Agilent 8648A/B/C/D
Signal Generators
Data Sheet

8648A, 100 kHz to 1 GHz
8648B, 9 kHz to 2 GHz
8648C, 9 kHz to 3.2 GHz
8648D, 9 kHz to 4 GHz

Specifications describe warranted instrument performance over the 0°C to 50°C temperature range and after a 30-minute warm-up, unless otherwise noted. All performance below a carrier frequency of 250 kHz is typical. Supplemental characteristics are intended to provide information useful in estimating instrument capability in your application by describing typical, but non-warranted performance.
Frequency

Range
8648A: 100 kHz to 1000 MHz
8648B: 9 kHz to 2000 MHz
8648C: 9 kHz to 3200 MHz
8648D: 9 kHz to 4000 MHz

Resolution
Settable
8648A/B/C/D: 0.001 Hz

Display
10 Hz

Accuracy
Typically \( \pm 3 \times 10^{-6} \times \) carrier frequency (Hz), \( \pm 0.15 \times 10^{-6} \times \) carrier frequency (Hz) for Option 1E5

Switching speed (typical)
8648A/B/C/D
\(<1001 \text{ MHz}: <75 \text{ ms}\)
\(\geq 1001 \text{ MHz}: <100 \text{ ms}\)

Internal reference oscillator

Accuracy and stability
(typical, calibration adjustment dependent)
± Aging rate ± temperature effects ± line voltage effects

<table>
<thead>
<tr>
<th></th>
<th>Standard timebase (typical)</th>
<th>High stability timebase (Opt 1E5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aging</td>
<td>(&lt;\pm 2 \text{ ppm/year})</td>
<td>(&lt;\pm 0.1 \text{ ppm/year})</td>
</tr>
<tr>
<td>Temperature</td>
<td>(&lt;\pm 1 \text{ ppm})</td>
<td>(&lt;\pm 0.0005 \text{ ppm/day})</td>
</tr>
<tr>
<td>Line Voltage</td>
<td>(&lt;\pm 0.5 \text{ ppm})</td>
<td>(&lt;\pm 0.1 \text{ ppm})</td>
</tr>
</tbody>
</table>

Output
10 MHz, typically \(>0.5 \text{ V}_{\text{rms}}\) level into 50 \(\Omega\)

External reference oscillator input
Accepts 2, 5, 10 MHz ±10 ppm typical (±1 ppm typical with option 1E5) and a level range of 0.5 \(\text{V}_{\text{rms}}\) to 2 \(\text{V}_{\text{rms}}\) into 50 \(\Omega\)

Spectral purity

Harmonics
\(<-30 \text{ dBc (output } \pm 4 \text{ dBm)}\)

Subharmonics (output \(\leq+4 \text{ dBm)}\)
\(<1001 \text{ MHz}: <-60 \text{ dBc}\)
\(\leq 3200 \text{ MHz}: <-50 \text{ dBc}\)
\(\leq 4000 \text{ MHz}: <-40 \text{ dBc}\)

Nonharmonics (≥5 kHz offset, output \(\leq+4 \text{ dBm)}\)
8648A/B/C/D
\(<249 \text{ MHz}: <-55 \text{ dBc}\)
\(<1001 \text{ MHz}: <-60 \text{ dBc}\)
\(<2001 \text{ MHz}: <-54 \text{ dBc}\)
\(\leq 4000 \text{ MHz}: <-48 \text{ dBc}\)

Residual FM (CCITT, rms)
8648A/B/C/D
\(<249 \text{ MHz}: <7 \text{ Hz, typically } <4 \text{ Hz}\)
\(<501 \text{ MHz}: <4 \text{ Hz, typically } <2 \text{ Hz}\)
\(<1001 \text{ MHz}: <7 \text{ Hz, typically } <4 \text{ Hz}\)
\(<2001 \text{ MHz}: <14 \text{ Hz, typically } <8 \text{ Hz}\)
\(\leq 4000 \text{ MHz}: <28 \text{ Hz, typically } <12 \text{ Hz}\)

SSB phase noise (at 20 kHz offset, typical)
8648A/B/C/D
at fc 500 MHz: <-120 dBc/Hz
at fc 1000 MHz: <-116 dBc/Hz
at fc 2000 MHz: <-110 dBc/Hz
at fc 3000 MHz: <-106 dBc/Hz
at fc 4000 MHz: <-104 dBc/Hz

Typical phase noise of the 8648A/B/C/D at 500 MHz

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1. After one hour warm-up and within one year of calibration.
2. After four days warm-up and within one year of calibration.
3. Applies over the 25°C ±5°C range.
4. Applies for line voltage change of ±5%.
Output

Range
8648A
+10 to –136 dBm

8648B/C/D
≤2500 MHz: +13 to –136 dBm
≤4000 MHz: +10 to –136 dBm

Maximum leveled power
(High power option 1EA)

8648B/C/D only\(^1\)
≤100 kHz: +17 dBm
≤1000 MHz: +20 dBm
≤1500 MHz: +19 dBm
≤2100 MHz: +17 dBm
≤2500 MHz: +15 dBm
≤4000 MHz: +13 dBm

Display resolution
0.1 dB

Accuracy
8648A/B/C/D\(^2,3,4\)
≤2500 MHz: ±1.0 dB
≤3200 MHz: ±1.5 dB
≤4000 MHz: ±2.0 dB

Reverse power protection (watts into 50\(\Omega\))
≤2000 MHz: 50 watts
≤4000 MHz: 25 watts

SWR (output <–6 dBm, typical)
8648A/B/C/D
<249 kHz: <2.5:1
<2500 MHz: <1.5:1
≤4000 MHz: <2.0:1

Output impedance
Nominal 50 ohms

Amplitude modulation (\(f_c >1.5\) MHz)\(^5\)

Range
0 to 100% (output ≤+4 dBm)

Resolution
0.1%

Accuracy (1 kHz rate)
±5% of setting ±1.5%

Rates
8648A/B/C/D
Internal: 400 Hz or 1 kHz or 10 Hz to 20 kHz with Opt 1E2
External: DC: dc to 25 kHz (typical, 3 dB BW)
AC: 1 Hz to 25 kHz (typical, 3 dB BW)

Distortion (1 kHz rate, THD+N, 0.3 to 3 kHz BW)
(at 30% AM): <2%
8648A (at 90% AM): <3%
8648B/C/D (at 70% AM): <3%

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1. Combining option 1E6 with 1EA reduces maximum output power by 2 dB above 100 MHz.
2. Accuracy is valid from maximum specified output power to –127 dBm.
3. Accuracy applies at 25°C ±5°C; and typically degrades up to ±0.5 dB over 0°C to 50°C or at output power levels >13 dBm.
4. Accuracy is ±3 dB for power levels between –100 dBm and –127 dBm for frequencies below 100 kHz or above 2500 MHz.
5. AM is typical above 1001 MHz.
6. AM accuracy applies at 25°C ±5°C and at <70% depth: it is typically ±7% of setting ±1.5% over 0°C to 50°C.
Frequency modulation

**Peak deviation** (rates >25 Hz ac FM)
- 8648A/B/C/D
  - <249 MHz: 0 to 200 kHz
  - <501 MHz: 0 to 100 kHz
  - <1001 MHz: 0 to 200 kHz
  - <2001 MHz: 0 to 400 kHz
  - ≤4000 MHz: 0 to 800 kHz

**Resolution**
- For ≤10% peak deviation
  - <2001 MHz: 10 Hz
  - ≥2001 MHz: 20 Hz
- For >10% to maximum peak deviation
  - <2001 MHz: 100 Hz
  - ≥2001 MHz: 200 Hz

**Deviation accuracy** (internal 1 kHz rate)
- 8648A/B/C/D
  - <1001 MHz: ±3% of FM deviation ±30 Hz
  - <2001 MHz: ±3% of FM deviation ±60 Hz
  - ≤4000 MHz: ±3% of FM deviation ±120 Hz

**Rates**
- 8648A/B/C/D
  - Internal: 400 Hz or 1 kHz or 10 Hz to 20 kHz with Opt 1E2
  - External: DC: dc to 150 kHz (typical, 3 dB BW)
  - AC: 1 Hz to 150 kHz (typical, 3 dB BW)

**Distortion** (1 kHz rate, THD + N, 0.3 to 3 kHz BW)
- <1001 MHz: <1% at deviations >4 kHz
- <2001 MHz: <1% at deviations >8 kHz
- ≤4000 MHz: <1% at deviations >16 kHz
  (88 to 108 MHz: <0.5% at deviations ≥75 kHz)

**Carrier frequency accuracy** (relative to CW in dcFM)
- 8648 A/B/C/D
  - <1001 MHz: ±100 (typical 40) Hz, deviations <10 kHz
  - <2001 MHz: ±200 (typical 80) Hz, deviations <20 kHz
  - ≤4000 MHz: ±400 (typical 160) Hz, deviations <40 kHz

**FM + FM**
Internal 1 kHz or 400 Hz source plus external. In internal plus external FM mode, the internal source produces the set level of deviation. The external input should be set to ≤±0.5V peak or 0.5 Vdc (one-half the set deviation).

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Phase modulation

**Peak deviation**
- <249 MHz: 0 to 10 radians
- <501 MHz: 0 to 5 radians
- <1001 MHz: 0 to 10 radians
- <2001 MHz: 0 to 20 radians
- ≤4000 MHz: 0 to 40 radians

**Resolution**
- <2001 MHz: 0.01 radians
- ≥2001 MHz: 0.02 radians

**Deviation accuracy** (internal 1 kHz rate, typical)
- 8648A/B/C/D
  - <1001 MHz: ±3% of deviation ±0.05 radians
  - <2001 MHz: ±3% of deviation ±0.1 radians
  - ≤4000 MHz: ±3% of deviation ±0.2 radians

**Rates**
- Internal
  - 400 Hz or 1 kHz or 10 Hz to 20 kHz with Opt 1E2
- External
  - 20 Hz to 10 kHz (typical, 3 dB BW)

**Distortion** (1 kHz rate)
- 8648 A/B/C/D
  - <1001 MHz: <1% at deviations ≥3 radians
  - <2001 MHz: <1% at deviations ≥6 radians
  - ≤4000 MHz: <1% at deviations ≥12 radians

**Modulation source**
- Internal
  - 400 Hz or 1 kHz, front panel BNC connector provided at nominally 1 Vpk into 600 Ω.
- External
  - 1 Vpk into 600 Ω (nominal) required for full scale modulation. (High/Low indicator provided for external signals ≤10 kHz.)

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1. Only on 8648 series.
2. Specifications apply over the 25°C ±5°C range within one hour of dc FM calibration.
Modulation generator (Option 1E2)\(^1\)

Adds variable frequency modulation source. Functions also included in Option 1EP Pager encoder/signalling option.

**Waveforms**
Sine, Square, Triangle, Sawtooth (Ramp)

**Frequency range**
- Sine: 10 Hz to 20 kHz
- Square, Triangle, Sawtooth: 100 Hz to 2 kHz\(^2\)

**Frequency accuracy**
\(±0.01\% \text{ typical}\)

**Frequency resolution**
1 Hz (3 digits or 10 Hz displayed)

**Depth and deviation accuracy** (1 kHz sine)
Refer to AM, FM, and Phase Modulation Accuracy specs

**Output**
Front panel BNC. Nominally 1 Vpk

Pulse modulation (Option 1E6)
(8648B/C/D Only)
Adds high performance pulse modulation capability

**On/off ratio**
- <2000 MHz: >80 dB
- \(≤4000\) MHz: >70 dB

**Rise/fall times**
<10 ns

**Maximum repetition rate**
10 MHz

**Video feedthrough**
<30 mV (typical)

**Delay**
<60 ns (typical)

**Pulse input**
TTL level (±15 V max)

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Pager encoder/signaling (Option 1EP)

(8648A only)
Adds functionality for testing POCSAG, FLEX™\(^3\) and FLEX-TD. Also includes Modulation Generator functions of Option 1E2. Instrument characteristics are the same as the 8648A except as noted below.

**Frequency**
Accuracy with Option 1E5\(^4\): Typically \(±0.15\times10^{-6}\) x carrier frequency in Hz or \(0.092\times10^{-6}\) x carrier frequency in Hz within 90 days of calibration.

**Frequency modulation**
FSK Deviation Accuracy with Option 1EP: \(±60\) Hz\(^5\)

**Pager signaling**
Supported Pager Protocols: POCSAG, FLEX™, and FLEX-TD

**POCSAG**
- Speed: 512, 1200, and 2400 bps
- Message Format: Tone only, Numeric, Alphanumeric

**FLEX/FLEX-TD**
- Speed
  - 2 Level FSK: 1600 and 3200 bps
  - 4 Level FSK: 3200 and 6400 bps
- Message Format: Tone only, Numeric (standard and special), Alphanumeric, HEX/Binary
- Address Type: Short, Long

**Messaging accessible from front panel or GP-IB**
- Message Types: Five fixed (built-in), one user-defined
- Message Length: 40 characters maximum
- Repetition Modes: Single, Burst, Continuous

**Messaging accessible only over GP-IB**
- Message Type: Arbitrary (user-defined)
- Batch Length
  - FLEX/FLEX-TD: 128 Frames
  - POCSAG: 128 Batches
- Repetition Mode: Single only
- Data Rate Accuracy: \(±5\) ppm\(^6\)

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1. Only on 8648 series.
2. Useable from 10 Hz to 20 kHz; however, bandwidth limitations may result in wave-form degradation. Refer to AM, FM, and Phase Modulation Rate specs (External AC mode).
3. FLEX is a Motorola trademark.
4. After one hour warm-up and within one year of calibration.
5. Specifications apply over the 25°C ±5°C range. 4.8 kHz deviation.
6. Meets FLEX requirements at 274 to 288, 322 to 329, 929 to 932 MHz.
7. Specifications apply over the 25°C ±5°C range.
Modulation source
Internal: 400 Hz or 1 kHz, or audio generator (see Option 1E2 for characteristics), front panel BNC connector provided at nominally 1 Vp into 600 Ω.

General
Storage Registers: 70 storage registers with sequence and register number displayed. Up to 10 sequences are available with 30 registers each.

ISO 9002 compliant
The Agilent 8648A/B/C/D signal generators are manufactured in an ISO 9002 registered facility in concurrence with Agilent Technologies’ commitment to quality.

Environmental
Operating temperature range
0°C to 50°C

Shock and vibration
Meets MIL STD 28800E Type III, Class 5

Leakage
Conducted and radiated interference meets MIL STD 461B RE02 Part 2 and CISPR 11. Leakage is typically <1 µV (nominally 0.1 µV with a two-turn loop) at ≤1001 MHz, when measured with a resonant dipole antenna one inch from any surface (except the rear panel) with output level <0 dBm (all inputs/outputs properly terminated).

Remote programming
Interface
GP-IB (IEEE-488.2-1987) with Listen and Talk.

Control languages
SCPI version 1992.0. 8656B and 8657 code compatibility on 8648A/B/C/D.

Functions controlled
All functions are programmable except the front-panel power key, the knobs, the increment set key, the arrow keys, the reference keys and the rear-panel display contrast control.

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

General
Power requirements
90 to 264 V; 48 to 440 Hz; 170 VA maximum

Internal diagnostics
Automatically executes on instrument power-up. Assists user in locating instrument errors and locating faulty module.

Storage registers
300 storage registers with sequence and register number displayed. Up to 10 sequences are available with 30 registers each.

Weight
8648A
7 kg (15 lb.) net, 9 kg (20 lb.) shipping
8648B/C/D
8.5 kg (19 lb.) net, 11 kg (24 lb.) shipping

Dimensions
8648A/B/C/D
165H x 330W x 368D mm (6.5H x 13W x 14.6D inches)

Accessories
Transit case
8648A/B/C/D: P/N 5961-4720
To add options to a model, use the following ordering scheme:

**Example**
Model # : 8648C
Model # -option# : 8648C-1EA
Model # -option# : 8348C-1E2

**Options**
Model # -1EA : High output power
Model # -1E2 : Modulation generator
Model # -1E5 : High stability time base
Model # -1E6 : Pulse modulation
Model # -1EP : Pager signaling capability

**Documentation**
Model # -UK6 : Commercial calibration certificate with testdata
Model # -08648-90048 : English Operation and Service Guide
Model # -AB0 : Chinese localization Taiwan
Model # -AB1 : Korean localization
Model # -AB2 : Chinese localization - China
Model # -ABD : German localization
Model # -ABE : Spanish localization
Model # -ABF : French localization
Model # -ABJ : Japanese localization
Model # -0B0 : Delete manuals

**Accessories**
Model # -1CM : Rack mount kit

**Warranty and Service**
Standard warranty is 12 months.
For warranty and service of 5 years, specify 60 months (quantity = 60)

R-51B : Return-to-Agilent warranty and service plan (months)

**Calibration**
For 3 years, specify 36 months of the appropriate calibration plan.
For 5 years, specify 60 months.

R-50C-001 : Standard calibration plan (months)
R-50C-002 : Standards compliant calibration plan (months)

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1. Not available on 8648A
2. Only available on 8648A
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