

# 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.



**Agilent Technologies**

# 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<sup>1</sup>

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

## Switching speed (typical)

### 8648A/B/C/D

<1001 MHz: <75 ms  
 ≥1001 MHz: <100 ms

# Internal reference oscillator

## Accuracy and stability<sup>1</sup>

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

	Standard timebase (typical)	High stability timebase (Opt 1E5)
Aging	<±2 ppm/year	<±0.1 ppm/year <sup>2</sup> <±0.0005 ppm/day <sup>2</sup>
Temperature	<±1 ppm	<±0.01 ppm <sup>3</sup> (typical)
Line Voltage <sup>4</sup>	<±0.5 ppm	<±0.1 ppm (typical)

## Output

10 MHz, typically >0.5 V<sub>rms</sub> level into 50 Ω

## 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 V<sub>rms</sub> to 2 V<sub>rms</sub> into 50 Ω

# Spectral purity

## Harmonics

<-30 dBc (output ≤+4 dBm)

## Subharmonics (output ≤+4 dBm)

<1001 MHz: <-60 dBc  
 ≤3200 MHz: <-50 dBc  
 ≥4000 MHz: <-40 dBc

## Nonharmonics (≥5 kHz offset, output ≤+4 dBm)

### 8648A/B/C/D

<249 MHz: <-55 dBc  
 <1001 MHz: <-60 dBc  
 <2001 MHz: <-54 dBc  
 ≤4000 MHz: <-48 dBc

## Residual FM (CCITT, rms)

### 8648A/B/C/D

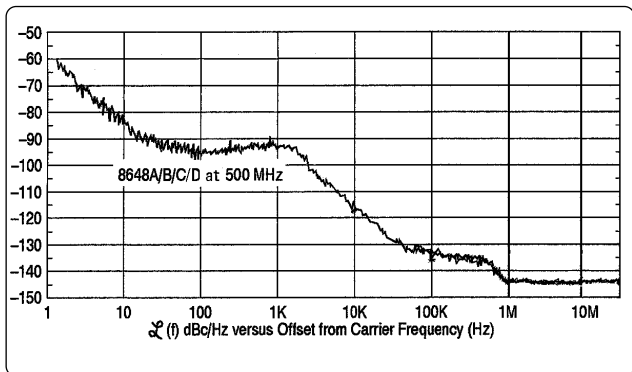
<249 MHz: <7 Hz, typically <4 Hz  
 <501 MHz: <4 Hz, typically <2 Hz  
 <1001 MHz: <7 Hz, typically <4 Hz  
 <2001 MHz: <14 Hz, typically <8 Hz  
 ≤4000 MHz: <28 Hz, typically <12 Hz

## 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



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<sup>1</sup>

≤100 kHz: +17 dBm

≤1000 MHz: +20 dBm

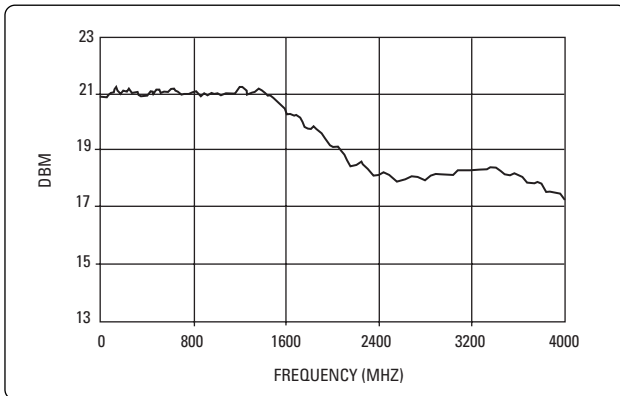
≤1500 MHz: +19 dBm

≤2100 MHz: +17 dBm

≤2500 MHz: +15 dBm

≤4000 MHz: +13 dBm

#### Option 1EA—Typical power versus frequency (GHz)



### Display resolution

0.1 dB

### Accuracy

8648A/B/C/D<sup>2,3,4</sup>

≤2500 MHz: ±1.0 dB

≤3200 MHz: ±1.5 dB

≤4000 MHz: ±2.0 dB

### Reverse power protection (watts into 50 Ω)

≤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

Nominally 50 ohms

## Amplitude modulation ( $f_c > 1.5$ MHz)<sup>5</sup>

### Range

0 to 100% (output ≤+4 dBm)

### Resolution

0.1%

### Accuracy<sup>6</sup> (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%

1. Combining option 1E6 with 1EA reduces maximum output power by 2 dB above 100 MHz. Below 100 MHz, maximum output is +13 dBm (typically +16 dBm for carrier frequencies between 100 kHz and 100 MHz).
2. Accuracy is valid from maximum specified output power to -127 dBm. Below -127 dBm, accuracy is typically ±3 dB in the range 100 kHz to 2500 MHz, and is not specified outside this frequency range.
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<sup>1</sup>)

### Carrier frequency accuracy

(relative to CW in dcFM)<sup>2</sup>

#### 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).

## 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<sup>1</sup>

#### 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.)

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)<sup>1</sup>

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<sup>2</sup>

### Frequency accuracy

±0.01% 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 V<sub>pk</sub>

## 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)

## Pager encoder/signaling (Option 1EP)

(8648A only)

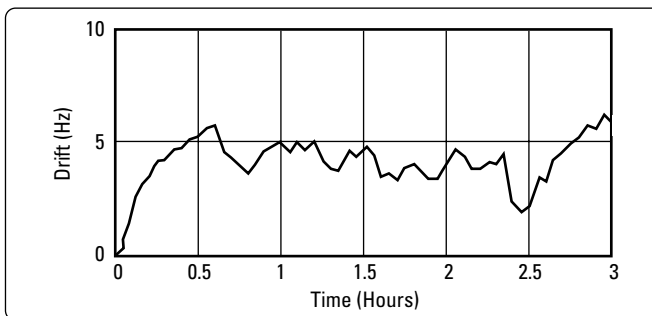
Adds functionality for testing POCSAG, FLEX<sup>TM3</sup> and FLEX-TD. Also includes Modulation Generator functions of Option 1E2. Instrument characteristics are the same as the 8648A except as noted below.

### Frequency

Accuracy with Option 1E5<sup>4</sup>: Typically ±0.15x10<sup>-6</sup> x carrier frequency in Hz or 0.092x10<sup>-6</sup> x carrier frequency in Hz within 90 days of calibration.

### Frequency modulation

FSK Deviation Accuracy with Option 1EP: ±60 Hz<sup>5</sup>



### Pager signaling

Supported Pager Protocols: POCSAG, FLEX<sup>TM</sup>, 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<sup>6</sup>

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 ModulationRate 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.

Meets FLEX requirements at 274 to 288, 322 to 329, 929 to 932 MHz.

6. 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  $\Omega$ .

## 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  $\mu$ V (nominally 0.1  $\mu$ V with a two-turn loop) at  $\leq$ 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

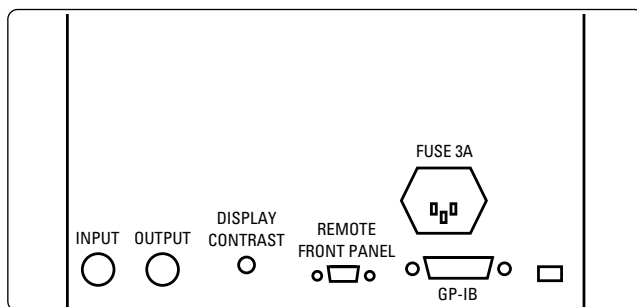
8648A/B/C/D

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



8648 Rear panel

**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 <sup>1</sup>
Model # -1E2	Modulation generator
Model # -1E5	High stability time base
Model # -1E6	Pulse modulation <sup>1</sup>
Model # -1EP	Pager signaling capability <sup>2</sup>

## Documentation

Model # -UK6	Commercial calibration certificate with testdata
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
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## 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)
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## 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

## Additional resources

For additional information and feature comparisons, refer to the 8648 product overview (literature number 5962-6191E).

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