Agilent
ESG-A and ESG-D
RF Signal Generators

Data Sheet

Discontinuance Notice
On 1 March 2007, the ESG-A/D Series will be discontinued. Agilent will continue to support these products until 1 March 2012. The recommended replacement is the Agilent MXG signal generator.

The Agilent MXG offers frequency ranges up to 6 GHz, the industry’s best ACPR, fast switching, and a simplified design for easy self-maintenance - all in two rack units (2RU).

For more information visit www.agilent.com/find/mxg.

<table>
<thead>
<tr>
<th>Range (kHz) – (GHz)</th>
<th>ESG-A series</th>
<th>ESG-D series</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kHz – 1 GHz</td>
<td>E4400B</td>
<td>E4430B</td>
</tr>
<tr>
<td>250 kHz – 2 GHz</td>
<td>E4420B</td>
<td>E4431B</td>
</tr>
<tr>
<td>250 kHz – 3 GHz</td>
<td>E4421B</td>
<td>E4432B</td>
</tr>
<tr>
<td>250 kHz – 4 GHz</td>
<td>E4422B</td>
<td>E4433B</td>
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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

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

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

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
- 1-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, multicarrier W-CDMA 1.0 personality
- Multichannel cdma2000 personality
- Real-time 3GPP W-CDMA personality
- Real-time 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

<table>
<thead>
<tr>
<th>Range</th>
<th>ESG-A series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E4400B 250 kHz to 1 GHz</td>
</tr>
<tr>
<td></td>
<td>E4420B 250 kHz to 2 GHz</td>
</tr>
<tr>
<td></td>
<td>E4421B 250 kHz to 3 GHz</td>
</tr>
<tr>
<td></td>
<td>E4422B 250 kHz to 4 GHz</td>
</tr>
<tr>
<td>ESG-D series</td>
<td>E4430B 250 kHz to 1 GHz</td>
</tr>
<tr>
<td></td>
<td>E4431B 250 kHz to 2 GHz</td>
</tr>
<tr>
<td></td>
<td>E4432B 250 kHz to 3 GHz</td>
</tr>
<tr>
<td></td>
<td>E4433B 250 kHz to 4 GHz</td>
</tr>
</tbody>
</table>

| Underrange | 100 kHz |
| Resolution | 0.01 Hz |
| Accuracy | Same as timebase |

Switching speed (typical) | ESG-A and ESG-D series

| Modulation on | Analog | < 50 ms |
|               | Digital | < 90 ms |
| Modulation off |        | < 40 ms |

| Phase offset | Phase is adjustable via GPIB or front panel in nominal 0.1° increments |

Frequency bands

<table>
<thead>
<tr>
<th>Band</th>
<th>Frequency range</th>
<th>N #</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>250 kHz to ≤ 249.999 MHz</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>&gt; 249.999 to ≤ 500 MHz</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>&gt; 500 MHz to ≤ 1 GHz</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 1 to ≤ 2 GHz</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 2 to ≤ 4 GHz</td>
<td>4</td>
</tr>
</tbody>
</table>

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-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 | < ±0.002 ppm, typical |
| (+5%, −10%) | (+5%, −10%) |

| Timebase reference output | Frequency | 10 MHz |
| Amplitude | > 0.35 Vrms into 50 Ω load |

| External reference input | Frequency | 1, 2, 5, 10 MHz |
| Amplitude | ± typical 10 ppm |
| ESG-A and ESG-D series Option 1E5 | |
| Input impedance | > 0.15 Vrms | 50 Ω |

Output

<table>
<thead>
<tr>
<th>Power²</th>
<th>Standard</th>
<th>Option UNB</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kHz to 1 GHz</td>
<td>+13 to −136 dBm</td>
<td>+17 to −136 dBm</td>
</tr>
<tr>
<td>&gt; 1 to 3 GHz</td>
<td>+10 to −136 dBm</td>
<td>+16 to −136 dBm</td>
</tr>
<tr>
<td>&gt; 3 to 4 GHz</td>
<td>+7 to −136 dBm</td>
<td>+13 to −136 dBm</td>
</tr>
</tbody>
</table>

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  

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Standard</th>
<th>Option UNB</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kHz to 1 GHz</td>
<td>23 dB</td>
<td>27 dB</td>
</tr>
<tr>
<td>&gt; 1 to 3 GHz</td>
<td>26 dB</td>
<td>26 dB</td>
</tr>
<tr>
<td>&gt; 3 to 4 GHz</td>
<td>23 dB</td>
<td>23 dB</td>
</tr>
</tbody>
</table>

Level accuracy (dB)¹  

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Level Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>+7 to –120 dBm</td>
<td>±0.5 dB</td>
</tr>
<tr>
<td>(–10 to –120 dBm, –120 dBm, –127 dBm)</td>
<td>±0.5 dB (±1.5)</td>
</tr>
<tr>
<td>&gt; –127 dBm</td>
<td>±0.5 dB</td>
</tr>
</tbody>
</table>

Output power  

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kHz to 2 GHz</td>
<td>±0.5 dB</td>
</tr>
<tr>
<td>2 to 3 GHz</td>
<td>±0.5 dB</td>
</tr>
<tr>
<td>3 to 4 GHz</td>
<td>±0.5 dB</td>
</tr>
</tbody>
</table>

Spectral purity

SSB phase noise² (at 20 kHz offset)

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Phase Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 MHz</td>
<td>&lt; –120 dBc/Hz</td>
</tr>
<tr>
<td>1 GHz</td>
<td>&lt; –116 dBc/Hz</td>
</tr>
<tr>
<td>2 GHz</td>
<td>&lt; –110 dBc/Hz</td>
</tr>
<tr>
<td>3 GHz</td>
<td>&lt; –104 dBc/Hz</td>
</tr>
<tr>
<td>4 GHz</td>
<td>&lt; –104 dBc/Hz</td>
</tr>
</tbody>
</table>

Residual FM³ (CW mode, 0.3 to 3 kHz BW, CCITT, rms)

<table>
<thead>
<tr>
<th>Phase Noise Mode</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt; N x 2 Hz</td>
</tr>
<tr>
<td>2</td>
<td>&lt; N x 4 Hz</td>
</tr>
</tbody>
</table>

Harmonics

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ +4 dBm (≤ +7.5 dBm, Option UNB)</td>
<td>&lt; –30 dBc</td>
</tr>
</tbody>
</table>

Nonharmonics

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ +7 dBm (≤ +10 dBm, Option UNB)</td>
<td>&lt; –30 dBc</td>
</tr>
</tbody>
</table>

Subharmonics

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1 GHz</td>
<td>None</td>
</tr>
<tr>
<td>&gt; 1 GHz</td>
<td>&lt; –40 dBc</td>
</tr>
</tbody>
</table>

Amplitude switching speed

<table>
<thead>
<tr>
<th>Without power search</th>
<th>&lt; 30 ms, typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>When using power search</td>
<td>&lt; 300 ms, typical</td>
</tr>
</tbody>
</table>

Reverse power protection²

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kHz to 2 GHz</td>
<td>50 watts</td>
</tr>
<tr>
<td>&gt; 2000 to 4 GHz</td>
<td>25 watts</td>
</tr>
<tr>
<td>Max DC voltage</td>
<td>50 V</td>
</tr>
</tbody>
</table>

SWR (typical)  

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Standard</th>
<th>Option UNB</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kHz to 1 GHz</td>
<td>1.5:1</td>
<td>1.3:1</td>
</tr>
<tr>
<td>1 to 2 GHz</td>
<td>1.4:1</td>
<td>1.3:1</td>
</tr>
<tr>
<td>2 to 3 GHz</td>
<td>1.3:1</td>
<td>1.4:1</td>
</tr>
<tr>
<td>3 to 4 GHz</td>
<td>1.5:1</td>
<td>1.5:1</td>
</tr>
</tbody>
</table>

Output impedance  

50 Ω

1. For 23 °C ±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.
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.
Jitter in µUI

<table>
<thead>
<tr>
<th>Carrier frequency</th>
<th>SONET/SDH data rates</th>
<th>rms jitter bandwidth</th>
<th>ESG-A, ESG-D (µUI RMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 MHz</td>
<td>155 MB/s</td>
<td>100 Hz to 1.5 MHz</td>
<td>(239)</td>
</tr>
<tr>
<td>622 MHz</td>
<td>622 MB/s</td>
<td>1 kHz to 5 MHz</td>
<td>(149)</td>
</tr>
<tr>
<td>2.488 GHz</td>
<td>2488 MB/s</td>
<td>5 kHz to 15 MHz</td>
<td>(375)</td>
</tr>
</tbody>
</table>

Jitter in seconds

<table>
<thead>
<tr>
<th>Carrier frequency</th>
<th>SONET/SDH data rates</th>
<th>rms jitter bandwidth</th>
<th>ESG-A, ESG-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 MHz</td>
<td>155 MB/s</td>
<td>100 Hz to 1.5 MHz</td>
<td>(1.54 ps)</td>
</tr>
<tr>
<td>622 MHz</td>
<td>622 MB/s</td>
<td>1 kHz to 5 MHz</td>
<td>(240 fs)</td>
</tr>
<tr>
<td>2.488 GHz</td>
<td>2488 MB/s</td>
<td>5 kHz to 15 MHz</td>
<td>(151 fs)</td>
</tr>
</tbody>
</table>

Frequency modulation

Maximum deviation
ESG-A and ESG-D series
N x 10 MHz

<table>
<thead>
<tr>
<th>Mode</th>
<th>Maximum deviation</th>
<th>Rates (3 dB BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΦM1</td>
<td>ΦM2</td>
</tr>
<tr>
<td>Normal BW</td>
<td>N x 360 rad</td>
<td>dc to 100 kHz</td>
</tr>
<tr>
<td>High BW</td>
<td>N x 90 rad</td>
<td>dc to 1.5 MHz (typ)</td>
</tr>
</tbody>
</table>

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

Distortion< 1%
1 kHz rate, THD, dev < N x 90 rad, Normal BW mode

External inputs Ext 1 or Ext 2

Sensitivity 1 V_{peak} for indicated deviation

Input impedance 50 Ω, nominal

Phase modulation

Maximum deviation
ESG-A and ESG-D series

<table>
<thead>
<tr>
<th>Mode</th>
<th>Maximum deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal BW</td>
<td>N x 90 radians</td>
</tr>
<tr>
<td>High BW</td>
<td>N x 8π radians</td>
</tr>
</tbody>
</table>

Resolution 0.1% of set deviation

Modulation frequency response
ESG-A and ESG-D series

<table>
<thead>
<tr>
<th>Mode</th>
<th>Maximum deviation</th>
<th>Rates (3 dB BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>dc to 100 kHz</td>
</tr>
<tr>
<td>High BW</td>
<td>N x 90 rad</td>
<td>dc to 1.5 MHz (typ)</td>
</tr>
</tbody>
</table>

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

Distortion< 1%
1 kHz rate, THD, dev < N x 90 rad, 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. Parentheses denote typical performance.
2. Calculated from phase noise performance in CW mode only at +2.0 dBm for standard instruments, +5.0 dBm with Option UNB.
3. For other frequencies, data rates, or bandwidths, please contact your sales representative.
4. Since the internal modulation source operates over 0.1 Hz to 50 kHz, FM rates above 50 kHz must be supplied externally.
5. Refer to frequency bands on page 4 to compute specifications.
6. 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%)\(^1\)
- **Distortion** (1 kHz rate, THD):
  - 30% AM: < 2.0%
  - 90% AM: < 4%, typical
- **External inputs**: Ext 1 or Ext 2
- **Sensitivity**: 1 \(V\)\(_{\text{peak}}\) for indicated depth
- **Input impedance**: 50 \(\Omega\), 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-D series only)

- **Rate** (1 dB bandwidth, typical):
  - ALC On: 400 Hz to 10 MHz
  - ALC Off: dc to 10 MHz
- **External input**: 1 input
- **Sensitivity**: 0.5 \(V\) = 100%
- **Input impedance**: 50 \(\Omega\), nominal

Pulse modulation

- **On/off ratio**:
  - \(\leq 3 \text{ GHz}\): > 80 dB
  - > 3 GHz: > 60 dB
- **Rise/fall times**: 150 ns, typical
- **Minimum width**
  - ALC On: 2 \(\mu\)s, typical
  - ALC Off: 0.4 \(\mu\)s, typical
- **Pulse repetition frequency**
  - ALC On: 10 Hz to 250 kHz, typical
  - ALC Off: dc to 1.0 MHz, typical
- **Level accuracy**:
  - < ±0.5 dB, typical ≤ 3 GHz
  - < ±0.8 dB, typical ≤ 4 GHz (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 \(\Omega\), nominal

Internal pulse generator

- **Square wave rate**: 0.1 Hz to 50 kHz
- **Pulse**
  - **Period**: 16 \(\mu\)s to 30 sec
  - **Width**: 8 \(\mu\)s to 30 sec
  - **Resolution**: 4 \(\mu\)s

High-performance pulse modulation

(Option 1E6, ESG-A series) \(^3\)

- **On/off ratio**:
  - \(\leq 2 \text{ GHz}\): > 80 dB
  - > 2 GHz: > 70 dB
- **Rise/fall times**: < 10 ns
- **Delay**: < 60 ns, typical
- **External input**: Pulse in
- **Input voltage**: +5 V (with RF on, TTL compatible)
- **Input impedance**

---

\(^1\) AM is typical above 2 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 repetition rates \(\leq 10 \text{ kHz}\) and pulse widths \(\geq 5 \mu\)s.

\(^3\) With high performance pulse modulation (Option 1E6) installed, all maximum power specifications drop by 4 dB.
**Internal modulation source**

(Provides FM, \(\Phi M\), 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 \(\mu\)s

**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 \(V_{\text{peak}}\) into 50 \(\Omega\)
- Output impedance: < 1 \(\Omega\)

---

**External modulation inputs**

**Modulation types**
- Ext 1: FM, \(\Phi M\), AM, and burst envelope
- Ext 2: FM, \(\Phi M\), 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-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  
  ±0.20 dB  
  ±0.30 dB

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

- **Constant amplitude formats**  
  (FSK, GMSK, etc)  
  ESG-D series  
  ±0.20 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-D series only)*

- **I/Q inputs**  
  Input impedance  
  50 Ω

  Full scale input\(^1\)  
  \( \sqrt{I^2 + Q^2} = 0.5 \ V_{rms} \)

**Adjustments/Impairments** (nominal)  
DC offset (I and Q independently adjustable) ±100%

I/Q gain ratio  
±4 dB

I/Q quadrature  
±10° (for fc \( \leq 3.3 \) GHz)

**External burst envelope**  
*(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  
\( V_{in} \) \( \leq –1.05 \) 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**  
50 Ω, nominal

**Coherent carrier out**  
*(ESG-D series only)*

**Range**  
250 MHz to maximum carrier frequency

**Level**  
0 dBm ±5 dB, typical

**Impedance**  
50 Ω

---

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 modulator then enables modulation.

3. Coherent carrier is modulated by FM or ΦM when enabled.
I/Q baseband generator
(Option UN8, ESG-D series only)

**Modulation**

**PSK**  
BPSK, QPSK, OQPSK, π/4DQPSK, 8PSK, 16PSK, 64PSK

**MSK**  
User-defined phase offset from 0 to 100°

**QAM**  
4, 16, 32, 64, 256

**FSK**  
Selective: 2, 4, 8, 16 level symmetric

**Custom:**  
Custom map of up to 16 deviation levels

**Deviation:**  
Modulation index ≤ 1, ≤ 1.5 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

**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.

<table>
<thead>
<tr>
<th>Bits/symbol</th>
<th>Maximum symbol rate (Msym/sec)</th>
<th>Maximum data rate (Mbits/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>2</td>
<td>12.5</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>8.33</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>12.5</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>8.33</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>7.14</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>6.25</td>
<td>50</td>
</tr>
</tbody>
</table>

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

---

1. PN15 is not continuous in bursted mode when TETRA is operated in a downlink mode.
2. Baseband I/Q outputs cannot be scaled for GSM and DECT.
3. Specifications apply for the frequency range, symbol 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.

---

**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 2⁹ –1) PN11**  
(PRBS 2²¹ –1), PN15¹  
(PRBS 2¹⁵ –1), PN20 (PRBS 2²⁰ –1),  
PN23 (PRBS 2²³ –1).

**Repeating sequence**  
Any 4-bit sequence

**Downloadable data**

**Maximum bit rate**  
5 Mbits/sec

**Direct-pattern RAM (PRAM)**

**Max size**  
1 Mbyte (standard)

**Use**  
8 Mbytes (Option UN9)

**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 Vpeak-to-peak into 50 Ω)²

<table>
<thead>
<tr>
<th>Standard</th>
<th>Default scaling</th>
<th>Maximum V (rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NADC, PHS, PDC</td>
<td>100</td>
<td>0.25</td>
</tr>
<tr>
<td>TETRA</td>
<td>65</td>
<td>0.25</td>
</tr>
<tr>
<td>GSM, DECT</td>
<td>N/A</td>
<td>0.35</td>
</tr>
</tbody>
</table>

(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 Vpeak-to-peak into 50 Ω)⁴

<table>
<thead>
<tr>
<th>Custom format</th>
<th>Default scaling</th>
<th>Maximum V (rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSK, MSK</td>
<td>NA</td>
<td>0.35</td>
</tr>
<tr>
<td>OQPSK, BPSK</td>
<td>70</td>
<td>0.32</td>
</tr>
<tr>
<td>8PSK, 16PSK, DBPSK</td>
<td>70</td>
<td>0.20</td>
</tr>
<tr>
<td>π/4DQPSK</td>
<td>70</td>
<td>0.25</td>
</tr>
<tr>
<td>QAM</td>
<td>70</td>
<td>&gt; 0.10</td>
</tr>
</tbody>
</table>

---

¹. PN15 is not continuous in bursted mode when TETRA is operated in a downlink mode.
². Baseband I/Q outputs cannot be scaled for GSM and DECT.
³. Specifications apply for the frequency range, symbol 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

<table>
<thead>
<tr>
<th></th>
<th>NADC 5</th>
<th>PDC</th>
<th>PHS</th>
<th>TETRA</th>
<th>DECT</th>
<th>GSM (DCS,PCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous</td>
<td>Burst</td>
<td>Continuous</td>
<td>Burst</td>
<td>Continuous</td>
<td>Burst</td>
</tr>
<tr>
<td>Error vector magnitude 1 (% rms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low EVM mode</td>
<td>0.7</td>
<td>1.4</td>
<td>0.9</td>
<td>1.3</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Low EVM mode (typical)</td>
<td>0.4</td>
<td>1.1</td>
<td>0.6</td>
<td>0.9</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Low ACP mode (typical)</td>
<td>1.0</td>
<td>1.4</td>
<td>0.8</td>
<td>1.0</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Global phase error 1 (°)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation accuracy 1 (kHz)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Channel spacing (kHz)</td>
<td>30</td>
<td>25</td>
<td>300</td>
<td>25</td>
<td>1,728</td>
<td>500</td>
</tr>
<tr>
<td>Adjacent channel power 1 (dBc, typical)</td>
<td>Continuous</td>
<td>Burst</td>
<td>Continuous</td>
<td>Burst</td>
<td>Continuous</td>
<td>Burst</td>
</tr>
<tr>
<td>at adjacent channel 3</td>
<td>- 35</td>
<td>- 34</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>at 1st alternate channel 3</td>
<td>- 79</td>
<td>77</td>
<td>- 70</td>
<td>- 70</td>
<td>- 78</td>
<td>- 78</td>
</tr>
<tr>
<td>at 3rd alternate channel 3</td>
<td>- 83</td>
<td>80</td>
<td>- 81</td>
<td>- 79</td>
<td>- 81</td>
<td>- 80</td>
</tr>
<tr>
<td>Supported burst types</td>
<td>Custom, up/down TCH</td>
<td>Custom, up/down TCH, up Vox</td>
<td>Custom, TCH, sync</td>
<td>Custom, up control 1 &amp; 2 up normal, down normal, down sync</td>
<td>Custom, dummy B 1 &amp; 2 traffic B low capacity</td>
<td>Custom, nomal, FCorr, sync, dummy, access</td>
</tr>
<tr>
<td>Scramble capabilities</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 alternate channel = 2 x channel spacing, 2nd alternate channel = 3 x channel spacing, etc.
4. TETRA ACP performance is typically < -69 dBc with Option H99 in continuous modulation mode.
5. Supports IS-54 and IS-136 traffic channels only.

---

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5. Supports IS-54 and IS-136 traffic channels only.
I/Q baseband generator (continued)

Digital communications 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

<table>
<thead>
<tr>
<th>Modulation</th>
<th>QPSK</th>
<th>π/4DQPSK</th>
<th>16QAM</th>
<th>2FSK</th>
<th>GMSK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filter factor (α or B₀T)</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Modulation index</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Symbol rate [Msym/s]</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Error vector magnitude</td>
<td>1,2</td>
<td>(% rms)</td>
<td>(% rms)</td>
<td>Shift error</td>
<td>(% rms)</td>
</tr>
<tr>
<td>fc = 1 GHz</td>
<td>(0.9)</td>
<td>(0.9)</td>
<td>(0.8)</td>
<td>(0.7)</td>
<td>(0.2)</td>
</tr>
<tr>
<td>fc = 2 GHz</td>
<td>(1.0)</td>
<td>(1.0)</td>
<td>(1.0)</td>
<td>(0.7)</td>
<td>(0.2)</td>
</tr>
<tr>
<td>fc = 3 GHz</td>
<td>(1.5)</td>
<td>(1.5)</td>
<td>(1.4)</td>
<td>(0.8)</td>
<td>(0.4)</td>
</tr>
<tr>
<td>fc = 4 GHz</td>
<td>(2.8)</td>
<td>(2.6)</td>
<td>(3.5)</td>
<td>(1.0)</td>
<td>(0.5)</td>
</tr>
</tbody>
</table>

Typical 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, a = 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, a = 0.25, modulation = QPSK)

1. Specifications apply at power levels ≤ +4 dBm, Option (UNB) with default scale factor of I/Q outputs.
2. Parentheses denote typical performance.
I/Q baseband generator (continued)

Non-constant amplitude formats

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

FSK formats

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

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

MSK formats

Phase error versus symbol rate
(fc = 1 GHz, Gaussian filter, BbT = 0.5, symbol rate = 1Msys/s)

Shift error versus frequency
(Gaussian filter, BbT = 0.5, modulation index = 0.5, symbol rate = 1Msys/s)
Dual arbitrary waveform generator
(Option UND, 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 1 Megasample
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
Frequency cutoff (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
\[ \leq 100 \text{ kHz} \quad < -80 \text{ dBc} \]
\[ 100 \text{ kHz to 2 MHz} \quad < -65 \text{ dBc} \]
Non-harmonic spurious
(spur frequencies \( \leq 10 \text{ MHz} \))
\[ < -80 \text{ dBc} \]
Phase noise
\[ < -120 \text{ dBc/Hz} \]
(baseband output of 1 MHz sinewave at 20 kHz offset)
IM performance
\[ < -69 \text{ dB} \]
(two sinewaves at 950 kHz and 1050 kHz at baseband, full scale)

**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
Truncated PN9
Continuous PN9

Impairments
Frequency offset
Resolution  –100 kHz to +100 kHz
1 kHz
Frequency drift/packet
Linear or Sinusoidal
Resolution  –100 kHz to +100 kHz
1 kHz
Modulation index
Resolution  0.250 to 0.400
0.001
Symbol timing error
Resolution  –50 ppm to 50 ppm
1 ppm
AWGN with adjustable C/N
Resolution
1 db
Burst
Resolution
1 to 10 #symbol/ramp
1 symbol/ramp
Clock/gate delay
Resolution
0 to 24999.9 symbols
0.1 symbols

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**
PUSK
BPSK, QPSK, OQPSK, \( \pi/4 \)
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-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**
  - Includes IS-95 modified filter, with equalizer
- **9 channel**
  - Includes pilot, paging, sync, 6 traffic and IS-95 modified filter, with equalizer
- **32 channel**
  - Includes pilot, paging, sync, 29 traffic and IS-95 modified filter, with equalizer
- **64 channel**
  - Includes pilot, 7 paging, sync, 55 traffic and IS-95 modified filter, with equalizer
- **Reverse channel**
  - Includes 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**
<table>
<thead>
<tr>
<th></th>
<th>IS-97 compliant</th>
<th>Equal channel power</th>
<th>Scaled to 0 dB</th>
<th>User-defined</th>
</tr>
</thead>
</table>

**IS-95 filter selection**
<table>
<thead>
<tr>
<th></th>
<th>IS-95</th>
<th>IS-95 with equalizer</th>
<th>IS-95 modified</th>
<th>IS-95 modified with equalizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All are IS-95 compliant. “Modified” filters reduce spurious emissions for adjacent channel power measurements.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other FIR filters**
- **Nyquist, root Nyquist**
  - \( \alpha = 0 \) to 1
- **Gaussian**
  - \( B_0 T = 0.1 \) to 1
- **Custom FIR**
  - Up to 256 coefficients
    - 16-bit resolution
    - Automatically scaled

**Oversample ratio**
<table>
<thead>
<tr>
<th>Range</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 8</td>
<td>1</td>
</tr>
</tbody>
</table>

**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**
  - Carrier power (per carrier) < 100 Hz

**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**
(dBC, with high crest factor on)

<table>
<thead>
<tr>
<th>Channels/offsets</th>
<th>0.885 to 1.25 MHz</th>
<th>1.25 to 1.98 MHz</th>
<th>1.98 to 5 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Option UNB</td>
<td>Option H99 (Rev B)</td>
</tr>
<tr>
<td><strong>Reverse (at ≤ 0 dBm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 – 699 MHz</td>
<td>–66 (–72)</td>
<td>–70 (–75)</td>
<td>–71 (–75)</td>
</tr>
<tr>
<td>700 – 1000 MHz</td>
<td>–68 (–73)</td>
<td>–72 (–76)</td>
<td>–78 (–79)</td>
</tr>
<tr>
<td>1000 – 2000 MHz</td>
<td>–63 (–66)</td>
<td>–70 (–74)</td>
<td>–78 (–79)</td>
</tr>
<tr>
<td><strong>9/64 channels (at ≤ –2 dBm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 – 699 MHz</td>
<td>–65 (–68)</td>
<td>–68 (–71)</td>
<td>–70</td>
</tr>
<tr>
<td>700 – 1000 MHz</td>
<td>–64 (–70)</td>
<td>–69 (–73)</td>
<td>–73 (–75)</td>
</tr>
<tr>
<td>1000 – 2000 MHz</td>
<td>–60 (–63)</td>
<td>–67 (–71)</td>
<td>–72 (–73)</td>
</tr>
</tbody>
</table>

1. Parentheses denote typical performance.
2. Specifications apply with high crest factor off.
Bit Error Rate (BER) analyzer
(Option UN7, 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

<table>
<thead>
<tr>
<th>Feature</th>
<th>2 Mbps mode</th>
<th>10 Mbps mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time display</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bit count</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Error-bit-count</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bit error rate</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pass/fail indication</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Valid data and clock detection</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Automatic re-synchronization</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Special pattern ignore</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

GSM/EDGE base station
Bit Error Rate Test (BERT)
(ESG-D series only)

(GSM BTS test only)
(Option 300 requires Option UN8 revision C or better.
Option UNA is highly recommended. The following are required:

GSM BTS test only
E4406A VSA-series transmitter tester with Options BAH (EDGE measurement personality) and 300 Rev. A (321.4 MHz output).

GSM/EDGE BTS test
E4406A VSA-series transmitter tester with Option 202 (GSM and EDGE measurement personality) and Option 300 Rev. B (321.4 MHz output). ESG firmware Option 202, EDGE personality, is also required. To upgrade from Option 300 Rev. A to Option 300 Rev. B requires new hardware.

See configuration guide for a bundled ordering convenience.

Test technique
RF loopback

Supported systems

GSM 400
GSM 850
GSM 900 (P-GSM)
DCS 1800
PCS 1900
E-GSM (extended)

GSM output data
Channel content
Data
Full-rate speech (FS)
PN9, PN15 coded as per ETSI GSM, 05.03 version 3.6.1 (Oct 94).

Frame structure
26-frame TCH multiframe structure as per ETSI GSM, 05.01 version 6.1.1 (1998-07).

Adjacent timeslots
Data
PN9, PN15 coded as per ETSI GSM, 05.03 version 3.6.1 (Oct 94).

Frame structure
26-frame TCH multiframe structure as per ETSI GSM, 5.01 version 6.1.1 (1998-07).

1. Perch power level is 3 dB below DPCCH power.
2. DPCCH power level is 6 dB below DPDCCH power.
**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

**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.

**Maximum RBER**
- 100%

**Maximum FER**
- 100%

**EDGE/EGPRS output data**
- **Channel content**
  - Continuous PN9 or PN15 Sequence for raw BER
  - Continuous PN9 or PN15 Sequence on header and data payload.
- **Data**
  - Fully coded MCS-5 and MCS-9; channel coding provided on PN9 or PN15 for data payload. Coding is done on frames 0 – 11, 13-24, 26-37, 39-50 on a 52 PDCH multiframe. The selected signal pattern is inserted continuously across the full payload.
- **Frame structure**
  - 52-frame multiframe structure for EDGE/EGPRS channel as per ETSI GSM 05.01 release 99. Frames 12, 25, 38 and 51 are empty (no burst).

**Baseband BER (Bit Error Rate) tester**
(Included with Option 300; cannot be ordered separately.)

**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**

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<tr>
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</tr>
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<td>Valid data and clock detection</td>
<td>X</td>
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</tr>
<tr>
<td>Special pattern ignore</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Multichannel Multicarrier 3GPP
W-CDMA personality
(Option 100, ESG-D series only)


**Chip rates**
3.84 Mchips/sec ± 10%

**Frame duration**
10 ms

**Filters**
- W-CDMA: $\alpha = 0.22$
- Nyquist, root Nyquist: $\alpha = 0$ to 1
- Gaussian: $B_0 T = 0$ to 1
- IS-95
- 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: $|I+Q|$, $|I|$ and $|Q|$ (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
  - Test Model 4
- User-defined channel parameters:
  - Symbol rates: 7.5, 15, 30, 60, 120, 240, 480, or 960 kbps
  - Number of channels: Up to 512
  - Spreading code: 0 to 511
  - Channel power: 0 to –40 dB, 0.01 dB resolution
t  - 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
  - TPC value: 0–5555
  - 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, SCCPCH, PSCH, SSCH, CPICH, DPCH
  - DPCCH, DPDCCH
- (uplink)

**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 kbps, spread code 0
  - DPCCH + 1 DPDCCH: 960 kbps, spread code 1
  - DPCCH + 2 DPDCCH: 960 kbps, spread code 2
  - DPCCH + 3 DPDCCH: 960 kbps, spread code 3
- User-defined channel parameters:
  - Symbol rates: 15, 30, 60, 120, 240, 480, or 960 kbps
  - Number of DPDCH channels: 6
  - Spreading code: 0 to 511, symbol rate
  - Scrambling code: 1 to 1FFFFFFFFFFFF, common for all channels
- Second DPDCH orientation: 1 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%)

**Adjacent channel power**
1.8 GHz < $f_c$ < 2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤ –2 dBm, (≤ 0 dBm with Option H99), 5 MHz offset

<table>
<thead>
<tr>
<th>Electronic attenuator (standard)</th>
<th>Mechanical attenuator (Option UNB)</th>
<th>Low ACP (Option H99 Rev B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 DPCH (-58 dBc)</td>
<td>Test Model 1 (-50 dBc)</td>
<td>64 (-66 dBc)</td>
</tr>
<tr>
<td>+ 64 DPCH</td>
<td></td>
<td>60 (-63 dBc)</td>
</tr>
</tbody>
</table>

**Alternate channel power**
1.8 GHz < $f_c$ < 2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤ -2 dBm (0 dBm with Option H99 and baseband filter ON), 10 MHz offset

<table>
<thead>
<tr>
<th>Low ACP (Option H99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 DPCH (-70 (-72 dBc)</td>
</tr>
<tr>
<td>Test model 1 + 64 DPCH</td>
</tr>
</tbody>
</table>

1. Parentheses denote typical performance.
2. Valid for 23 ± 5 °C.
**Multichannel cdma2000 personality**
*(Option 101, 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
- Gaussian
- Custom FIR
  - $\alpha = 0$ to 1
  - $B_R T = 0.1$ to 1
  - Up to 256 coefficients
  - 16-bit resolution
  - Automatically scaled
- Rectangle

**I/O mapping**
- Normal, invert

**Clipping**
- Clip location: Pre- or post-FIR filter
- Clipping type: $|I+Q|$, $|I|$, 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 channel, DS/SR3
  - Multicarrier/SR3
  - 9 channel, DS/SR1

**Reverse link**
- Spreading type: Direct spread only
- Pre-defined channel configurations (partially coded)
  - Pilot channel, SR1
  - 5 channel, (SR1 or SR3)

**User-defined cdma2000**
- Channel types (partially coded)
- Data rate
  - 1.2 kbps 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

**EVM**
- $< 2.1\%$ (825 to 2100 MHz, SR3 pilot, IS-95 filter, which is optimized for EVM, typical)
**Multichannel cdma2000 spurious emissions**

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

<table>
<thead>
<tr>
<th>Channels/offsets</th>
<th>Offsets from center of carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.135 to 2.50 MHz</td>
</tr>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Forward 9 channel, SR3/multicarrier</strong>&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>30 – 200 MHz</td>
<td>(–68)</td>
</tr>
<tr>
<td>700 – 1000 MHz</td>
<td>(–69)</td>
</tr>
<tr>
<td>1000 – 2000 MHz</td>
<td>(–61)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channels/offsets</th>
<th>Offsets from center of carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.655 to 3.75 MHz</td>
</tr>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Forward 9 channel, SR3/DS</strong>&lt;sup&gt;4&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>30 – 200 MHz</td>
<td>(–75)</td>
</tr>
<tr>
<td>700 – 1000 MHz</td>
<td>(–76)</td>
</tr>
<tr>
<td>1000 – 2000 MHz</td>
<td>(–68)</td>
</tr>
</tbody>
</table>

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<th>Offsets from center of carrier</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>5.94 to 10 MHz&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Reverse 5 channel, SR3/DS</strong>&lt;sup&gt;5&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>30 – 200 MHz</td>
<td>(–77)</td>
</tr>
<tr>
<td>700 – 1000 MHz</td>
<td>(–77)</td>
</tr>
<tr>
<td>1000 – 2000 MHz</td>
<td>(–71)</td>
</tr>
</tbody>
</table>

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 3GPP¹
W-CDMA personality
(Option 200, ESG-D series only)

Description
Option 200 W-CDMA personality adds a flexible solution for
W-CDMA mobile and base station test to Agilent ESG-D series RF
signal generators. Signals are fully coded in both forward and
reverse links to provide complete testing of receivers.

Channel types generated
Primary Synchronization (PSCH), Secondary Synchronization
(SSCH), Primary Common Control (P-CCPCH), Common Pilot
(CPICH), Dedicated Physical (DPCH), Page Indication (PICH),
Orthogonal Channel Noise Source (OCNS), Dedicated Physical
Control Channel (DPCCH), Dedicated Physical Data Channel (DPDCH)

BTS setup
FIR filter
Root Nyquist, Nyquist a = 0 to 1
Gaussian BbT = 0 to 1
User defined FIR Up to 256 coefficients,
16-bit resolution

Chip rate
1 kcps to 4.25 Mcps

Primary scramble code
0 to 511

Downlink channel configurations
(Up to 4 channels can be configured simultaneously. With a two
ESG setup, an additional four channels may be configured.)

PSCH
Power –40 to 0 dB

SSCH
Power –40 to 0 dB
Scramble code group 0 to 63 (coupled to primary
scramble code)

P-CCPCH
Power –40 to 0 dB
OVSF 0 to 255
Transport channel BCH coding
Data field PN9, PN15, 4-bit repeating
pattern, user file

CPICH
Power –40 to 0 dB

DPCH
Reference measurement
channels 12.2, 64, 144, 384 kbps
Transport layer
(DCH) control (Up to 6 DCH’s for each DPCH)
block size, Transport Time
Interval (TTI), rate matching,
CRC size, transport
channel number
Data Coding
none, convolutional 1/2,
convolutional 1/3, turbo

Physical layer control
Power –40 to 0 dB
Symbol rate 7.5, 15, 30, 60, 120, 240, 480,
960 Kbps
OVSF 0 to 511 (dependent on channel
symbol rate)
Slot format 0 to 16 (dependent on channel
symbol rate)
TFCl pattern 10-bit user defined input pattern
(converted to 30-bit code word
with Reed-Mueller coding)
TPC pattern Ramp up/down N number of
times (N = 1 to 80), all up,
all down
ρDPCH offset 0 to 149
Secondary scramble
code offset 0 to 15
Data PN9, PN15, 4-bit repeating
pattern, user file, transport
channel

PICH
Power –40 to 0 dB
OVSF 0 to 511
Data PN9, PN15, user file, 4-bit
repeating pattern

OCNS
Power –40 to 0 dB
Symbol rate 7.5, 15, 30, 60, 120, 240, 480,
960 Kbps
OVSF 0 to 511 (Dependent on channel
symbol rate)
Data PN9, PN15
Secondary scramble code offset 0 to 15

**User equipment (UE) setup**

**FIR filter**
- Root Nyquist, Nyquist Gaussian: \( a = 0 \) to \( 1 \)

**Chip rate**
- 1 kcps to 4.25 Mcps

**Primary scrambling code**
- 0 to 16777215

**Secondary scrambling offset**
- 0 to 15

**Uplink synchronization signal setup**
- Timing offset range: Timing offset 512 to 2560 chips or frame clock
- Slot delay: 0 to 119 slots
- Synchronization signal: System Frame Number (SFN) reset
- Frame clock interval: 10 ms, 20 ms, 40 ms, 80 ms
- Frame clock polarity: Positive, negative
- SFN RST polarity: Positive, negative
- Sync trigger mode: Single, continuous
- BBG data clock (chip clock) setup: internal, external
- External clock rate: \( x \) 1 (3.84 MHz), \( x \) 2 (7.68 MHz), \( x \) 4 (15.36 MHz)
- External clock polarity: Positive, negative

**Uplink channel configurations**
- Pre-set channel type
  - Reference measurement channel: 12.2 kbps, 64 kbps, 144 kbps, 384 kbps
  - UDI 64 k
  - AMR 12.2 k

**User defined channels**
- One DPCCH, one DPDCH, up to 6 transport channels

**DPDCH (Dedicated Physical Data Channel)**
- Power: Off, \(-40 \) to \(0 \) dB
- Beta: 0 to 15 (coupled to power)
- Channel code: 0 to 255 (maximum value depends on symbol rate/slot format)
- Data: PN9, PN15, 4-bit repeating pattern, user file, transport channel
- Symbol rate: 15, 30, 60, 120, 240, 480, 960 kbps depending on slot format
- Slot format: 0 to 6

**Transport channel setup**
- Block size: 0 to 5000
- Number of blocks: 0 to 4095
- Coding: 1/2 convolutional, 1/3 convolutional, turbo, none
- TTI: 10 ms, 20 ms, 40 ms, and 80 ms
- Data: PN9, 4-bit repeating pattern, user file
- Rate matching attributes: 1 to 256
- CRC size: 0, 8, 12, 16, 24
- Error insertion: BLER or BER, or none
- BLER (Block Error Rate): 0 to 1 (resolution 0.001)
- BER (Bit Error Rate): 0 to 1 (resolution 0.0001)
- Bits frame: Automatically calculated

**Input**
- Synchronization signal (SFN RST or frame clock): Pattern trigger in BBG data clock (chip clock): data clock in

**Output**
- Chip clock out (3.84 MHz): Data clock out
- Frame timing out: system sync out
- DPDCH (I) symbol data: event1 out
- DPDCH (Q) symbol clock: event2 out
- DPCCH (Q) symbol data: data out
Real-time cdma2000 personality
(Option 201, ESG-D series only)

Description
Option 201, cdma2000 personality, adds a flexible solution for cdma2000 mobile and base station test to Agilent ESG-D series RF signal generators. Option 201 is a firmware personality that requires Option UN8, [hardware revision C or greater], real-time baseband generator to be installed in the ESG. The fully coded nature of this solution in both forward and reverse mode supports long and short codes, cyclic redundancy checks, convolutional or turbo encoding, interleaving, power control, and complex scrambling. Additional capabilities allow flexible channel configurations with individually adjustable power levels and data rates, customizable user data, and variable chip rates. The option is backwards compatible with IS–95A, in both the base station and mobile simulation modes, through support of radio configuration 1 and 2.

Global controls across all channels
- Channel power: 0 to –40 dB
- I/Q voltage scale: 0 to –40 dB

Forward channel configurations
Channel types generated
Up to four channels simultaneously, of any of the following
- Pilot
- Paging
- Sync
- F-Fundamental
- F-Supplemental
- OCNS

BNC MUX outputs
- Event 1: Delayed even second, 20 ms trig delay, 80 ms trig delay, offset 80 ms trig, 25 ms clock, page enable sync, offset 80 ms sync
- Data out: PC ramp, Yi FFCH, Yq FFCH, FPCH W, Sync W, FPCH X, 25 ms clock
- Data clock out: Chip clock, 19.2 clock, 38.4 clock, offset 80 ms trig, forward channel clock, forward channel I clock, forward channel Q clock
- Symbol sync out: Even second, FPCH page, page sync, FFCH page, 20 ms trig delay, FFCH frame sync, PN sync

BTS setup
Filter
- Root Nyquist, Nyquist, Gaussian, IS-95, IS-95 W/ EQ, IS-95 MOD, IS-95 MOD W/ EQ, rectangle, APCO 25 C4FM, user file
- Spread rate: 1
- PN offset: 0-511
- Chip rate: 50 cps-1.3 Mcps
- Even second delay: 0.5 to 128 chips
- Long code state: 0 to 3FFFFFFh

Pilot channel
- Walsh
- 0 (non-adjustable)

Sync channel
- Walsh
- Data
- 0 to 63
- 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
- Data
- 0 to 63
- Default paging message or userfile
- Long code mask: 0-3FFFFFFh
- Rate: 4.8 or 9.6 kbps

Fundamental channel
- Radio configuration: 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: 0-3FFFFFFh
- Power control: N up/down, "N" may be set from 1 to 80
- Power puncture: On/off
- Frame offset: 0 (non-adjustable)
- Frame length: 20 ms (non-adjustable)

Supplemental channel
Same channel configuration as fundamental, except:
- Radio configuration: 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 153.6 kbps
- 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
Reverse channel configurations

IS-95 is supported using RC1 or RC2 which utilizes a single, selectable channel type:
- Reverse Access Control Channel (R–ACH)
- Reverse Fundamental Channel (R–FCH)
- Reverse Supplemental Channel (R–SCH)

IS-2000 features are supported using RC3 or RC4. The channel types consist of the following:
- Reverse Pilot Channel (R–PICH) (with or without gating)
- Reverse Dedicated Control Channel (R–DCCH)
- Reverse Common Control Channel (R–CCCH)
- Reverse Enhanced Access Channel (R–EACH)
- Reverse Fundamental Channel (R–FCH)
- Reverse Supplemental Channel (R–SCH)

BNC MUX outputs
- Event 1: Delayed even second, PN sync
- Data out: Long code, pilot, coded RSCH, coded RDCCH, coded RFCH, coded RCCCH, coded REACH, Z1, Z2
- Data clock out: Chip clock, 5 ms, 10 ms, 20 ms, 40 ms, 80 ms
- Symbol sync out: Even second, long code sync

Mobile set-up
- Radio configuration: 1 to 4
- Trigger advance: 1 to 2457599
- Trigger edge: Rising, falling
- Long code state: 0 to 3FFFF FFFF FFFF FFFF hex
- Long code mask: 0 to 3FFFF FFFF FFFF FFFF hex

Radio configurations 1\(^1\) and 2\(^1\)
- Reverse Access Control Channel (RACH)
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Data rate: 4.8 kbps
  - Frame length: 20
  - Frame offset: 0 to 15

- Reverse Fundamental Channel (R–FCH)
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Data rate: 1.2 kbps, 2.4 kbps, 4.8 kbps, 9.6 kbps for RC1
  - 1.8 kbps, 3.6 kbps, 7.2 kbps, 14.4 kbps for RC2
  - Frame length: 20 mSec
  - Frame offset: 0 to 15

- Reverse Supplemental Channel 0 (R–SCH)
  - Turbo coding: On/off
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Data rate: 1.2 kbps, 2.4 kbps, 4.8 kbps, 9.6 kbps for RC1
  - 1.8 kbps, 3.6 kbps, 7.2 kbps, 14.4 kbps for RC2
  - Frame length: 20 mSec
  - Frame offset: 0 to 15

Radio configurations 3 and 4
- Reverse Pilot Channel (R-PICH)
  - Walsh code: 0 (non adjustable)
  - Gating rate: Quarter, half, full
  - PCB data: 0 to FFFFF hex

- Reverse Dedicated Control Channel (R-DCCH)
  - Walsh code: 0 to 15
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Frame length: 5 or 20 mSec
  - Data rate: For frame length = 5
  - 9.6 kbps, for RC 3 or 4
  - For frame length = 20
  - 9.6 kbps for RC 3 and 14.4 kbps for RC4
  - Frame offset: (0 to frame length/1.25) – 1

- Reverse Fundamental Channel (R–FCH)
  - Walsh code: 0 to 15
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Frame length: 5 or 20 mSec
  - Data rate: For frame length = 5
  - 9.6 kbps, for RC 3 or 4
  - For frame length = 20
  - 1.5, 2.7, 4.8, and 9.6 kbps for RC 3
  - 1.8, 3.6, 7.2, and 14.4 kbps for RC4
  - Frame offset: (0 to frame length/1.25) – 1

- Reverse Supplemental Channel 0 (R–SCH0)
  - Walsh code: 0 to 7
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Frame length: 20, 40 or 80 mSec
  - Data rate: For frame length = 20
  - 1.5, 2.7, 4.8, 9.6,19.2, 38.4,76.8,153.6, 307.2 kbps for RC 3
  - 1.8, 3.6, 7.2, 14.4, 28.8, 57.6, 115.2, 230.4 kbps for RC4
  - For frame length = 40
  - 1.35, 2.4, 4.8, 9.6,19.2, 38.4,76.8, 153.6 kbps for RC 3
  - 1.8, 3.6, 7.2, 14.4, 28.8, 57.6, 115.2 kbps for RC4
  - Frame offset: (0 to frame length/1.25) – 1

- Reverse Supplemental Channel 1 (R–SCH1)
  - Walsh code: 0 to 7
  - Data: PN9, PN15, fixed 4 bit pattern, user file
  - Frame length: 20, 40 or 80 mSec
  - Data rate: For frame length = 20
  - 1.5, 2.7, 4.8, 9.6,19.2, 38.4,76.8, 153.6 kbps for RC 3
  - 1.8, 3.6, 7.2, 14.4, 28.8, 57.6, 115.2 kbps for RC4
  - Frame offset: (0 to frame length/1.25) – 1

---
1. Only one channel is available in RC1 and RC2.
2. These data rates are available with turbo encoding.
3. If either REACH or RCCCH is on, then RPICH is the only other channel that can be on.
For frame length = 80
1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 76.8 kbps
for RC 3
1.8, 3.6, 7.2, 14.4, 28.8, 57.6 kbps
for RC 4
Frame offset
(0 to frame length/1.25) – 1

R-CCCH³ (Reverse Common Control Channel) and R-EACH³
(Reverse-Enhanced Access Channel)
Walsh code
0 to 7
Data
PN9, PN15, fixed 4 bit pattern, user file
Frame length
5, 10 or 20 mSec
Data rate
For frame length = 5
38.4 kbps
For frame length = 10
19.2, 38.4 kbps
For frame length = 20
9.6, 19.2, 38.4 kbps

Real-time EDGE³ personality
(Option 202, 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 gen-
erated 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) 270.833 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.

EVM performance (typical)¹

<table>
<thead>
<tr>
<th>Output power</th>
<th>Output frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>≤ 7 dBm</td>
<td>≤ 10 dBm</td>
</tr>
<tr>
<td>≤ 4 dBm</td>
<td>≤ 7 dBm</td>
</tr>
</tbody>
</table>

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

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

1. All specifications apply at 23 ± 5 °C.
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.
3. EDGE and IS-136HS traffic channels have the same physical layer. This EDGE signal
can be used to simulate an IS-136HS traffic channel for component tests.
General characteristics

**Power requirements**
90 to 254 V; 50, 60, or 400 Hz; 200 W maximum

**Operating temperature range**
0 to 55 °C

**Storage temperature range**
-40 to 71 °C

**Shock and vibration**
Meets MIL-STD-28800E Type III, Class 3.

**Leakage**: Conducted and radiated interference meets MIL-STD-461C CE02 Part 2 and CISPR 11. Leakage is typically < 1 µV (nominally 0.1 µV with a 2-turn loop) at ≤ 1000 MHz, measured with a resonant dipole antenna, one inch from any surface with output level < 0 dBm (all inputs/outputs properly terminated).

**Storage registers**: Memory is shared by instrument states, user data files, sweep list files and waveform sequences. Depending on the number and size of these files, up to 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**


**Control languages** SCPI version 1992.0, also compatible with 8656B and 8657A/B/C/D/J1 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’s commitment to quality.

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 Vpeak into 50 ohms, or 0 to 5 Vpeak 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 Vrms and 10 Vpeak. (BNC, front panel)

**External input 2**
Drives either AM, FM, ΦM, or pulse. Nominal input impedance 50 ohms, damage levels are 5 Vrms and 10 Vpeak. (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)

**GPIB**
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 4 µs 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-A series and

**Option 1E6 only**

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

With 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 Vrms and 10 Vpeak. (BNC, front panel)

**“Q” input**
Accepts a “Q” input for I/Q modulation. Nominal input impedance 50 ohms, damage levels are 1 Vrms and 10 Vpeak. (BNC, front panel)

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1. ESG series does not implement 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 Vdc and 13 dBm reverse RF power. (SMA, rear panel)

With 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 falling edges. The data must be valid on the DATA CLOCK rising 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, 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, 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, rear panel)

Data output
Outputs data from the internal data generator or the externally supplied signal at data input. CMOS signal. (BNC, rear panel)

Data clock output relays a CMOS bit clock signal for synchronizing serial data. (BNC, rear panel)

Symbol sync output
Outputs CMOS symbol clock for symbol synchronization, one data clock period wide. (BNC, 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 Vpeak to peak. Nominal impedance 50 ohms, DC-coupled, damage levels are > +2 and < –2 V. (BNC, rear panel)

With 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 Vpeak 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, rear panel)

With ESG-D series and Option UN7 only

Data, clock and clock gate inputs
Accepts TTL or 75 Ω input. Polarity is selected. Clock duty cycle is 30% to 70%. Damage levels are > +8 V and < –4 V (BNC, 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-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, rear panel)

With ESG-D and Option 300

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

<table>
<thead>
<tr>
<th>Model #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E4400B</td>
<td>1 GHz ESG-A series RF signal generator</td>
</tr>
<tr>
<td>E4420B</td>
<td>2 GHz ESG-A series RF signal generator</td>
</tr>
<tr>
<td>E4421B</td>
<td>3 GHz ESG-A series RF signal generator</td>
</tr>
<tr>
<td>E4422B</td>
<td>4 GHz ESG-A series RF signal generator</td>
</tr>
<tr>
<td>E4430B</td>
<td>1 GHz ESG-D series RF signal generator</td>
</tr>
<tr>
<td>E4431B</td>
<td>2 GHz ESG-D series RF signal generator</td>
</tr>
<tr>
<td>E4432B</td>
<td>3 GHz ESG-D series RF signal generator</td>
</tr>
<tr>
<td>E4433B</td>
<td>4 GHz ESG-D series RF signal generator</td>
</tr>
</tbody>
</table>

### Options

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

To add options to a model, use the following ordering scheme:

**Example**

<table>
<thead>
<tr>
<th>Model #</th>
<th>Description</th>
</tr>
</thead>
</table>
| E4432B | Model-
| E4432B-UND | Model-
| E4432B-100 | Option# |

- **Model # -OB1**: Adds extra manual set
- **Model # -OBV**: Adds service documentation, component level
- **Model # -OBW**: Adds service documentation, assembly level
- **Model # -OBX**: Adds service documentation, assembly and component level
- **Model # -1CM**: Adds rack mount kit, part number 5063-9214
- **Model # -1CN**: Adds front handle kit, part number 5063-9227
- **Model # -1CP**: Adds rack mount kit with handles, part number 5063-9221
- **Model # -1E5**: Adds high-stability timebase
- **Model # -1E6**: High-performance pulse modulation
- **Model # -1EM**: Moves all front panel connectors to rear panel
- **Model # -UN5**: Adds multichannel IS-95 CDMA personality
- **Model # -UN7**: Adds internal bit-error-rate analyzer
- **Model # -UN8**: Adds real-time I/Q baseband generator with TDMA standards and 1 Mbit of RAM
- **Model # -UN9**: Adds 7 Mbits of RAM to Option UN8
- **Model # -100**: Adds multichannel W-CDMA personality
- **Model # -101**: Adds multichannel cdma2000 personality
- **Model # -200**: Adds real-time 3GPP W-CDMA personality
- **Model # -201**: Adds real-time cdma2000 personality
- **Model # -202**: EDGE personality for Real-Time BB generator
- **Model # -300**: Base station BERT extension for Option UN7 (internal bit-error-rate analyzer)
- **Model # -404**: Signal Studio for 1xEV-DO
- **Model # -406**: Signal Studio for Bluetooth
- **Model # -UNA**: Alternate timeslot power level control
- **Model # -UNB**: Adds higher power with mechanical attenuator
- **Model # -UND**: Adds internal dual arbitrary waveform generator
- **Model # -H99**: Improves ACP performance for TETRA, CDMA, and W-CDMA
ESG family application and product information

Application notes, product notes, and product overviews
• 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.
• Generating and Downloading Data to the ESG-D RF Signal Generator for Digital Modulation, Product Note, literature number 5966-1010E.
• Using Vector Modulation Analysis in the Integration, Troubleshooting and Design of Digital Communications Systems, Product Note, 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, Application Note 1307, literature number 5967-5486E.
• Customizing 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.
• ESG Series RF Signal Generators Option 200 W-CDMA, Product Overview, literature number 5988-0369EN.
• ESG Series RF Signal Generators Option 201 cdma2000, Product Overview, literature number 5988-0371EN.

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.
• Signal Generators: Vector, Analog, and CW Models, 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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Canada:
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China:
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(fax) 800 820 2816

Europe:
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Japan:
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(fax) (81) 426 56 7840

Korea:
(tel) (080) 769 0800
(fax) (080) 769 0900

Latin America:
(tel) (305) 269 7500

Taiwan:
(tel) 0800 047 866
(fax) 0800 286 331

Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6755 0042
Email: tm_ap@agilent.com
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