruments with high spectral purity
E4434B, E4435B, E4436B, E4437B

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

Key standard features for entire family

- Expandable architecture
- Broad frequency coverage
- Choice of electronic or mechanical attenuator
- Superior level accuracy
- Wideband FM and ΦM
- Step sweep (frequency, power and list)
- Built-in function generator
- Lightweight, rack-mountable
- 3-year warranty
- 2-year calibration cycle

Standard features only in the digital series

- Broadband analog I/Q inputs
- I/Q adjustment capabilities and internal calibration
- Excellent modulation accuracy and stability
- Coherent carrier output

Options available only with the digital series

- Built-in dual arbitrary waveform generator
- Multichannel, multicarrier CDMA personality
- Multichannel W-CDMA 1.0 personality
- Multichannel cdma2000 personality
- Real-time EDGE personality
- Internal bit-error-rate analyzer
- Versatile timeslot, data and burst generation
- Adjustable symbol rates, filter factors and burst shape
- Digital modulation formats for DECT, GSM, NADC, PDC, PHS, and TETRA

Options available only with the analog series

- High-performance pulse modulation

Specifications for analog and digital models

Frequency

Range

ESG-A series	
E4400B	250 kHz to 1 GHz
E4420B	250 kHz to 2 GHz
E4421B	250 kHz to 3 GHz
E4422B	250 kHz to 4 GHz
ESG-AP series	
E4423B	250 kHz to 1 GHz
E4424B	250 kHz to 2 GHz
E4425B	250 kHz to 3 GHz
E4426B	250 kHz to 4 GHz
ESG-D series	
E4430B	250 kHz to 1 GHz
E4431B	250 kHz to 2 GHz
E4432B	250 kHz to 3 GHz
E4433B	250 kHz to 4 GHz
ESG-DP series	
E4434B	250 kHz to 1 GHz
E4435B	250 kHz to 2 GHz
E4436B	250 kHz to 3 GHz
E4437B	250 kHz to 4 GHz

Underrange 100 kHz

Resolution 0.01 Hz

Accuracy **Same as timebase**

Switching speed (typical)[1]	**ESG-A and ESG-D series**	**ESG-AP and ESG-DP series**
Modulation on		
Analog	<50 ms	<65 ms
Digital	<90 ms	<100 ms
Modulation off	<40 ms	<55 ms

Phase offset Phase is adjustable via HP-IB or front panel in nominal 0.1° increments

Frequency bands

Band	**Frequency range**	**N #**
1	250 kHz to ≤249.999 MHz	1
2	>249.999 to ≤500 MHz	0.5
3	>500 MHz to ≤1 GHz	1
4	>1 to ≤2 GHz	2
5	>2 to ≤4 GHz	4

Sweep modes

Operating modes Frequency step, amplitude step and arbitrary list

Dwell time 1 ms to 60 s

Number of points 2 to 401

Internal reference oscillator

Stability

	ESG-A and ESG-D series standard	**ESG-AP and ESG-DP series standard HP ESG-A and ESG-D series Option 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, typical	<±0.05 ppm, typical
Line voltage	<±0.1 ppm, typical (+5%, –10%)	<±0.002 ppm, typical (+5%, –10%)

Timebase reference output

Frequency	10 MHz
Amplitude	>0.35 V_{rms} into 50 Ω load

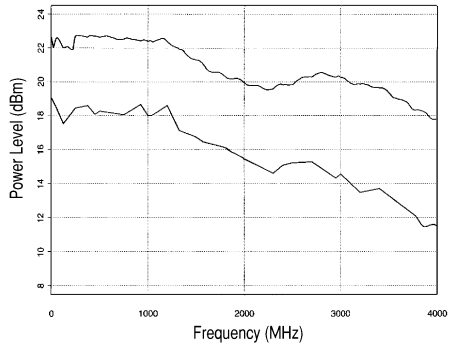
External reference input

Frequency	1, 2, 5, 10 MHz ± typical 10 ppm (typical 1 ppm, HP ESG-AP and ESG-DP series, HP ESG-A and ESG-D series Option 1E5)
Amplitude	>0.15 Vrms
Input impedance	50 Ω

Output

Power[2]

	Standard	**Option UNB**
250 kHz to 1 GHz	+13 to –136 dBm	+17 to –136 dBm
>1 to 3 GHz	+10 to –136 dBm	+16 to –136 dBm
>3 to 4 GHz	+7 to –136 dBm	+13 to –136 dBm



Typical maximum available power

1. To within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below 250 MHz.
2. With high performance pulse modulation (Option 1E6) installed, all maximum power specifications drop by 4 dB.

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 while in phase noise mode 2, unless otherwise noted. Supplemental characteristics, denoted typical or nominal, provide additional (nonwarranted) information useful in applying the instrument.

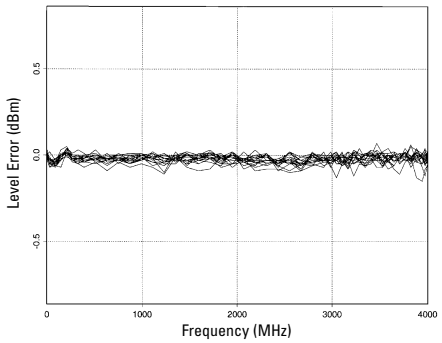
Resolution 0.02 dB

Attenuator hold level range

	Standard	Option UNB
250 kHz to 1 GHz	23 dB	27 dB
>1 to 3 GHz	20 dB	26 dB
>3 to 4 GHz	17 dB	23 dB

Level accuracy (dB)[1]

	Output power		
	+7 to –120 dBm		
Freq range	(+10 to –120 dBm, Option UNB)	–120 to –127 dBm	<–127 dBm
250 kHz to 2 GHz	±0.5	±0.5	±1.5
2 to 3 GHz	±0.9	±0.9	±2.5
3 to 4 GHz	±0.9	±0.9 (±1.5, Option UNB)	±2.5



Typical level accuracy

Amplitude switching speed <30 ms, typical
When using power search <300 ms, typical

Reverse power protection[2]

250 kHz to 2 GHz	50 watts
>2000 to 4 GHz	25 watts
Max DC voltage	50 V

SWR (typical)

	Standard	Option UNB
250 kHz to 2 GHz	<1.4:1	<1.25:1
>2 to 4 GHz	<1.9:1	<1.35:1

Output impedance 50 Ω

Spectral purity

SSB phase noise[3] (at 20 kHz offset)

	ESG-A and ESG-D Series	ESG-AP and ESG-DP Series
at 500 MHz	(<–120 dBc/Hz)	<–134 dBc/Hz, (<–138 dBc/Hz)
at 1 GHz	(<–116 dBc/Hz)	<–130 dBc/Hz, (<–134 dBc/Hz)
at 2 GHz	(<–110 dBc/Hz)	<–123 dBc/Hz, (<–127 dBc/Hz)
at 3 GHz	(<–104 dBc/Hz)	<–120 dBc/Hz, (<–124 dBc/Hz)
at 4 GHz	(<–104 dBc/Hz)	<–118 dBc/Hz, (<–122 dBc/Hz)

Residual FM[4] (CW mode, 0.3 to 3 kHz BW, CCITT, rms)

ESG-AP and ESG-DP series
<N x 1 Hz (<N x 0.5 Hz, typical)

ESG-A and ESG-D series

Phase noise mode 1	<N x 2 Hz
Phase noise mode 2	<N x 4 Hz

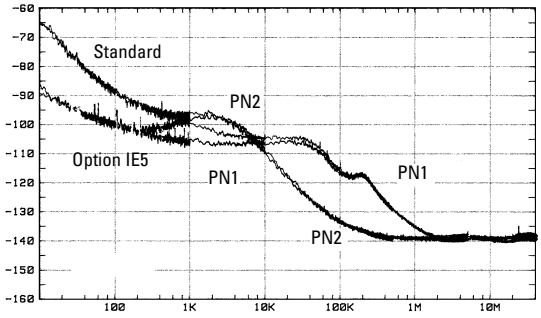
Harmonics
(≤+4 dBm (≤+7.5 dBm, Option UNB) output level) <–30 dBc

Nonharmonics
(<+7 dBm (<+10 dBm, Option UNB) output level)[5]

	ESG-A and ESG-D series[6]		ESG-AP and ESG-DP series[7]	
	>3 kHz offset	>10 kHz offset[3]	>3 kHz offset	>10 kHz offset[3]
250 kHz to 250 MHz	<–65 dBc	(<–75 dBc)	<–65 dBc	(<–75 dBc)
250 MHz to 500 MHz	<–65 dBc	(<–75 dBc)	<–80 dBc	<–80 dBc
500 MHz to 1 GHz	<–65 dBc	(<–75 dBc)	<–80 dBc	<–80 dBc
1 to 2 GHz	<–59 dBc	(<–69 dBc)	<–74 dBc	<–74 dBc
>2 GHz	<–53 dBc	(<–63 dBc)	<–68 dBc	<–68 dBc

Subharmonics

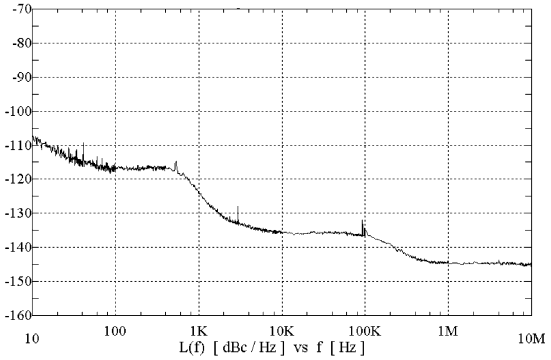
	ESG-A and ESG-D series	ESG-AP and ESG-DP series
≤1 GHz	None	None
>1 GHz	<–40 dBc	None



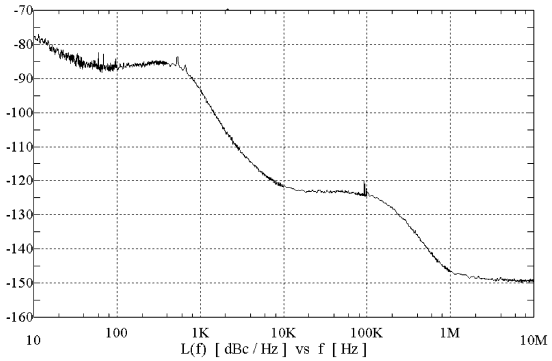
Characteristic ESG-A and ESG-D series SSB phase noise at 1 GHz (phase noise modes 1 and 2)

1. For 23° ±5° C. Accuracy degrades by 0.02 dB/° C over the full temperature range and by 0.3 dB above +7 dBm (degraded by 0.5 dB above +10 dBm with Option UNB). Level accuracy specification maintained only with return to calibration.
2. The reverse power protection circuitry triggers at nominally 1 watt.
3. Parentheses denote typical performance.
4. Refer to frequency bands on page 4 to compute specifications.
5. Performance is typical for spurs at frequencies above the maximum operating frequency of the instrument. Performance typically is –60 dBc between 225 and 249.999 MHz.
6. Specifications apply for FM deviations <100 kHz and are not valid for FM.
   For non-constant amplitude digital formats, unspecified spur levels occur up to the second harmonic of the baseband rates.
7. Specifications apply for CW mode only.

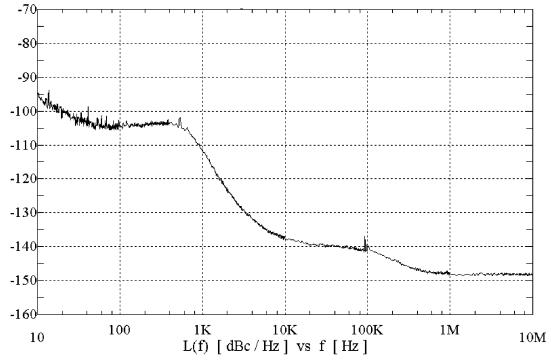
Characteristic SSB phase noise for ESG-AP and ESG-DP series



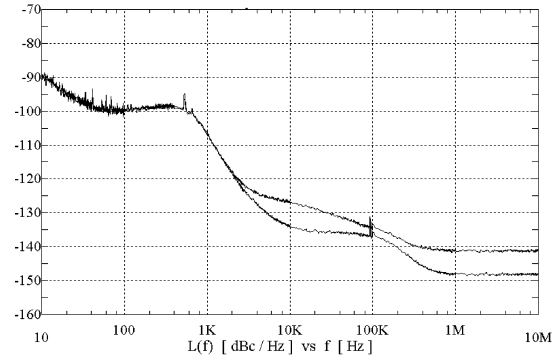
f_c = 100 MHz (CW, standard instrument)



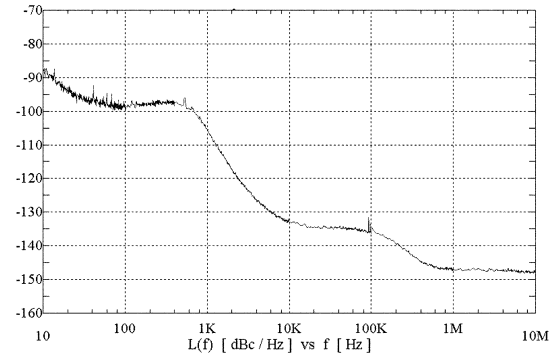
f_c = 4 GHz (CW, standard instrument)



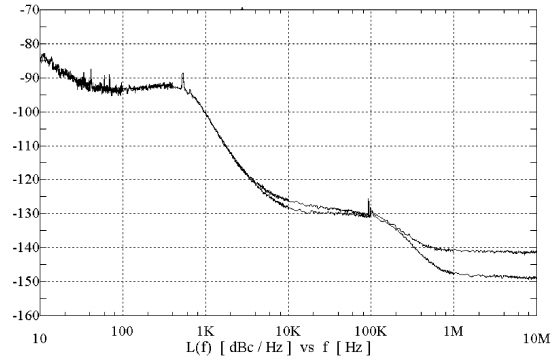
f_c = 500 MHz (CW, standard instrument)



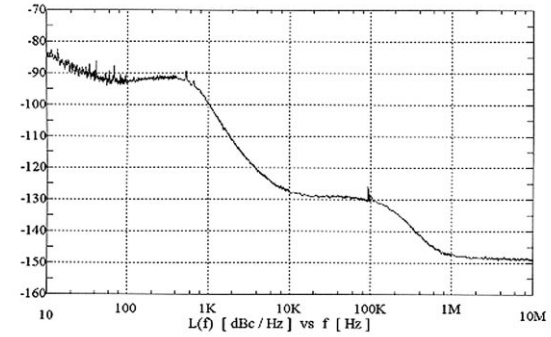
f_c = 900 MHz (CW and I/Q modulation on)



f_c = 1 GHz (CW, standard instrument)



f_c = 1.8 GHz (CW and I/Q modulation on)



f_c = 2 GHz (CW, standard instrument)

Frequency modulation

Maximum deviation

ESG-A and ESG-D series	ESG-AP and ESG-DP series
N x 10 MHz	N x 1 MHz

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

Modulation frequency response (deviation = 100 kHz)[1]

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

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

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

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

External inputs Ext 1 or Ext 2

Sensitivity 1 V_{peak} for indicated deviation

Input impedance 50 Ω, nominal

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

Phase modulation

Maximum deviation[2]

	ESG-A and ESG-D series	ESG-AP and ESG-DP series
Normal BW	N x 90 radians	N x 10 radians
High BW	N x 90 radians	N x 1 radian

Resolution 0.1% of set deviation

Modulation frequency response[2]
ESG-A and ESG-D series

Mode	Maximum deviation	Rates (3 dB BW) ΦM1	ΦM2
Normal BW	N x 90 rad	dc to 100 kHz	dc to 100 kHz
High BW	N x 2π rad	dc to 1.5 MHz (typ)	dc to 0.9 MHz (typ)
	N x π/2 rad	dc to 4 MHz (typ)	dc to 1 MHz (typ)

ESG-AP and ESG-DP series

Mode	Maximum deviation	Rates (3 dB BW) ΦM1	ΦM2
Normal BW	N x 10 rad	dc to 100 kHz	dc to 100 kHz
High BW	N x 1 rad	dc to 1 MHz (typ)	dc to 1 MHz (typ)

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

Distortion[2] <1%
1 kHz rate, THD, dev <N x 90 rad (dev < N x 10 rad for HP ESG-AP
and ESG-DP series), Normal BW mode

External inputs Ext 1 or Ext 2

Sensitivity 1 V_{peak} for indicated deviation

Input impedance 50 Ω, nominal

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

1. Since the internal modulation source operates over 0.1 Hz to 50 kHz, FM rates above 50 kHz must be supplied externally.
2. Refer to frequency bands on page 4 to compute specifications.
3. At the calibrated deviation and carrier frequency, within 5° C of ambient temperature at time of calibration.

Amplitude modulation[1] (fc > 500 kHz)

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

Resolution 0.1%

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

Accuracy (1 kHz rate) < ±(6% of setting + 1%)

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

External inputs Ext 1 or Ext 2

Sensitivity 1 V_{peak} for indicated depth

Input impedance 50 Ω, nominal

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

Wideband AM (ESG-DP and ESG-D series only)

Rate (1 dB bandwidth, typical)
ALC On 400 Hz to 10 MHz
ALC Off dc to 10 MHz

External input I input

Sensitivity 0.5 V = 100%

Input impedance 50 Ω, nominal

Pulse modulation

On/off ratio
≤ 3 GHz >80 dB
>3 GHz >60 dB

Rise/fall times 150 ns, typical

Minimum width
ALC On 2 µs, typical
ALC Off 0.4 µs, typical

Pulse repetition frequency
ALC On 10 Hz to 250 kHz, typical
ALC Off dc to 1.0 MHz, typical

Level accuracy ± 0.5 dB, typical
(relative to CW)[2]

External input Ext 2

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

Input impedance 50 Ω, nominal

Internal pulse generator
Squarewave rate 0.1 Hz to 50 kHz
Pulse
Period 16 µs to 30 sec
Width 8 µs to 30 sec
Resolution 4 µs

High-performance pulse modulation (Option 1E6, ESG-AP and ESG-A series)[3]

On/off ratio
≤2 GHz >80 dB
>2GHz >70 dB

Rise/fall times <10 ns

Delay <60 ns, typical

External input Pulse in

Input voltage +5V (with RF on, TTL compatible)

Input impedance

1. AM is typical above 3 GHz or if wideband AM or I/Q modulation is simultaneously enabled.
2. With ALC off, specifications apply after the execution of power search. With ALC on, specifications apply for pulse repetitionrates ≤10 kHz and pulse widths ≥5µs.
3. With high performance pulse modulation (Option 1E6) installed, all maximum power specifications drop by 4 dB.

Internal modulation source

(provides FM, ΦM, and AM modulation signals and LF out)

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

Rate range

Sine	0.1 Hz to 50 kHz
Square, ramp, triangle	0.1 Hz to 10 kHz

Resolution	0.1 Hz
Pulse only	4 µs

Frequency accuracy	0.005%, typical

Swept sine mode (frequency, phase continuous)

Operating modes	Triggered or continuous sweeps
Frequency range	0.1 Hz to 50 kHz
Sweep time	1 ms to 65 sec
Resolution	1 ms

Dual sinewave mode

Frequency range	0.1 Hz to 50 kHz
Amplitude ratio	0 to 100%
Amplitude ratio resolution	0.1%

LF out (internal modulation source)

Amplitude	0 to 3 V_{peak} into 50Ω
Output impedance	<1Ω

External modulation inputs

Modulation types

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

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

Simultaneous modulation

All modulation types may be simultaneously enabled, except: FM with FM; AM with burst envelope; Wideband AM with I/Q. AM, FM, and FM can sum simultaneous inputs from any two sources (INT, EXT 1, and EXT 2.) Any given source (INT, EXT 1, or EXT 2) may only be routed to one activated modulation type.

Specifications for digital models only

Level accuracy with digital modulation (ESG-DP and ESG-D series only)

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

π/4 DQPSK or QPSK formats

ESG-D series	ESG-DP series
±0.15 dB	±0.20 dB

(Relative to CW; with raised cosine or root-raised cosine filter and $\alpha \geq 0.35$; with 10 kHz ≤ symbol rate ≤1 MHz; at RF freq ≥25 MHz; power ≤ max specified –3 dB or –6 dB with Option UNB)

Constant amplitude formats (FSK, GMSK, etc)

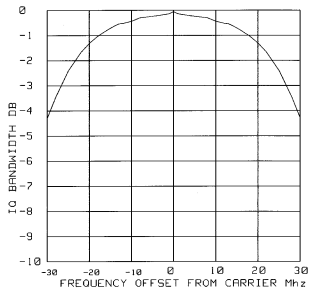
ESG-D series	ESG-DP series
No degradation	±0.10 dB

Level accuracy with ALC off[2] ±0.3 dB, typical
(After power search is executed; relative to CW level accuracy with
ALC on; with burst off; if external I/Q is enabled $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$)

I/Q modulation (ESG-DP and ESG-D series only)

I/Q inputs

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



Typical I/Q frequency response

Adjustments/Impairments (nominal)

DC offset (I and Q independently adjustable)	±100%
I/Q gain ratio	±4 dB
I/Q quadrature	±10° (for fc ≤ 3.3 GHz)

DC vector accuracy[3]
(Relative to full scale, power ≤ +7 dBm (≤+10 dBm, Option UNB))

Frequency (GHz)	<0.6	0.6 to 2	2 to 3.7	≤ 4
Static EVM[4] (rms)	<0.75%	<0.5%	0.75%	<1%
Mag. error[4] (rms)	<0.5%	< 0.35%	<0.5%	<0.75%
Phase error[4] (rms)	<0.35°	< 0.25°	<0.35°	<0.5°
Origin offset (dBc)	<–46	<–46	<–40	<–40

External burst envelope (ESG-DP and ESG-D series only)

Input voltage

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

On/off ratio

≤3 GHz	>75 dB
>3 GHz	>60 dB
V_{in}	≤–1.05 V

Rise/fall time <2 µs with rectangular input, typical

Minimum burst repetition frequency

ALC on	10 Hz, typical
ALC off	dc

External input Ext 1

Input impedance 50Ω, nominal

Coherent carrier out[5] (ESG-DP and ESG-D series only)

Range 250 MHz to maximum carrier frequency

Level 0 dBm ±5 dB, typical

Impedance 50Ω

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. Power Search is an internal calibration routine used to set output power when ALC is off. The routine disables all modulation inputs, adjusts output power while applying 0.5 V_{rms} to the I/Q modulathen enables modulation.
3. Valid for 10 days after executing internal calibration routine, provided temperature is maintained within ±5° C of calibration temperature.
4. Measured at full scale with origin offset removed.
5. Coherent Carrier is modulated by FM or ΦM when enabled.

I/Q baseband generator

(Option UN8, ESG-DP and ESG-D series only)

Modulation

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
Custom:	Custom map of up to 16 deviation levels
Deviation:	Modulation index ≤1, ≤1.5 Msym/sec Modulation index ≤0.5, ≤2.0 Msym/sec
Resolution:	0.1 Hz
I/Q:	Custom map of 16 unique values for I and Q

Filter

Selectable	Nyquist, root Nyquist, Gaussian, rectangular α: 0 to 1, B_bT: 0.1 to 1
Custom FIR	256 coefficients, 16-bit resolution, 16 symbols long, automatically scaled

Symbol rate

For external data or internal PN sequences in pattern mode, symbol rate is adjustable from 200 symbols/sec to maximum listed in table.

Bits/symbol	Maximum symbol rate (Msym/sec)	Maximum data rate (Mbits/sec)
1	12.5	12.5
2	12.5	25
3	8.33	25
4	12.5	50
5	10	50
6	8.33	50
7	7.14	50
8	6.25	50

For all other data types and data structures the maximum bit rate is 5 Mbits/sec.

TDMA data structure

Frames and timeslots may be configured as different types of traffic or control channels. The data field of a timeslot can accept a user file, PRBS (PN9 or PN15), or external data. Maximum bit rate is 5 Mbits/sec.

Reference frequency

Internal or external 1, 2, 5, 10 MHz reference
Data clock can be locked to an external 13 MHz (GSM) reference

Frame trigger delay control

Range	0 to 65,535 bits
Resolution	1 bit

Data types

Internally generated data	
Pseudo-random patterns	(meets ITU-T standard) Continuous PN9 (PRBS 2^9 –1) PN11 (PRBS 2^{11} –1), PN15[1] (PRBS 2^{15} –1), PN20 (PRBS 2^{20} –1), PN23 (PRBS 2^{23} –1).
Repeating sequence	Any 4-bit sequence
Downloadable data	
Maximum bit rate	5 Mbits/sec
Direct-pattern RAM (PRAM)	
Max size	1 Mbytes (standard) 8 Mbytes (Option UN9)
Use	Nonstandard framing
User file	
Max size	128 kbytes
Use	Continuous modulation or internally generated TDMA standard
Externally generated data	
Type	Serial data
Inputs	Data, bit/symbol clocks 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

I/Q outputs

(Baseband I/Q outputs can be scaled from 0 to 1 $V_{peak\text{-}to\ peak}$ into 50 Ω)[2]

Standard	Default scaling	Maximum V (rms)
NADC, PHS, PDC	100	0.25
TETRA	65	0.25
GSM, DECT	N/A	0.35

EVM (NADC, PDC, PHS, TETRA)[3]	1% rms
Global phase error (GSM)[3]	0.75° rms
Deviation accuracy (DECT)[3]	1 kHz rms

I/Q outputs

(Baseband I/Q outputs can be scaled from 0 to 1 $V_{peak\text{-}to\ peak}$ into 50Ω)[4]

Custom Format[5]	Default scaling	Maximum V(rms)
FSK, MSK	NA	0.35
QPSK, BPSK	70	0.32
8PSK, 16PSK, D8PSK	70	0.20
π/4DQPSK	70	0.25
QAM	70	>0.10

1. PN15 is not continuous in bursted mode when TETRA is operated in a downlink mode.
2. Baseband I/Q ouputs cannot be scaled for GSM and DECT.
3. Specifications apply for the frequency range, symbol rates, root Nyquist filter, filter factors, and default scaling factor specified for each standard.
4. Baseband I/Q outputs cannot be scaled for FSK and MSK.
5. Filter factor (a or BbT) is set to 0.5.

I/Q baseband generator
(continued)

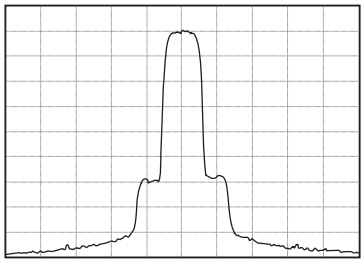
Digital communications standards

	NADC		PDC		PHS		TETRA		DECT	GSM (DCS, PCS)	
Error vector magnitude[1] (% rms)	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst	N/A	N/A	
Low EVM mode	0.7	1.4	0.9	1.3	0.9	0.9	0.8	1.7			
Low EVM mode (typical)	0.4	1.1	0.6	0.9	0.6	0.7	0.5	1.3			
Low ACP mode (typical)	1.0	1.4	0.8	1.0	0.9	0.9	0.9	1.5			
Global phase error[1] (rms/pk)	N/A		N/A		N/A		N/A		N/A	0.6°/2.2° 0.3°/1.3° (typ)	
Deviation accuracy[1] (kHz)	N/A		N/A		N/A		N/A		3 (2, typ)	N/A	
Channel spacing (kHz)	30		25		300		25		1,728	200	
Adjacent channel power[1] (ACP)	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst[2]	N/A	Cont.	Burst
(Low ACP Mode, dBc, typical)											
at adjacent channel[3]	–35	–34	–	–	–	–	–69[4]	–64		–37	–37
at 1st alternate channel[3]	–80	–78	–74	–72	–80	–78	–80	–78		–72	–71
at 2nd alternate channel[3]	–82	–81	–	–	–80	–79	–81	–80		–82	–80
at 3rd alternate channel[3]	–84	–83	–81	–79	–	–	–81	–80		–82	–81
Supported burst types	Custom, Up/Down TCH		Custom, Up/Down TCH, Up Vox		Custom, TCH, Sync		Custom, Up Control 1 & 2 Up Normal, Down Normal, Down Sync		Custom, Dummy B 1 & 2, Traffic B, Low Capacity	Custom, Normal, FCorr, Sync, Dummy, Access	
Scramble capabilities					Yes		Yes				

1. Specifications apply for the, symbol rates, root raised cosine filter, filter factors (a or BbT) and default scaling factor specified for each standard and at power levels ≤+7 dBm (≤+10 dBm, Option UNB).
2. ACP for TETRA is measured over a 25 kHz bandwidth, with an 18 kHz root raised cosine filter applied at power levels ≤+4 dBm (≤+8 dBm, Option UNB).
3. The "channel spacing" determines the offset size of the adjacent and alternate channels: Adjacent channel offset = 1 x channel spacing, 1st Alt. chan.= 2 x channel spacing, 2nd alt. channel = 3 x channel spacing, etc.
4. TETRA ACP performance is typically 72 dBc with Option H99 in continuous modulation mode.

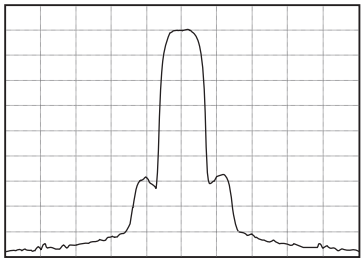
I/Q baseband generator
(continued)

Digital communication standards



NADC spectrum

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

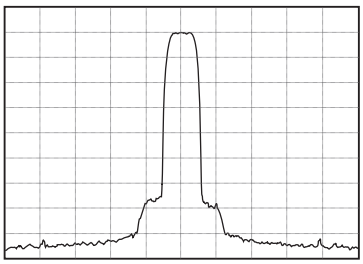


PDC spectrum

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

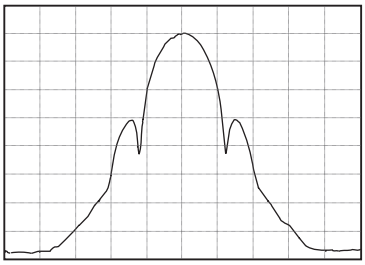
PHS spectrum

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



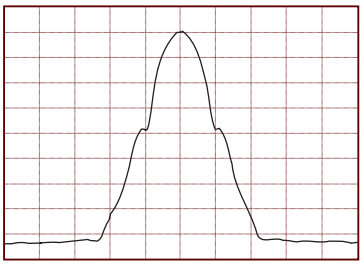
TETRA spectrum

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



DECT spectrum

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



GSM spectrum

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

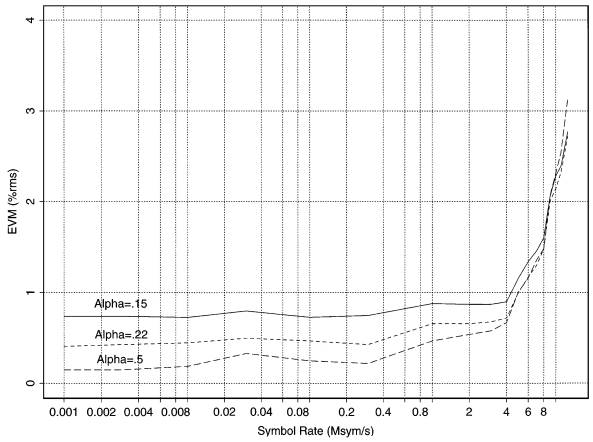
I/Q baseband generator
(continued)

Custom digitally modulated signals

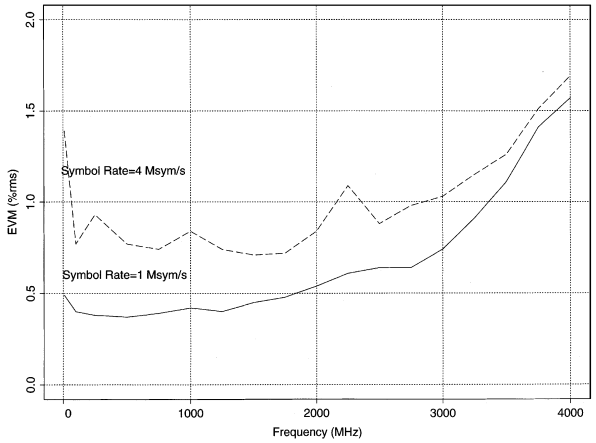
Modulation	QPSK	π/4DQPSK	16QAM	2FSK	GMSK
Filter	**Root Nyquist**			**Gaussian**	
Filter factor (α or B_bT)	0.25	0.25	0.25	0.5	0.5
Modulation index	N/A	N/A	N/A	0.5	N/A
Symbol rate (Msym/s)	4	4	4	1	1
	Error vector magnitude[1]			**Shift error**[1]	**Global phase error**[1]
		(% rms)	(% rms)		(degrees rms)
fc = 1 GHz	1.2	1.2	1.0	0.8	0.4
fc = 2 GHz	1.3	1.3	1.2	0.9	0.4
fc = 3 GHz	1.8	1.9	1.7	1.0	0.6
fc = 4 GHz	3.7	3.6	4.0	1.3	1.0

Typcal performance (power levels ≤ + 4 dBm [≤ + 8 dBm, Option UNB])

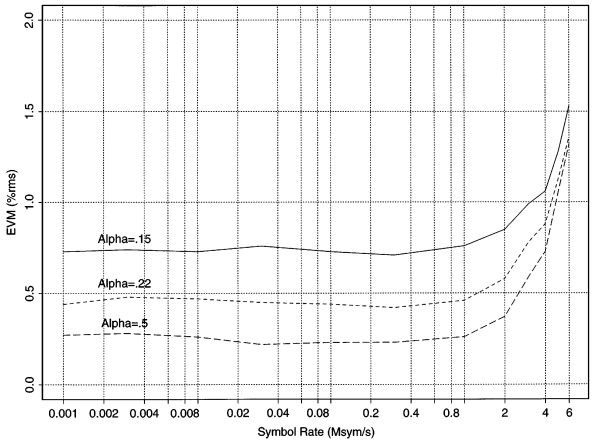
PSK formats



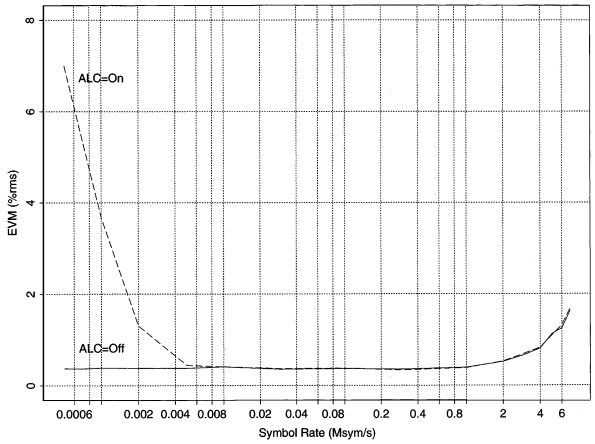
Baseband EVM performance versus symbol rate (root Nyquist filter, modulation = QPSK)



RF EVM performance versus frequency (root Nyquist filter, α = 0.25, ALC = off, modulation = π/4DQPSK)



RF EVM performance versus symbol rate (fc = 1 GHz, root Nyquist filter, ALC = off, modulation = QPSK)

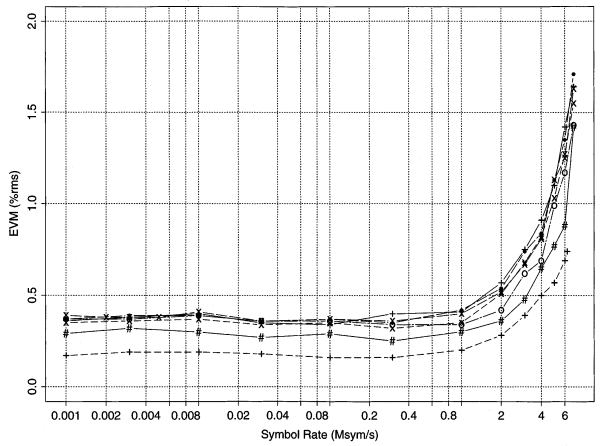


Effects of automatic level control (ALC) on EVM performance (fc = 1 GHz, root Nyquist filter, α = 0.25, modulation = QPSK)

1. Specifications apply at power levels ≤ +4 dBm, Option UNB) with default scale factor of I/Q outputs.

I/Q baseband generator
(continued)

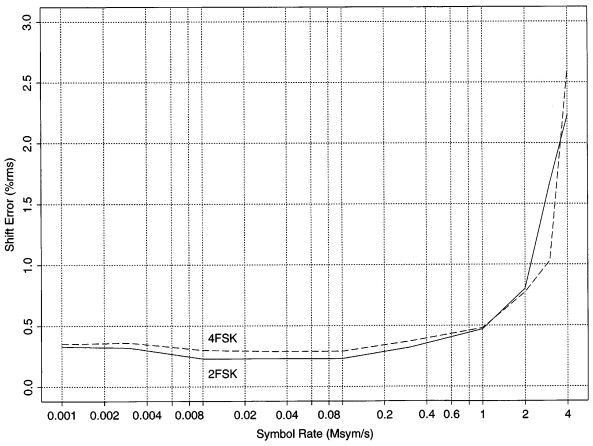
Non-constant amplitude formats



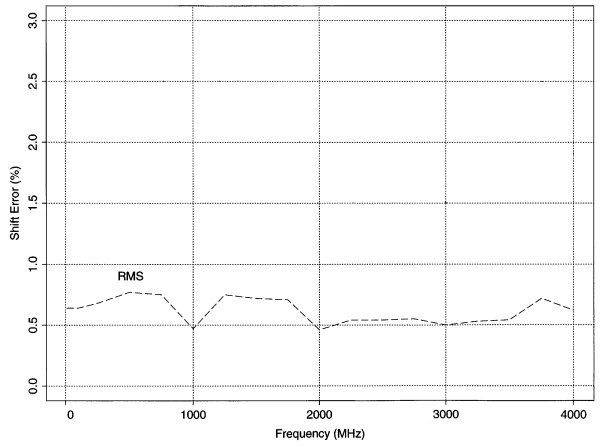
RF EVM performance versus symbol rate (fc = 1 GHz, root Nyquist filter, α = 0.25)

\+ ——— BPSK
X – – – OQPSK
• — — π/4DQPSK
o ——– 8PSK
-------- 16QAM
\+ -- -- -- 256QAM
x --- --- QPSK

FSK formats

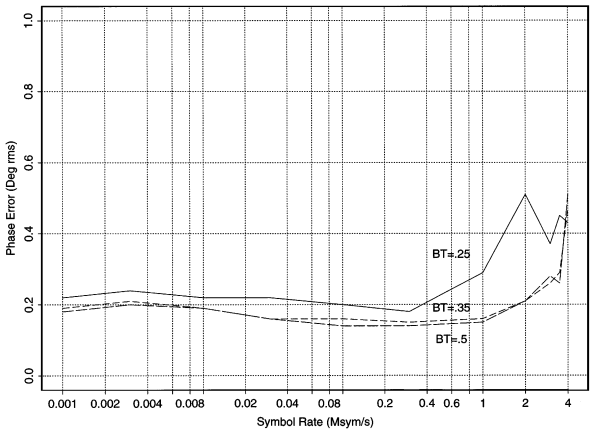


Shift error versus symbol rate (fc = 1 GHz, Gaussian filter, B_bT = 0.5, modulation index = 0.5)

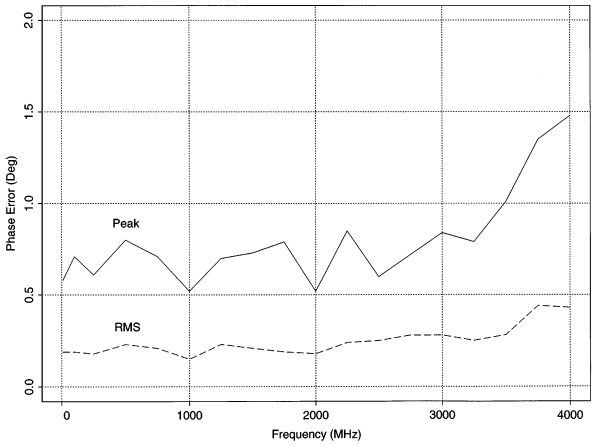


Shift error versus frequency (Gaussian filter, B_bT = 0.5, modulation index = 0.5, symbol rate = 1Msys/s)

MSK formats



Phase error versus symbol rate (fc = 1 GHz, Gaussian filter)



Phase error versus frequency (Gaussian filter, B_bT = 0.5, symbol rate = 1Msys/s)

Dual arbitrary waveform generator
(Option UND, ESG-DP and ESG-D series only)

Number of channels	2
Resolution	14 bits (1/16384)

Waveform memory

Length (playback)	1 Megasample/channel
Length (storage)	1 Megasample/channel in non-volatile RAM

Waveform segments

Segment length	16 samples to 1Megasample
Number of segments	1 to 128 (even number of samples)

Waveform sequences

Sequencing	Continuously repeating
Number of sequences	1 to 128
Segments/sequence	1 to 65,535
Segment repetitions	1 to 4,095

Clock

Sample rate	1 Hz to 40 MHz
Resolution	1 Hz
Accuracy	Same as timebase

Output reconstruction filters

Type	Elliptic
FCutoff (nominal, 3 dB)	250 kHz, 2.5 MHz, 8 MHz, and through (user-supplied external filter)

Baseband spectral purity
(typical, full scale sinewave, >20 x oversampling)

Harmonic distortion	
≤100 kHz	<–80 dBc
100 kHz to 2 MHz	<–65 dBc
Non-harmonic spurious (spur frequencies ≤ 10 MHz)	<–80 dBc
Phase noise (baseband output of 1 MHz sinewave at 20 kHz offset)	<–120 dBc/Hz
IM performance (two sinewaves at 950 kHz and 1050 kHz at baseband, full scale)	<–69 dB

Triggers

Types	Continuous, single, gated, segment advance
Source	Trigger key, bus, external
External polarity	Negative, positive
External delay time	2 µs to 3.6 ksec

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

Bluetooth (UND)

Packet type	DH1
Select Bluetooth device address (BD_ADDR)	12 Hex digits
Active member address (AM_ADDR)	0 to 7
Payload data	8-bit repeating pattern or PN9
Impairments	
Frequency offset	–100 kHz to +100 kHz
Frequency drift/packet	–100 kHz to +100 kHz
Resolution	1.0 kHz
Modulation index	0.250 to 0.400
Resolution	0.001
Burst	1 to 10 #symbol/ramp

Other formats (UND)

NADC, PDC, PHS, GSM, DECT, TETRA, APCO25, CDPD, PWT, EDGE and custom

Multicarrier

Number of carriers	Up to 64 (limited by a max bandwidth of 15 MHz)
Frequency offset (per carrier)	–7.5 MHz to +7.5 MHz
Power offset (per carrier)	0 dB to –40 dB

Modulation

PSK	BPSK, QPSK, OQPSK, π/4 DQPSK, 8PSK, 16PSK, D8PSK
QAM	4, 16, 32, 64, 256
FSK	Selectable: 2, 4, 8, 16 level symmetric
MSK	
Data	Random ONLY (For external data, bursting and framing refer to real-time I/Q baseband generator, Option UN8)

Multitone

Number of tones	2 to 64, with selectable on/off state per tone
Frequency spacing	100 Hz to 5 MHz
Bandwidth	up to 16 MHz, typical
Phase (per tone)	0 to 360 degrees

Additive white Gaussian noise

Bandwidth	50 kHz to 15 MHz
Waveform lengths	16, 32, 64, 128, 256, 512, 1024 ksamples
Noise seeds	Fixed, random

Multichannel, multicarrier CDMA personality
(Option UN5, ESG-DP and ESG-D series only)

Chip (symbol) rate 1.2288 MHz (default)
Adjustable from 1 Hz to
10 MHz with 4x oversampling

Modulation
QPSK (forward) with Walsh and short code spreading
Offset QPSK (reverse) with short code spreading of random data

Pre-defined channel configurations
(power levels per IS-97-A)
Pilot channel Incl. IS-95 modified filter, with equalizer
9 channel Incl. pilot, paging, sync, 6 traffic and IS-95 modified filter, with equalizer
32 channel Incl. pilot, paging, sync, 29 traffic and IS-95 modified filter, with equalizer
64 channel Incl. pilot, 7 paging, sync, 55 traffic and IS-95 modified filter, with equalizer
Reverse channel Incl. IS-95 filter

Rho 0.9996
(≤ 4 dBm, IS-95 filter, ≤ 2 GHz, typical)

Pilot time offset ≤ 2 µs, typical

User-defined CDMA
Channel table editor
- Number of channels 1 to 256
- Walsh codes 0 to 63
- Channel power 0 to –40 dB
- PN Offset 0 to 511
- Data 00-FF(HEX) or random

Walsh code power selection
IS-97 compliant
Equal channel power
Scaled to 0 dB
User-defined

IS-95 filter selection
IS-95
IS-95 with equalizer
IS-95 modified
IS-95 modified with equalizer
All are IS-95 compliant. "Modified" filters reduce spurious emissions for adjacent channel power measurements.

Other FIR filters
Nyquist, root Nyquist α = 0 to 1
Gaussian B_bT = 0.1 to 1
Custom FIR Up to 256 coefficients
16-bit resolution
Automatically scaled

Oversample ratio
Range 2 to 8
Resolution 1

Multicarrier
Number of carriers 3 or 4 (predefined), up to 12 (user-defined)
Carrier channels Pilot, 9 channel, 32 channel, 64 channel, reverse, custom
Frequency offset (per carrier) ±7.5 MHz
Offset resolution <100 Hz
Carrier power (per carrier) 0 dB to –40 dB

Clipping
Clip location pre or post FIR filter
Clipping type |I+jQ|, |I| and |Q|
Clipping range 10% to 100%
(clip the modulation level to a percentage of full scale.
A level of 100% equates to no clipping)

Multichannel CDMA spurious emissions[1]
(dBc, with high crest factor on)

	0.885 to 1.25 MHz			1.25 to 1.98 MHz			1.98 to 5 MHz[2]		
Channels/offsets	**Standard**	**Option UNB**	**Option H99**	**Standard**	**Option UNB**	**Option H99**	**Standard**	**Option UNB**	**Option H99**
Reverse (at ≤ 0 dBm)									
30 – 200 MHz	–66 (–72)	–70 (–75)	–71 (–73)	(–76)	(–78)	(–74)	(–79)	(–79)	(–77)
700 – 1000 MHz	–68 (–73)	–72 (–76)	–78 (–79)	(–76)	(–79)	(–82)	(–79)	(–79)	(–79)
1000 – 2000 MHz	–63 (–66)	–70 (–74)	–78 (–79)	(–70)	(–78)	(–82)	(–79)	(–79)	(–79)
9/64 channels (at ≤–2 dBm)									
30 – 200 MHz	–65 (–68)	–68 (–71)	–70 (–72)	(–73)	(–76)	(–72)	(–78)	(–78)	(–77)
700 – 1000 MHz	–64 (–70)	–69 (–73)	–73 (–75)	(–75)	(–77)	(–79)	(–79)	(–79)	(–79)
1000 – 2000 MHz	–60 (–63)	–67 (–71)	–72 (–74)	(–68)	(–75)	(–78)	(–78)	(–78)	(–78)

1. Parentheses denote typical performance.
2. Specifications apply with high crest factor off.

Bit Error Rate (BER) analyzer
(Option UN7, ESG-DP and ESG-D series only)

Clock rate 100 Hz to 10 MHz

Supported data patterns PN9 and PN15

Resolution 10 digits (6 digits for BER (exp))

Minimum synchronization length

2 Mbps mode	9 bits (PN9), 15 bits (PN15)
10 Mbps mode	43 bits (PN9), 48 bits (PN15)

Bit sequence length 100 bits to 4.294 Gbits after synchronization

Features

	2 Mbps mode	10 Mbps mode
Real-time display		
Bit count	X	X
Error-bit-count	X	
Bit Error Rate	X	
Pass/fail indication	X	X
Valid data and clock detection	X	X
Automatic re-synchronization	X	
Special pattern ignore	X	

Base station Bit Error Rate Test (BERT) extension for Option UN7 (BER analyzer)
(Option 300, requires Options UN8, UN7, and UNA; E4406A VSA-series transmitter tester with Options BAH and 300. ESG-D series only)

GSM base station BERT with the ESG-D RF signal generator and E4406A VSA-series transmitter tester.

Test technique RF loopback

Supported systems GSM 900 (P-GSM)
DCS 1800
PCS 1900
E-GSM (Extended)

GSM output data

Timeslot under test	
Timeslots tested	0 to 7
Frequency channels	Any single ARFCN (no frequency hopping)
Channel content	Full-rate speech (FS)
Encryption	None
Data	PN9, PN15 coded as per ETSI GSM, Rec. 05.03 version 3.6.1 (Oct 94)
Frame structure	26-frame TCH multiframe structure as per ETSI GSM, Rec. 05.01 version 6.1.1 (1998-07)
Minimum power level	–136 dBm (ESG minimum)
Maximum power level	+13 dBm (ESG maximum)
Power level accuracy	±0.5 dB (23 ± 5oC)
Adjacent timeslots	
Data	PN9, PN15 coded as per ETSI GSM, Rec. 05.03 version 3.6.1 (Oct 94)
Frame structure	26-frame TCH multiframe structure as per ETSI GSM, Rec. 05.01 version 6.1.1 (1998-07)
Relative power level	0 to ±130 dB relative to timeslot under test (Limited only by output power range of the ESG. Based on Option UNA specification.)

Measurements

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	100%
Maximum FER	100%
Measurement triggers	Immediate, trigger key, bus, external
Measurement modes	
Static reference sensitivity test (BER%)	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
BER sensitivity search	Automatically finds the input level (sensitivity) that causes a user specified RBER (normally 2%) for Class II bits
Measurement indication	Pass/fail
Maximum frame count	6,000,000 speech frames
Threshold	Termination of measurement when error count exceeds user specified threshold
BCH sync	BCH signal from the BTS is used to determine TCH frame and multiframe location

1. Perch power level is 3 dB below DPCH power.
2. DPCCH power level is 6 dB below DPDCH power.

Multichannel 3GPP W-CDMA personality
(Option 100, ESG-DP and ESG-D series only)

(Specifications apply to 3GPP W-CDMA Version 3.1 (12-99). Provides partially coded data for component test applications.

Chip rates 3.84 Mchips/sec ± 10%

Frame duration 10 ms

Filters

W-CDMA	α = 0.22
Nyquist, root Nyquist	α = 0 to 1
Gaussian	B_bT = 0 to 1
IS-9S	
IS-2000	
Custom FIR	Up to 256 coefficients, 16-bit resolution
Rectangle	
APCO 25 c4FM	
Reconstruction filters	250 kHz, 2.5 MHz 8.0 MHz, and through

I/Q mapping Normal, invert

Clipping

Clip location	pre-or post-FIR filter
Clipping type	|I+jQ|, |I| and |Q|
Clipping range	10% to 100% (clip the modulation level to a percentage of full scale. A level of 100% equates to no clipping)

Downlink

Modulation QPSK

Pre-defined channel configurations (partially coded)

1 DPCH	
3 DPCH	
PCCPCH + SCH	
PCCPCH + SCH + 1 DPCH	
PCCPCH + SCH + 3 DPCH	
Test Model 1	with 16, 32, or 64 DPCH
Test Model 2	
Test Model 3	with 16 or 32 DPCH

User-defined channel parameters

Symbol rates	7.5, 15, 30, 60, 120, 240, 480, or 960 ksps
Number of channels	Up to 512
Spreading code	0 to 511
Channel power	0 to –40 dB, 0.02 dB resolution
tDPCH offset	0 to 149
Scrambling code	0 to 511
Scramble types	Standard, Left Alternate, Right Alternate
Data pattern	Random, 00 to FF (HEX), PN9
TPC power	–20 to 20 dB relative to channel power
TFCI field	On /Off
TFCI value	0–1023
TFCI power	–20 to 20 dB relative to channel power
Pilot power	–20 to 20 dB relative to channel power
Pilot bits	4 or 8

Channel Types

(downlink)	PICH, OCNS, PCCPCH, PSCH, SSCH CPICH, DPCH
(uplink)	DPCCH, DPDCH

Multicarrier

Number of carriers	Up to 4 (user defined, individually configurable)
Frequency offset (per carrier)	Up to ±7.5 MHz
Offset resolution	<1 Hz
Carrier power (per carrier)	0 dB to –40 dB

Uplink

Modulation OCQPSK (HPSK)

Pre-defined channel configurations (partially coded)

1 DPCCH	15 ksps, spread code 0
DPCCH[2] + 1 DPDCH	960 ksps, spread code 1
DPCCH[2] + 2 DPDCH	960 ksps, spread code 1
DPCCH[2] + 3 DPDCH	960 ksps, spread code 2
DPCCH + 4 DPDCH	960 ksps, spread code 2
DPCCH + 5 DPDCH	960 ksps, spread code 3

User-defined channel parameters

Symbol rates	15, 30, 60, 120, 240, 480, or 960 ksps
Number of DPDCH channels	6
Spreading code	0 to 511, symbol rate
Scrambling code	1 to 1FFFFFFFFF, common for all channels
Second DPDCH orientation	I or Q
Channel power	0 to –60 dB
Data pattern	Random, 00 to FF (HEX), PN9
FBI bits	0–2

Error vector magnitude

1.8 GHz<f_c<2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤4 dBm, (≤7 dBm with Option UNB)

1 DPCH 2.3%, typical

Adjacent channel power[1,2]

1.8 GHz<f_c<2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤–2 dBm, (≤0 dBm with Option H99)

	Electronic attenuator (standard)	Mechanical attenuator (Option UNB)	Low ACP (Option H99)
1 DPCH	(–58 dBc)	(–58 dBc)	–61 dBc (–63 dBc)
Test Model 1 + 64 DPCH	(–50 dBc)	(–55 dBc)	–59 dBc (–61 dBc)

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

Multichannel cdma2000 personality
(Option 101, ESG-DP and ESG-D series only)

This personality conforms to cdma2000 specification revision 8. Provides partially coded data for component test applications.

Spreading rate 1x (SR1), 3x (SR3)

IS-95 filter selection
IS-95
IS-95 with equalizer
IS-95 modified
IS-95 modified with equalizer
All are IS-95 compliant. "Modified" filters reduce spurious emissions for adjacent channel power measurements.

Other FIR filters

Nyquist, root Nyquist	α = 0 to 1	
Gaussian	B_bT = 0.1 to 1	
Custom FIR	Up to 256 coefficients 16-bit resolution automaticallyscaled	
Rectangle		

I/Q mapping Normal, invert

Clipping

Clip location	pre-or post-FIR filter
Clipping type	|I+jQ|, |I| and |Q|
Clipping range	10% to 100% (clip the modulation level to a percentage of full scale. A level of 100% equates to no clipping)
Multicarrier	Up to 12 (user defined, individually configured)
Frequency offset (per carrier)	–7.5 MHz to +7.5 MHz
Power offset	0 dB to –40 dB

Forward link

Spreading type: Direct spread (DS), multicarrier

Pre-defined channel configurations (partially coded)

Pilot channel, DS/SR1	Pilot at Walsh 0
Pilot channel, DS/SR3	Pilot at Walsh 0
Pilot channel, Multicarrier/SR3	Pilot at Walsh 0
9 channel, DS/SR1	Radio configuration 3 Pilot at 9.6 kbps, paging at 9.6 kbps, sync at 1.2 kbps, two fundamental channels at 9.6 kbps, and four supplemental channels at 153.6 kbps
9 channel, DS or Multicarrier/SR3	Radio configuration 6 Pilot at 9.6 kbps, sync at 1.2 kbps, three fundamental channels at 9.6 kbps, and four supplemental channels at 153.6 kbps

User-defined cdma2000

Channel types (partially coded)	Pilot, paging (SR1 only), sync, fundamental, and supplemental
Radio configuration	SR1: 1 to 5 SR3: 6 to 9
Data rate	1.2 kpbs to 1036.8 kbps, depends on the selected radio configuration
Walsh code	Pilot and sync have fixed codes, Walsh 0 and 32. Other channels have codes selected from specific ranges depending on the radio configuration chosen
Channel power	0 to –40 dB
PN offsets	0 to 511
Data pattern	00-FF(HEX) or random

Reverse link

Spreading type: Direct spread only

Pre-defined channel configurations (partially coded)

Pilot channel, SR1	Pilot at Walsh 0
5 channel, (SR1 or SR3)	Includes pilot, dedicated control channel, traffic RC3 at 9.6 bps, and two supplemental RC3 at 153.6 kbps

User-defined cdma2000

Channel type (partially coded)	Pilot, dedicated control channel, fundamental, and supplemental
Radio configuration[4]	1 to 6
Data rate	1.2 kbps to 1036.8 kbps, depends on the selected radio configuration
Channel power	0 to –40 dB
Data pattern	00-FF(HEX) or random

EVM <2.1%
(825 to 2100 MHz, SR3 pilot, IS-95 filter, which is optimized for EVM, typical)

Multichannel cdma2000 spurious emissions[1]

(dBc, with high crest factor on IS95 modified with equalizer filter and amplitude = ≤0 dBm)

	Offsets from Center of Carrier					
	2.135 to 2.50 MHz		2.50 to 3.23 MHz		3.23 to 10 MHz[2]	
Channels/offsets	**Standard**	**Option H99**	**Standard**	**Option H99**	**Standard**	**Option H99**
Forward 9 channel, SR3/multicarrier[3]						
30 – 200 MHz	(–68)	(–68)	(–66)	(–68)	(–69)	(–68)
700 – 1000 MHz	(–69)	(–73)	(–68)	(–73)	(–70)	(–73)
1000 – 2000 MHz	(–61)	(–72)	(–61)	(–72)	(–64)	(–73)

	Offsets from Center of Carrier					
	2.655 to 3.75 MHz		3.75 to 5.94 MHz		5.94 to 10 MHz[2]	
Channels/offsets	**Standard**	**Option H99**	**Standard**	**Option H99**	**Standard**	**Option H99**
Forward 9 channel, SR3/DS[4]						
30 – 200 MHz	(–75)	(–73)	(–76)	(–74)	(–77)	(–73)
700 – 1000 MHz	(–76)	(–79)	(–78)	(–81)	(–78)	(–79)
1000 – 2000 MHz	(–68)	(–78)	(–72)	(–80)	(–78)	(–79)
Reverse 5 channel, SR3/DS[3]						
30 – 200 MHz	(–77)	(–73)	(–77)	(–72)	(–76)	(–73)
700 – 1000 MHz	(–77)	(–81)	(–78)	(–82)	(–78)	(–79)
1000 – 2000 MHz	(–71)	(–80)	(–72)	(–81)	(–78)	(–79)

1. Parentheses denote typical performance.
2. Excluding 10 MHz reference clock spur (>67 dBc, typical).
3. Measurements performed with 30 kHz bandwidth relative to power in one carrier.
4. Measurements performed with 30 kHz bandwidth relative to total power.

Real-time cdma2000 personality, Option 201

Description

Option 201 is a firmware personality built upon the internal real-time I/Q baseband generator (Option UN8). This option will generate fully coded IS-2000 signals (phase 1) for mobile receiver test and provide the stimulus for frame or bit error tests, and functional tests of the mobile unit's protocol handling. It is backward compatible with IS-95 systems using Radio Configurations 1 or 2. Option 201 also provides forward link signals according to the TS-B-2000 version of the IS-2000 standard.

Channel types generated

Up to four channels simultaneously,of any of the following
- Pilot
- Paging
- Sync
- F-Fundamental
- F-Supplemental
- OCNS

Global controls across all channels

Channel Power	0 to –40 dB
Filter	IS95, IS95 w/eq, IS95 mod, IS95 mod w/eq, IS2000 SR3 direct spread, Root Nyquist, Nyquist, Gaussian, User defined FIR, Rectangle, APCO 25 C4FM
Spread rate	1
PN offset	0-511
Chip Rate	50Hz-1.3MHz
Even second delay	0.5 to 128 chips
I/Q voltage scale	0 to -40 dB
Code domain power	Equal powers or scale to 0 dB

Pilot channel

Walsh	0 (non-adjustable)

Sync channel

Walsh	0 to 63
Data	Free editing of the following fields: SID, NID, F-synch type, Sys_Time, PRAT, LTM_Off, Msg_Type, P_REV, MIN_P_REV, LP_SEC, DAYLT, Cdma Freq, ext Cdma freq, and Reserved

Paging channel

Walsh	0 to 63
Data	Default paging message or Userfile
Long Code Mask	0-3FFFFFFFFFh
Rate	4.8 or 9.6 kbps

Fundamental channel

Radio Config.	1 to 5
Walsh	0 to 63
Data Rate	1.2 to 14.4 kbps, depending on radio configuration
Data	PN9, PN15, Userfile, External serial data, or predefined bit patterns
Long Code Mask	0-3FFFFFFFFFh
Power Control	N up/down, "N" may be set from 1 to 80
Power Puncture	On/Off
Frame Offset	0 (non-adjustable)
Frame Length	20ms (non-adjustable)

Supplemental channel

Same channel configuration as Fundamental, except

Radio Config.	3 to 5
Walsh	0-63, depending on RC and Data Rate
Data Rate	19.2 to 307.2 kbps, depending on radio configuration
Turbo Coding	May be selected for data rates from 28.8 to 153.6kbps
Power Control	not provided
Power Puncture	not provided

OCNS channel

Walsh	0 to 63

Inputs

External data	Can be selected for one channel, either fundamental or supplemental

Outputs various timing signals such as chip clock and even second

Real-time EDGE personality
(Option 202, ESG-DP and ESG-D series only)

Description

Option 202 is a firmware personality built upon the internal real-time I/Q baseband generator (Option UN8). This option will simulate both uplink and downlink EDGE signals. Data can be generated internally or externally with continuous data or bursted and framed signals. Use custom filtering and framing to keep pace with the evolving definition of EDGE.

Modulation 3π/8-rotating 8PSK (per EDGE specifications)
User-selectable (see Modulation under Option UN8)

Filter "linearized" Gaussian (per EDGE specifications)
User-selectable (see Filter under Option UN8)

Symbol rate User-adjustable (see Symbol rate under Option UN8)
270.83$\overline{3}$ kHz (default)

Burst Shape Defaults to EDGE standard power vs. time mask with user definable rise and fall time. Alternatively, upload externally defined burst shape waveforms.

Data structure Time slots may be configured as Normal or Custom. The data field of a time slot can accept a user file, PRBS (PN9 or PN15), a fixed sequence or external data. All other fields in a timeslot are editable.

Improved ACP performance for TETRA, CDMA and W-CDMA (Option H99, ESG-D and ESG-DP series only)

ACP improvements for TETRA, CDMA and W-CDMA are listed in the appropriate heading under Options 100, 101, UN8, UN5, and H98 respectively. Specifications that are changes from the standard are listed below.

Output power
250 kHz to 3 GHz + 10 dBm to –136 dBm
>3 GHz + 4 dBm to –136 dBm

Level accuracy Specifications degrade by 0.2 dB

Spectral purity
Nonharmonics >3 GHz specifications apply at < +4 dBm output power

Amplitude modulation 500 kHz to 3 GHz specification is typical
>3 GHz not specified

Pulse modulation
On/Off ratio
<250 MHz >60 dB

Level accuracy with digital modulation
<3 GHz specifications apply at <+7 dBm output power
>3 GHz specifications apply at <+4 dBm output power

Alternate time slot power level control
(Option UNA, ESG-DP and ESG-D series only)

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

General characteristics

Power requirements	90 to 254 V; 50, 60, or 400 Hz; 200 W max
Operating temperature range	0 to 55° C
Storage temperature range	–40 to 71° C
Shock and vibration	Meets MIL-STD-28800E Type III, Class 3.

Leakage Conducted and radiated interference meets MIL-STD-461C CE02 Part 2 and CISPR 11. Leakage is typically <1µV (nominally 0.1µV 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 800 storage registers and 10 register sequences are available.

Weight	<13.5 kg (28 lb.) net, <19.5 kg (42 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 GP-IB (IEEE-488.2-1987) with listen and talk. RS-232.

Control languages SCPI version 1992.0, also compatible with 8656B and 8657A/B/C/D/J[1] mnemonics.

Functions controlled All front panel functions except power switch and knob.

IEEE-488 functions SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E2.

ISO compliant

The ESG series RF signal generators are manufactured in an ISO-9001 registered facility in concurrence with Agilent Technologies commitment to quality.

Accessories

Transit case	Part number 9211-1296
Remote interface	83300A

Inputs and outputs

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

RF output
Nominal output impedance 50 ohms. (Type-N female, front panel)
LF output
Outputs the internally-generated LF source. Outputs 0 to 3 V_{peak} into 50 ohms, or 0 to 5 V_{peak} into high impedance. (BNC, front panel)
External input 1
Drives either AM, FM, ΦM, or burst envelope. Nominal input impedance 50 ohms, damage levels are 5 V_{rms} and 10 V_{peak}. (BNC, front panel)
External input 2
Drives either AM, FM, ΦM, or pulse. Nominal input impedance 50 ohms, damage levels are 5 V_{rms} and 10 V_{peak}. (BNC, front panel)
Auxiliary interface
Used with 83300A remote keypad sequencer (9-pin RS-232 connector female, rear panel)
10 MHz input
Accepts a 10 MHz ±10 ppm (standard timebase) or ±1 ppm (high-stability timebase) reference signal for operation with an external timebase. Nominal input impedance 50 ohms. (BNC, rear panel)
10 MHz output
Outputs the 10 MHz internal reference level nominally +7 dBm ±2 dB. Nominal output impedance 50 ohms. (BNC, rear panel)
GP-IB
Allows communication with compatible devices. (rear 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)
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 4µs pulse at start of LF sweep. (BNC, rear panel)
Trigger input
Accepts TTL signal for triggering point-to-point in manual sweep mode, or to trigger start of LF sweep. Damage levels ≥+10 V or ≤–4 V. (BNC, rear panel)

With ESG-AP and ESG-A series and Option 1E6 only

Pulse input
Drives pulse modulation. Input impedance TTL. (BNC, front or rear panel)

With ESG-DP and ESG-D series only

"I" input
Accepts an "I" input either for I/Q modulation or for wideband AM. Nominal input impedance 50 ohms, damage levels are 1 V_{rms} and 10 V_{peak}. (BNC, front panel)
"Q" input
Accepts a "Q" input for I/Q modulation. Nominal input impedance 50 ohms, damage levels are 1 V_{rms} and 10 V_{peak}. (BNC, front panel)

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

General characteristics, continued

Coherent carrier output
Outputs RF modulated with FM or ΦM, but not IQ or AM. Nominal power 0 dBm ±5 dB. Frequency range from 249.99900001 MHz to maximum frequency. For RF carriers below this range, output frequency = 1 GHz – frequency of RF output. Damage levels 20 V_{dc} and 13 dBm reverse RF power. (SMA, rear panel)

With ESG-DP and ESG-D series and Option UN8 only

Data input
Accepts serial data for digital modulation applications. Expects CMOS input. Leading edges must be synchronous with DATA CLOCK rising edges. The data must be valid on the DATA CLOCK falling edges. Damage levels are >+8 and <–4 V. (BNC, front panel)
Data clock input
Accepts CMOS clock signal (either bit or symbol) to synchronize inputting serial data. Damage levels are >+8 and <–4 V. (BNC, front panel)
Symbol sync input
Accepts CMOS synchronization signal. Symbol sync might occur once per symbol or be a single, one bit wide pulse to synchronize the first bit of the first symbol. Damage levels are >+8 and <–4 V. (BNC, front panel)
Baseband generator reference input
Accepts 0 to +20 dBm sinewave or TTL squarewave to use as reference clock for GSM applications. Only locks the internal data generator to the external reference; the RF frequency is still locked to the 10 MHz reference. Nominal impedance is 50 ohms at 13 MHz, AC-coupled. Damage levels are >+8 and <–8 V. (BNC, rear panel)
Burst gate input
Accepts CMOS signal for gating burst power when externally supplying data. Damage levels are >+8 and <–4 V. (BNC[1], rear panel)
Pattern trigger input Accepts CMOS signal to trigger internal pattern or frame generator to start single pattern output. Damage levels are >+ 8 and <–4 V. (BNC[1], rear panel)
Event 1 output
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. Damage levels are >+ 8 and <–4 V. (BNC[1], rear panel)
Event 2 output
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. Damage levels >+8 and <–4 V. (BNC[1], rear panel)
Data output
Outputs data from the internal data generator or the externally supplied signal at data input. CMOS signal. (BNC[1], rear panel)
Data clock output
Outputs a CMOS bit clock signal for synchronizing serial data. (BNC[1], rear panel)
Symbol sync output
Outputs CMOS symbol clock for symbol synchronization, one data clock period wide. (BNC[1], rear panel)
"I" and "Q" baseband outputs
Outputs in-phase and quadrature-phase component of I/Q modulation from the internal baseband generator. Full scale is 1 V peak to peak. Nominal impedance 50 ohms, DC-coupled, damage levels are >+2 and <–2 V. (BNC, rear panel)

With ESG-DP and ESG-D series and Option UND only

Baseband generator reference input
Accepts a TTL or > –10 dBm sinewave. Rate is 250 kHz to 20 MHz. Pulse width is >10 ns.
Trigger Types Continuous, single, gated, segment advance
"I" and "Q" baseband outputs
Outputs in-phase and quadrature-phase component of I/Q modulation from the internal baseband generator. Full scale is 1 V peak to peak. Nominal impedance 50 ohms, DC-coupled, damage levels are >+2 and <–2 V. (BNC, rear panel)
Event 1 output
Even second output for multichannel CDMA. Damage levels are >+8 V and <–4 V. (BNC[1], rear panel)

With ESG-DP and ESG-D series and Option UN7 only

Data, clock and clock gate inputs
Accepts TTL or 75Ω input. Polarity is selected. Clock duty cycle is 30% to 70%. Damage levels are >+8 V and <–4 V (BNC[1], rear panel)
Sync loss output
Outputs a TTL signal that is low when sync is lost. Valid only when measure end is high. Damage levels are >+8 V and <–4 V. (SMB, rear panel)
No data detection output
Outputs a TTL signal that is low when no data is detected. Valid only when Measure End is high. (SMB, rear panel)
Error-bit-output (Not supported at 10 Mbps rate)
Outputs 80 ns (typical) pulse when error bit is detected. (SMB, rear panel)
Test result output
Outputs a TTL signal that is high for fail and low for pass. Valid only on Measure end falling edge. (SMB, rear panel)
Measure end output
Outputs a TTL signal that is high during measurement. Trigger events are ignored while high. (SMB, rear panel)

With ESG-DP and ESG-D series and Option UNA

Alternate power input
Accepts CMOS signal for synchronization of external data and alternate power signal timing. Damage levels are >+8 and <–4V. (BNC[1], rear panel)

With ESG-DP and ESG-D series and Option 300 only

321.4 MHz input
Accepts a 321.4 MHz IF signal. Nominal input impedance 50 ohms. (SMB, rear panel)

1. Option 1EM replaces this BNC connector with an SMB connector.

Ordering information

See *ESG Family RF Signal Generators Configuration Guide* (literature number 5965-4973E) for more information

E4400B 1 GHz ESG-A series RF signal generator
E4420B 2 GHz ESG-A series RF signal generator
E4421B 3 GHz ESG-A series RF signal generator
E4422B 4 GHz ESG-A series RF signal generator

E4423B 1 GHz ESG-AP series RF signal generator
E4425B 3 GHz ESG-AP series RF signal generator
E4424B 2 GHz ESG-AP series RF signal generator
E4426B 4 GHz ESG-AP series RF signal generator

E4430B 1 GHz ESG-D series RF signal generator
E4431B 2 GHz ESG-D series RF signal generator
E4432B 3 GHz ESG-D series RF signal generator
E4433B 4 GHz ESG-D series RF signal generator

E4434B 1 GHz ESG-DP series RF signal generator
E4435B 2 GHz ESG-DP series RF signal generator
E4436B 3 GHz ESG-DP series RF signal generator
E4437B 4 GHz ESG-DP series RF signal generator

Options

See *ESG Family RF Signal Generators Configuration Guide* (literature number 5965-4973E) for more information

0B0 Deletes the standard manual set
0B1 Adds extra manual set
0BV Adds service documentation, component level
0BW Adds service documentation, assembly level
0BX Adds service documentation, assembly and component level
1CM Adds rack mount kit, part number 5063-9214
1CN Adds front handle kit, part number 5063-9227
1CP Adds rack mount kit with handles, part number 5063-9221
1E5 Adds high-stability timebase
1E6 High-performance pulse modulation
1EM Moves all front panel connectors to rear panel
UN5 Adds multichannel CDMA personality
UN7 Adds internal bit-error-rate analyzer
UN8 Adds real-time I/Q baseband generator with TDMA standards and 1 Mbit of RAM
UN9 Adds 7 Mbits of RAM to Option UN8
100 Adds multichannel W-CDMA personality
101 Adds multichannel cdma2000 personality
300 Basestation BERT extension for Option UN7 (internal bit-error-rate analyzer)
UNA Alternate timeslot power level control
UNB Adds higher power with mechanical attenuator
UND Adds internal dual arbitrary waveform generator
H99 Improves ACP performance for TETRA, CDMA, and W-CDMA
W50 Adds additional warranty for a total of five years

ESG family application and product information

Application notes and product notes

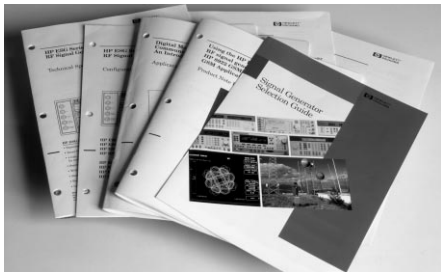
- *Digital Modulation in Communications Systems—An Introduction*, literature number 5965-7160E.
- *Generating and Downloading Data to the ESG-D RF Signal Generator for Digital Modulation*, literature number 5966-1010E.
- *Using Vector Modulation Analysis in the Integration, Troubleshooting and Design of Digital Communications Systems*, literature number 5091-8687E.
- *Controlling TDMA Timeslot Power Levels in the ESG-D Series Option UNA,* Product Note, literature number 5966-4472E.
- *Testing CDMA Base Station Amplifiers*, literature number 5967-5486E.
- *Customize Digital Modulation with the ESG-D Series Real-Time I/Q Baseband Generator, Option UND,* Product Note, literature number 5966-4096E.
- *Using the ESG-D RF Signal Generator's Multicarrier, Multichannel CDMA Personality for Component Test, Option UN5*, Product Note, literature number 5968-2981E.
- *Generating Digital Modulation with the ESG-D Series Dual Arbitrary Waveform Generator, Option UND,* Product Note, literature number 5966-4097E.
- *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.
- *Using the ESG-D series of RF signal generators and the 8922 GSM Test Set for GSM Applications*, Product Note, literature number 5965-7158E.

Product literature

- *ESG Family RF Signal Generators* (brochure), literature number 5968-4313E.
- *ESG Family RF Signal Generators Technical Specifications*, literature number 5965-3096E.
- *ESG Family RF Signal Generators Configuration Guide*, literature number 5965-4973E.
- *ESG Family RF Signal Generators Options* (profile), literature number 5968-2807E.
- *Signal Generators* (selection guide), literature number 5965-3094E.

See the ESG family 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 family is: **http://www.agilent.com/find/esg**



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