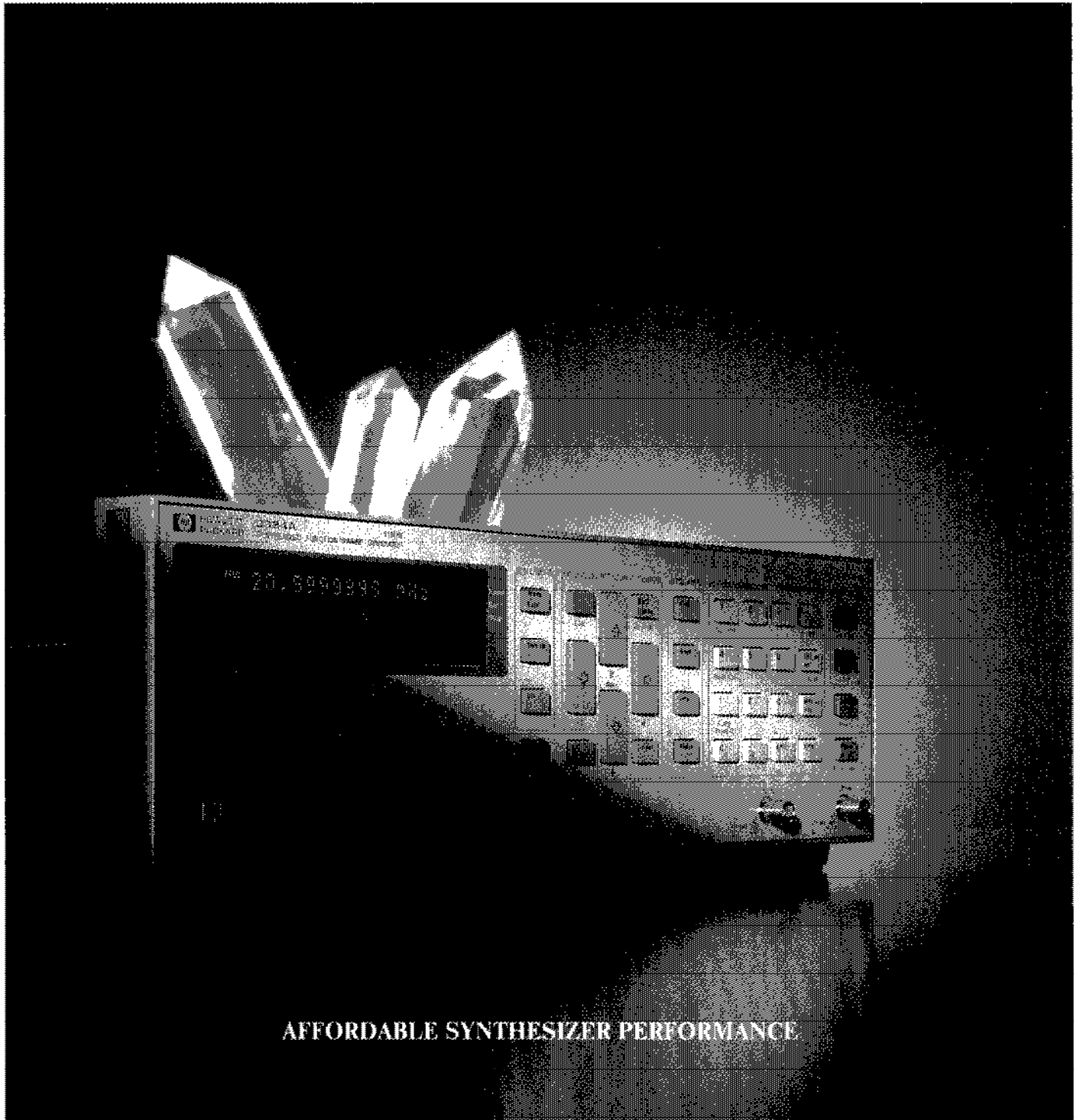


# SYNTHESIZED FUNCTION/SWEEP GENERATOR

MODEL HP 3324A

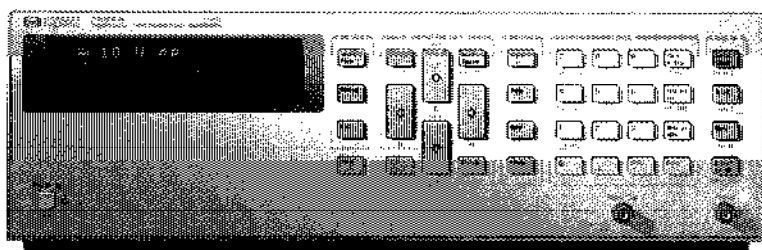
TECHNICAL DATA



AFFORDABLE SYNTHESIZER PERFORMANCE

## ALL IN ONE

- SYNTHESIZER
- FUNCTION GENERATOR
- SWEEP GENERATOR
- ATE INSTRUMENT



### 5 ppm Frequency Accuracy

A measurement result is only as good as the instrument used. To achieve reliable results it is necessary to use instruments which are much more accurate than the device under test.

The frequency accuracy delivered by the HP 3324A is 5 ppm. Therefore, there are very low tolerances between what is displayed and what is generated, thus making a frequency counter to check the frequency unnecessary.

### High Frequency-Stability

Frequency accuracy is not the only specification that leads to reliable measurement results, frequency stability is also one.

The long-term frequency stability of the HP 3324A, which is 5 ppm/year, leads to reliable measurement results and reduces the calibration cycles which would be necessary if standard function generators were used.

### 0.05 ppm High-Stability Option

The high-stability frequency-reference option improves the stability of the HP 3324A to 0.05 ppm/week. This is useful in applications which require an extremely stable reference source.

## As a synthesizer

### Frequency Resolution down to 1 mHz

The high frequency-resolution of 1 mHz is important, especially for low-frequency applications, for example, for the stimulation of mechanical vibrations.

Even at 20 MHz the 3324A has a frequency resolution of only 100 mHz.

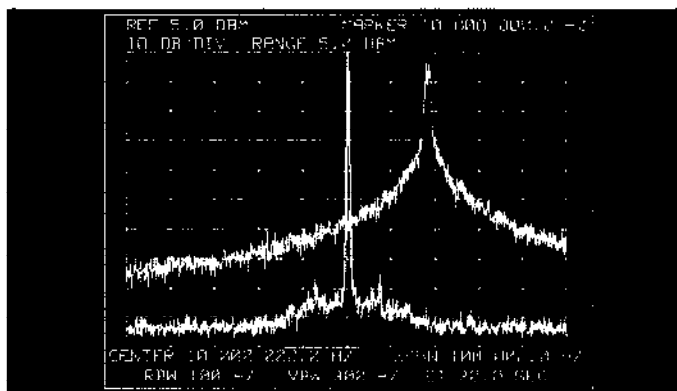


The 9 digit display allows you to set up frequencies with a resolution down to 1 mHz.

### Outstanding Signal Purity

Synthesizer performance not only means excellent frequency stability but also good signal purity, which is essential, for example, in the qualification of amplifiers, filters or Phase Locked Loops.

Signal purity is characterized by phase noise, harmonic and spurious signals. The specifications of the HP 3324A meet the requirements for pure input signals.



The comparison of the spurious distortion of a conventional function generator (top) with the HP 3324A (bottom) shows significant differences in terms of frequency accuracy and noise level.



## Synthesizer Performance

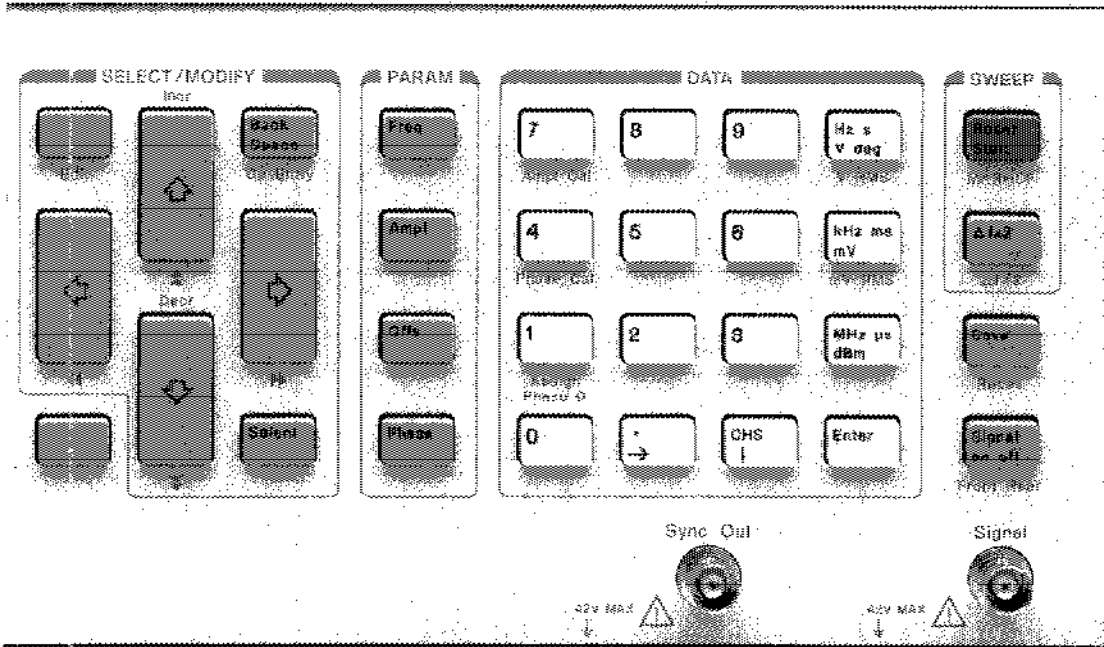
- \* 1 MHz - 21 MHz Sinewave
- \* 9 Digits Frequency Resolution
- \* 5 ppm Frequency Accuracy
- \* 0.05 ppm High-Stability Frequency-Reference Option
- \* Low Sinewave Harmonic Distortion
  - 50 dBc Phase Noise
  - 55 dBc Spurious

## Function/Sweep Generator Waveforms

- \* Sinewave (1 MHz - 21 MHz)
  - \* Square (1 MHz - 11 MHz)
  - \* Triangle, negative and positive ramp
  - \* Auxiliary TTL clock (1 MHz - 60 MHz)
  - \* DC
- ## Sweep
- \* Multi-Interval
  - \* Linear
  - \* Logarithmic
  - \* Phase continuous over the full frequency range
  - \* Multi-Marker mode
  - \* 40 V (p-p) High-Voltage Output (optional)

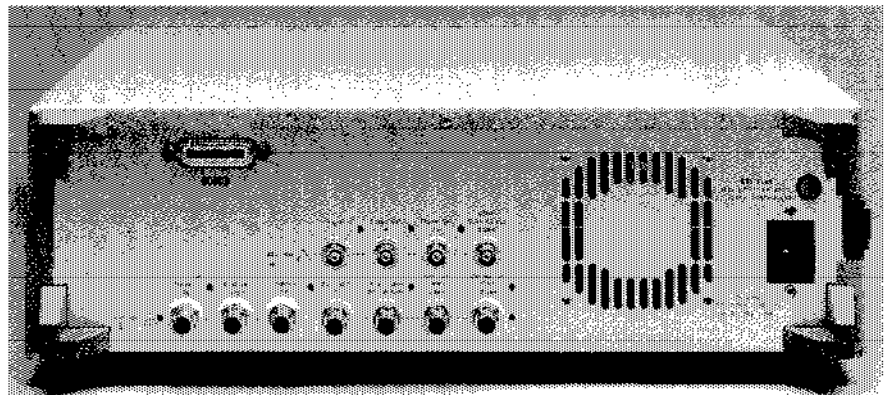
AND ...

... CONVENIENT OPERATION ...



## Generator Features

- MHz)
- Hz)
- 1 positive ramps (1 mHz - 11 kHz)
- (1 mHz - 60 MHz)



*Note: Photo shows instrument with all options.*

er the full frequency range

age Output Option

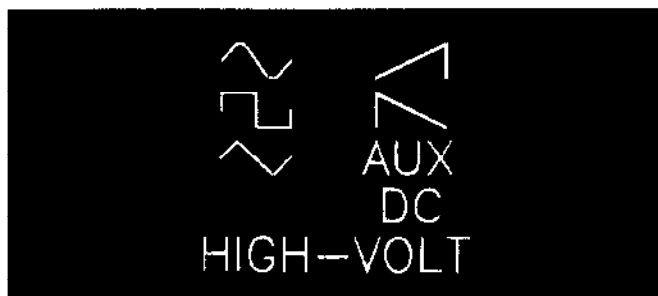
# ... FOR A VARIETY OF APPLICATIONS ...

## 1 mHz - 21 MHz Sine

## 1 mHz - 60 MHz TTL Clock

Five different waveforms are a part of the HP 3324A's function generator. All waveforms are, of course, generated with synthesizer accuracy.

The SYNC output can be switched to deliver an Auxiliary TTL clock ranging from 1 mHz to 60 MHz, also providing synthesizer stability and resolution over the full frequency range. This is useful, for example, for a complex measurement set-up which requires a highly stable master clock, or for the clock generation of fast A/D or D/A converters.



*The HP 3324A offers 5 standard waveforms, an Auxiliary TTL clock and DC. The standard waveforms and DC can be combined with the High-Voltage Output Option.*

## Variable Offset and Amplitude

Many applications require different output voltages, ranging from millivolts to volts. Therefore, the HP 3324A provides amplitudes which can be set with 4-digit resolution, from 1 mV (p-p) to 10 V (p-p).

The DC offset "shifts" the AC signal from + 4.5 V to - 4.5 V.

## High Linearity

Triangle and ramps are generated with a linearity of 0.05% of full p-p output. This performance makes the HP 3324A the ideal function generator for the fast evaluation of nonlinearities of A/D converters or for driving xy-plotters.

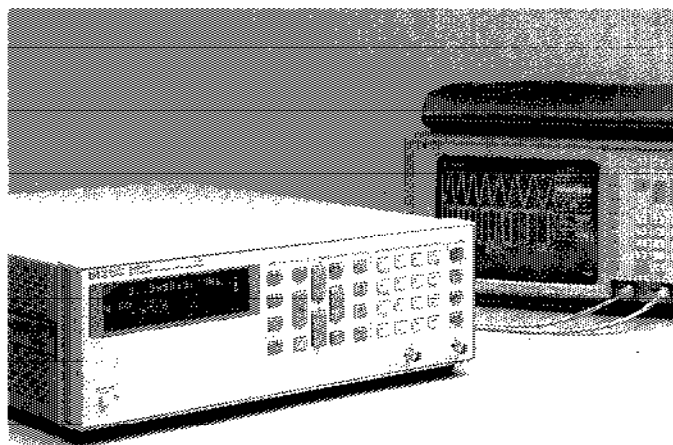
## Accurate DC Source

Switching off the waveforms makes the HP 3324A a precise DC source. The voltage at the 50 Ohm output can be varied between  $\pm 5$  V with 4-digit resolution, which covers the most common voltage levels.

## 40 V (p-p) High-Voltage Output Option

The high-voltage output option delivers an amplitude up to 40 V (p-p) into 500 Ohms for frequencies up to 1 MHz. The DC offset is also increased by a factor of 4 compared to the standard DC offset. The high-voltage output option is useful, for example, in attenuator or amplifier measurements.

## As a function generator



# ... WITH EXTENDED SWEEP CAPABILITIES ...

## Multi-Interval Sweep

The HP 3324A provides sweep capabilities which go much further than those of a conventional sweep generator. This is performed by the Multi-Interval Sweep. Up to 50 *different* intervals can be set, each containing its individual sweep parameters, such as start and stop frequency, sweep time, and linear or logarithmic sweep.

A sequence can be programmed which determines the order of the intervals to be swept. Each interval can be set up n-times in the sequence. This means an interval defined once, can be generated n-times while the HP 3324A sweeps the sequence.

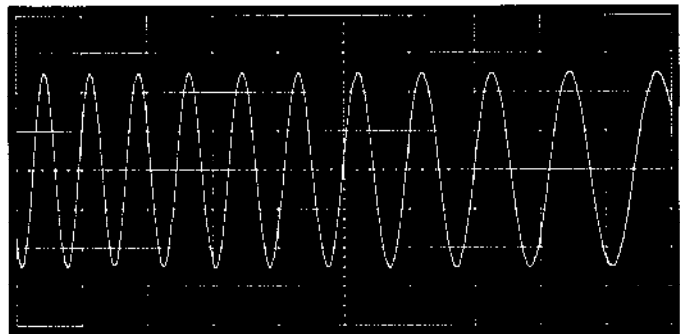
The Multi-Interval Sweep also makes the change of sweep parameters easier and faster than with a conventional sweep generator. Just set-up the required interval parameters once and then change the sequence whenever you want to vary the sweeping.

## Phase Continuous Sweep

The HP 3324A performs all sweep modes without any phase discontinuity even if a sudden transition of the frequency is performed.



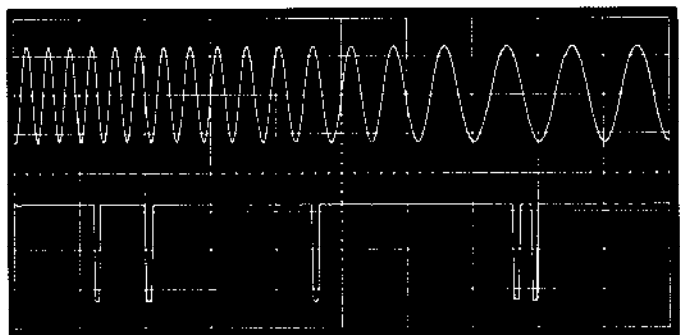
The sweep menu allows you to set up sweep parameters for each individual interval.



The Multi-Interval Sweep allows phase-continuous Frequency Shift Keying, the simulation of accelerated rotation signals or other complex sweep sequences.

## Multi-Marker Mode

As an alternative to the Multi-Interval Sweep the HP 3324A offers the Multi-Marker Mode. This allows you to define up to 9 different marker frequencies by using one interval only. When the HP 3324A achieves one of the specified frequencies during sweeping, it generates a pulse at its marker output. This feature is very useful for the evaluation of filter characteristics or networks to determine critical frequencies.



In the Multi-Marker Mode up to 9 different frequencies can be marked with an output signal at the marker output.

## As a sweep generator

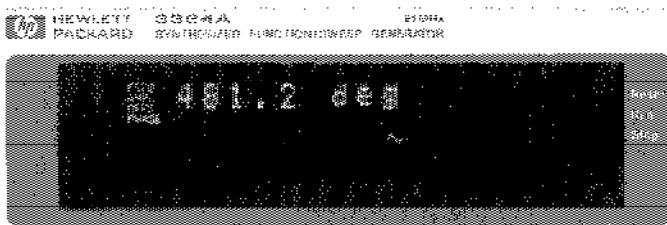


The sequence of intervals is entered in the sweep menu. The displayed sequence performs a sweep starting with interval 9 followed by intervals 10 to 21, followed by interval 2, followed by intervals 1 to 4 and then by 9.

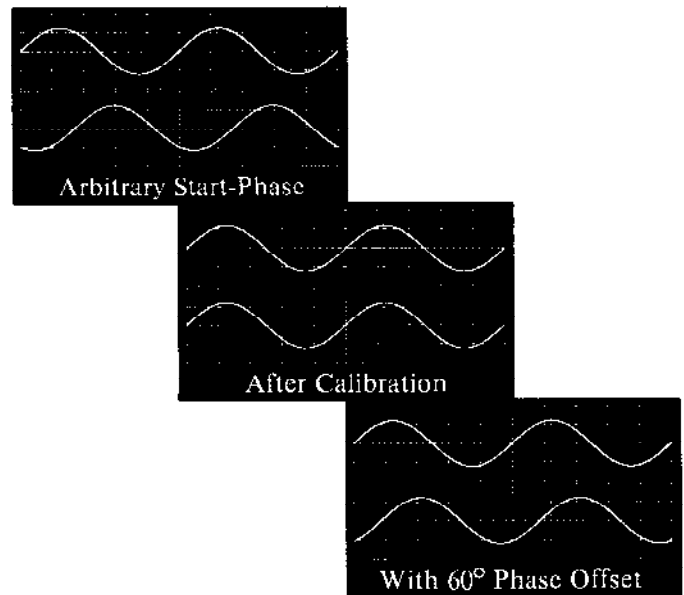
## ... AT AN AFFORDABLE PRICE

### Two-Phase Signals

For the calibration of phase meters or phase discriminators, for example, two HP 3324A can be connected to generate phase related output signals. The synchronisation is performed by connecting the reference output of one instrument with the reference input of the other, this guarantees that both instruments are phase locked. The phase can be adjusted with the help of an oscilloscope or a phase-meter. The adjusted phase can be defined to be 0 degree by just pressing the ASSIGN PHASE 0 key. Then each phase offset, which can be programmed between +720 and -720 degrees, refers to the assigned zero-phase.



*The phase offset at each HP 3324A can be adjusted to +/- 720 degree with 0.1 degree resolution.*



*After calibration a phase offset can be assigned to 0 degree. All phase parameters are then related to the assigned zero-phase value.*

## As an ATE instrument

### Automatic Phase Calibration Options

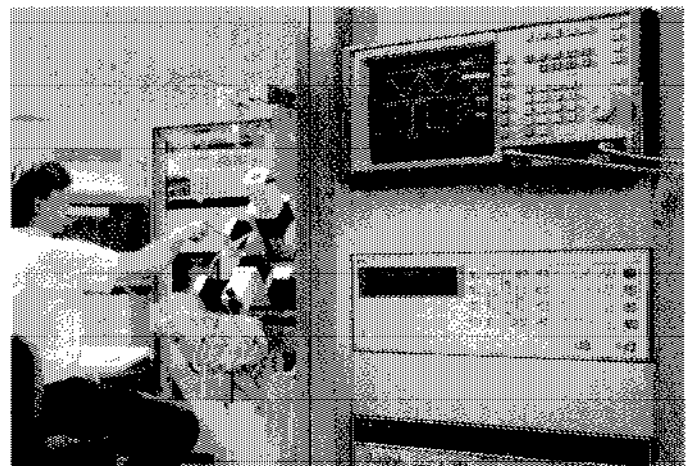
These options provide phase calibration between two HP 3324As by a simple keystroke or HP-IB command without the need of an oscilloscope, phasemeter or other instruments.

The calibration can be started after connecting the two instruments with BNC cables. After calibration the phase offset between the two generators is at the required value, which has previously been set.

The procedure can even be performed with different output levels for any signals that have equal waveform and frequency. This allows quick phase calibration under computer control via HP-IB and avoids complex calibration routines.

### Floating Ground

Distortion of the output signal, which could occur when a few instruments are connected together in an ATE system, is significantly reduced with the HP 3324A's floating ground.



*The HP 3324A is designed to be used on the bench and in ATE systems, therefore it is fully HP-IB programmable.*

# SPECIFICATIONS

All specifications apply after a 30 minute warm-up phase and are valid at 0°C to 55°C ambient temperature.

describe the instruments warranted performance.

describe the instruments typical performance.

## Waveforms

Sine, Square, Triangle, negative and positive Ramps, DC, TTL clock

### Frequency

Range  
Sine: 1 MHz - 21,000,000.0 MHz  
Square: 1 MHz - 11,000,000.0 MHz  
Triangle: 1 MHz - 11,000,000.0 kHz  
Ramps: 1 MHz - 11,000,000.0 kHz  
Auxiliary  
TTL clock: 1 MHz - 60,000,000.0 MHz

### Resolution:

1 MHz, up to 999,999,999 kHz.  
100 MHz, 1 MHz up to 21,000,000.0 MHz.

### Accuracy:

± 5 ppm of selected value, 20° to 30°C, at time of calibration with standard frequency reference.

### Stability:

± 5 ppm/year, 20° to 30°C, standard (see also option 001, high stability frequency reference).

### Warm-up time:

20 minutes to within specified accuracy.

## Main Signal Output

### Impedance:

50Ω ± 1Ω, 0 - 10 kHz.

### Return loss:

> 20 dB, 10 kHz to 20 MHz, except > 10 dB for > 3 V, 5 MHz to 20 MHz.

### Floating:

Output may be floated up to 42V peak (AC + DC).

### Connector:

BNC, switchable to front or rear panel.

## Amplitude

(all waveforms except Auxiliary TTL clock).

### Range:

1 mV to 10 V (p-p) in 8 amplitude ranges, 1-3-10 sequence, amplitude can be set up in rms and dBm also.

### Ranges (without DC offset):

1 mV - 2.999 mV	100 mV - 299.9 mV
3 mV - 9.999 mV	300 mV - 999.9 mV
10 mV - 29.99 mV	1 V - 2.999 V
30 mV - 99.99 mV	3 V - 10.00 V

### Resolution:

4 digits (0.03% of full range).

Function	peak to peak	rms	dBm (50Ω)
Sine	min.	1.000 mV	0.354 mV
	max.	10.00 V	3.536 V
Square	min.	1.000 mV	0.500 mV
	max.	10.00 V	5.000 V
Triangle/ Ramps	min.	1.000 mV	0.289 mV
	max.	10.00 V	2.887 V
			-56.02
			+23.98
			-53.01
			+26.99
			-57.78
			+22.22

## Accuracy: (with 0 Vdc offset)

### Sine:

	.001 Hz	100 kHz	10 MHz	20 MHz
+ 23.98 dBm	± .2 dB		± .4 dB	
+ 13.52 dBm	± .2 dB		± .6 dB	± .6 dB
- 16.02 dBm	± .2 dB		± .6 dB	± .9 dB
- 56.02 dBm	± .2 dB		± .6 dB	± .9 dB

### Square Wave:

	.001 Hz	100 kHz	10 MHz
10 Vp-p	± 1.5%		± 5%
3 Vp-p	± 2.2%		± 10%
1 mVp-p	± 2.2%		± 10%

### Triangle:

	.001 Hz	2 kHz	10 kHz
10 Vp-p	± 1.5%	± 5.0%	
3 Vp-p	± 2.7%	± 6.2%	
1 mVp-p	± 2.7%	± 6.2%	

### Ramps:

	.001 Hz	500 Hz	10 kHz
10 Vp-p	± 1.5%	± 10%	
3 Vp-p	± 2.7%	± 11.2%	
1 mVp-p	± 2.7%	± 11.2%	

With DC offset, increase all sinewave tolerances by .2 dB and all function tolerances by 2%.

## Sinewave Spectral Purity

### Phase noise:

- 50 dBc for a 30 kHz band centered on a 20 MHz carrier (excluding ± 1 Hz about the carrier).

### Spurious:

All non-harmonically related output signals will be more than 55 dB below the carrier (- 50 dBc with DC offset) or less than - 85 dBm, whichever is greater.

### Sinewave harmonic distortion:

Harmonically related signals will be less than the following levels relative to the fundamental:

Frequency Range	Harmonic Level
0.1 Hz - 199 kHz	- 60 dBc
200 kHz - 1.99 MHz	- 40 dBc
2 MHz - 14.9 MHz	- 30 dBc
15 MHz - 20 MHz	- 25 dBc

## Squarewave Characteristics

### Rise/Fall time:

(10% to 90%, at full output): ≤ 20 ns.

### Overshoot:

5% of p-p amplitude, at full output.

### Symmetry:

≤ 0.02% of period + 3 ns.

## Triangle/Ramp Characteristics

### Linearity:

(10% - 90%, 10 kHz): ± 0.05% of full p-p output voltage for each range.

### Ramp retrace time:

(90% to 10%): ≤ 3 μs.

### Period variation for alternate ramp cycles:

≤ 1% of period.

## DC Offset

### Range:

DC only (no AC signal): 0 to ± 5 V/50Ω  
DC + AC: Maximum DC offset ± 4.5 V on highest range; decreasing to ± 4.5 mV on lowest range.

### Resolution:

4 digits

### Accuracy:

DC only: ± 0.015 mV to ± 50 mV, depends on offset chosen, ± 0.02 mV.

DC + AC, to 1 MHz: ± 0.06 mV to 60 mV, depends on AC output level, ± 0.2 mV to ± 120 mV for ramps to 10 kHz.

DC + AC, 1 MHz to 20 MHz: ± 0.15 mV to ± 150 mV, depends on AC output level.

## Phase Offset

### Range:

± 719.9° with respect to arbitrary starting phase or assigned zero phase. For square wave frequencies below 25 kHz, phase changes greater than 25° may result in a phase shift ± 180° from the desired amount.

### Resolution:

0.1°

### Increment accuracy:

± 0.5°

### Stability:

± 1° of phase/°C.

## Frequency Sweep

### Sweep sequence modes:

Single, continuous.

### Sweep function modes:

#### Multi-Interval:

Up to 50 different intervals can be sequenced and repeated in a sequence which can contain up to 100 intervals.

Frequency-switching-time between intervals (to within 1 Hz):

≤ 12 ms for 100 kHz step,

≤ 27 ms for 1 MHz step,

≤ 72 ms for 20 MHz step.

#### Multi-Marker:

Up to 9 marker frequencies can be set if a standard sweep (no Multi-Interval) is performed.

Achieving a marker frequency generates a high to low transition at the marker output. Time between start- and marker-frequency, succeeding marker-frequencies, marker- and stop-frequency ≥ 1.5 ms.

#### Linear sweep (settable for each interval):

Sweep time: 0.01 s to 10<sup>5</sup> s.

Maximum sweep width: Full frequency range of the main signal output for the waveform in use.

Minimum sweep width: 0 Hz.

One marker frequency can be set in each interval.



# SPECIFICATIONS

**Logarithmic sweep** (settable for each interval):  
Sweep time: 0.1 s to 10<sup>5</sup> s.  
Maximum sweep width: Full frequency range of the main signal output for the waveform in use, minimum start frequency is 1 Hz.  
Minimum sweep width: 1 decade.

**Phase continuity:**  
Sweep is phase continuous over the full frequency range of the main output for all sweep modes.

## Auxiliary Outputs

**SYNC output:**  
1 MHz to 21 MHz phase synchronous squarewave with same frequency as main signal output or 1 MHz to 60 MHz Auxiliary TTL clock (main signal output switched off).  
Output impedance: 50 Ω.  
Output levels: High level > 1.2 V, Low level < 0.2 V.  
Connector: BNC front and rear panels.  
Note: Level doubles into open input.

**Auxiliary frequency output:**  
Squarewave.  
Frequency range: 21 MHz to 60 MHz.  
Output impedance: 50 Ω.  
Amplitude: 0 dBm.  
Connector: Rear panel BNC.

**X-Axis drive output:**  
(0 - 100 s sweeps only).  
The ramp is proportional to the entire sweep time, including each individual interval sweep time and the switching times between intervals.  
Load impedance: > 10 kΩ.  
Output level: 0 to +10 V.  
Connector: Rear panel BNC.

**Z-Axis blank output:**  
TTL compatible voltage levels capable of sinking current from a positive source. Current 200 mA, voltage 45 V, power dissipation max. 1 W.  
Connector: Rear panel BNC.

**Sweep marker output:**  
High to low transitions at selected marker frequencies. TTL and CMOS compatible output levels. Pulse width in Multi-Marker mode: 1 ms.  
Connector: Rear panel BNC.  
Fan out: 4.

**1 MHz reference output:**  
1 MHz squarewave for phase locking additional instruments to the HP 3324A.  
Output impedance: 50 Ω.  
Output amplitude: 0 dBm.  
Connector: Rear panel BNC.

## Auxiliary Inputs

**Reference input:**  
For phase locking the HP 3324A to an external frequency reference.  
Signal from 0 dBm to 20 dBm into 50 Ω.  
Reference signal must be a subharmonic of 10 MHz from 1 MHz to 10 MHz.  
Connector: Rear panel BNC. With option 001 this input must be connected to the 10 MHz oven output.

## HP-1B Control

**Frequency switching time** (to within 1 Hz exclusive of programming time):  
≤ 10 ms for 100 kHz step, ≤ 25 ms for 1 MHz step, ≤ 70 ms for 20 MHz step.

**Phase switching time** (to within 90° of phase lock exclusive of programming time):  
≤ 15 ms.

**Amplitude switching time** (to within amplitude specification, exclusive of programming time):  
< 30 ms.

**Interface functions:**  
SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT0, C0, E2.

## Option 001 High Stability Frequency Reference

**Aging rate:**  
± 5 × 10<sup>-8</sup>/week after 72 hours continuous operation.  
± 1 × 10<sup>-7</sup>/month after 15 days continuous operation.

**Warm-up time:**  
Reference will be within ± 1 × 10<sup>-7</sup> of final value 15 minutes after turn-on at 25° C for an off time of less than 24 hours.

**10 MHz oven output:**  
10 MHz squarewave for phaselocking additional instruments to the HP 3324A.  
Output impedance: 50 Ω.  
Output level: 4.5 dBm.  
Connector: Rear panel BNC.

## Option 002 High Voltage Output

**Frequency range:**  
1 MHz to 1 MHz.

**Amplitude:**  
4 mV to 40 V (p-p) in 8 ranges, 4-12-40 sequence into 500 Ω, < 500 pF load. Ranges are four times the standard instrument ranges, without DC offset.  
Accuracy: ± 2% of full output for each range at 2 kHz.  
Flatness: ± 10% relative to programmed amplitude.

**Sinewave harmonic distortion:**  
Harmonically related signals will be less than the following levels (relative to the fundamental full output into 500 Ω, 500 pF load):

Frequency range	Harmonic level
10 Hz - 199 kHz	-60 dBc
200 kHz - 1 MHz	-40 dBc

**Square wave rise/fall time:**  
≤ 125 ns, 10% to 90% of p-p output voltage with 500 Ω, 500 pF load.

**Square wave overshoot:**  
≤ 10% of p-p output voltage with 500 Ω, 500 pF load.

**Output impedance:**  
< 3 Ω at DC, < 10 Ω at 1 MHz.

**DC offset:**  
Range: 4 times the specified range of the standard instrument.  
Accuracy: ± (1% of full output voltage for each range + 25 mV).

**Maximum output current:**  
± 40 mA peak.

## Automatic Phase Calibration Options

The Automatic Phase Calibration options 003 (slave) and 004 (master) provide the automatic phase calibrator between two HP 3324A without external measuring instruments. Option 003 has to be installed into one HP 3324A, option 004 has to be installed into the other instrument. Adjust factors for different cable delays between master/slave and 3324A/device-under-test can be entered in the UTILITY menu.

## Phase Error

The phase error is measured between the main signal outputs at the rear panel with either unequal or equal amplitudes and without DC offset. Phase is defined as the difference in rising edge to rising edge (measured with AC-coupled zero-crossing-points as reference points) for sine and squarewaves.

	Sine / Sine			
	3-10 V (p-p)		0,3-10 V (p-p)	
1 MHz - 100 Hz	± 1.5°	± 2°	± 1.5°	± 2°
> 100 Hz - 1 MHz	± 1°	± 1.5°	± 1°	± 1.5°
> 1 MHz - 10 MHz	± 1°	± 2°	± 1°	± 3.5°
> 10 MHz - 21 MHz	± 2.6°	± 4°	± 2.6°	± 7°

	Square / Square			
	3-10 V (p-p)		0,3-10 V (p-p)	
1 MHz - 100 Hz	± 1°	± 1.5°	± 1°	± 1.5°
> 100 Hz - 1 MHz	± 0.4°	± 1°	± 0.4°	± 1°
> 1 MHz - 10 MHz	± 1.2°	± 2°	± 1.2°	± 3°

## General

**Operating environment:**  
Temperature: 0° C to 55° C if not otherwise noted.  
Relative humidity: 95%, 0° C to 40° C.  
Storage temperature: -40° to 75° C.

**Power:**  
100/120/220/240 V, ± 10%, 48 to 66 Hz, 70 VA, 100 VA with all options installed, 20 VA standby.

**Weight:**  
11 kg net, 16.5 kg shipping.

**Dimensions:**  
132.6 mm high x 425.5 mm wide x 497.8 mm deep (5 1/4" x 16 3/4" x 19 5/8").

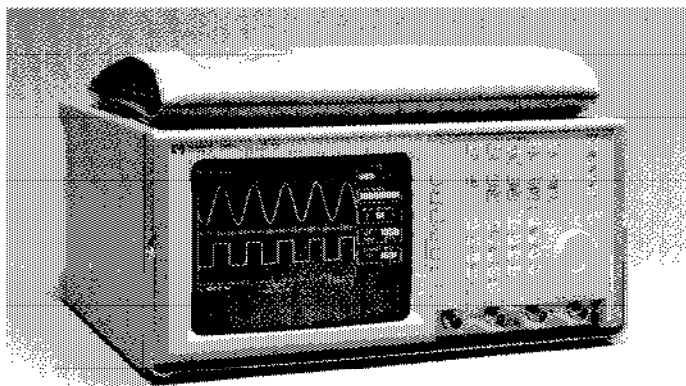
# ORDERING INFORMATION



- HP 3324A** ☎ Synthesized Function/Sweep Generator  
(includes Operating/Programming Manual)
- Opt. 001** ☎ High Stability Frequency Reference
- Opt. 002** ☎ High Voltage Output
- Opt. 003** Automatic Phase Calibration, Slave
- Opt. 004** Automatic Phase Calibration, Master
- Opt. 907** Front Handle Kit (P/N 5062-3989)
- Opt. 908** Rack Flange Kit (P/N 5062-3977)
- Opt. 909** Rack Flange and Handle Combination Kit  
(P/N 5062-3983)
- Opt. 916** Operating/Programming Manual  
(P/N 03324-90011)
- W30** Two additional years of return-to-HP service

*NOTE: Automatic phase calibration between two 3324A requires options 003 and 004.*

☎ These products are available for fast ship service.  
Call HP DIRECT at toll-free 800-538-8787.



*Recommended equipment at the receiving end:  
HP 54501A Digitizing Oscilloscope*

**United States:**  
Hewlett-Packard Company  
4 Choke Cherry Road  
Rockville, MD 20850  
(301) 670-4300

Hewlett-Packard Company  
5201 Tollview Drive  
Rolling Meadows, IL 60008  
(312) 255-9800

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5161 Lankershim Blvd.  
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(31) 205479999

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