

# FREQUENCY, FUNCTION & WAVEFORM SYNTHESIZERS

## Multifunction Synthesizer

Model 8904A

- Sinewaves dc to 600 kHz
- Square, ramp, triangle dc to 50 kHz
- Direct digital synthesis
- Tone, DTMF, digital sequence modes
- One or two outputs
- One to four internal channels
- AM, FM, 0M, DSBSC and pulse modulation
- External timing control for fast hop



### HP 8904A Multifunction Synthesizer

The HP 8904A Multifunction Synthesizer uses the latest VSLIC technology to create complex signals from six fundamental waveforms. The standard HP 8904A digitally synthesizes precise sine, square, triangle, ramp, white noise, and dc waveforms and routes these signals to a single output. Option 001 adds three more identical internal synthesizers (channels) which either can modulate the first synthesizer or be summed to the output. Frequency, amplitude, waveform, phase, and destination can be set independently for each synthesizer. Available modulation types for channel A include AM, FM, 0M, DSBSC, and pulse modulation. Option 002 adds a second output, providing a second, separate signal for two-channel applications. Option 003 adds fast hop and digital modulation capability to the HP 8904A. All this unique capability makes the HP 8904A a powerful new tool for demanding applications like VOR, ILS, FM Stereo, and communications signaling.

#### Function Synthesizer

The HP 8904A Multifunction Synthesizer delivers synthesizer accuracy, along with six waveforms in a compact, economical package. Broad sinewave frequency coverage from 0 Hz to 600 kHz with 0.1 Hz resolution make the HP 8904A ideal for a number of low-frequency applications. In addition to sinewave generation, the HP 8904A has five other standard functions: square, triangle, ramp, dc, and Gaussian white noise. Of these five, square, ramp, and triangle functions are available from 0 Hz to 50 kHz. All waveform values in the HP 8904A are DIGITALLY calculated in real time by Hewlett-Packard's Digital Waveform Synthesis IC. The use of this chip results in signals with very well-defined accuracy and exact repeatability.

#### Two Outputs

Option 002 adds a second, identical synthesizer and floating output section to make the HP 8904A TWO synthesizers in one half-rack width instrument. Frequency, amplitude, waveform, and phase can be independently set for each of the two synthesizers.

Although both synthesizers are independent, the relative phase between the two outputs can be controlled precisely. Either synthesizer can be varied in phase from 0 degrees to 359.9 degrees with a resolution of 0.1 degree. Testing phase detectors, servo systems, shaft encoders, sonar, and other phase sensitive two-port devices is easy and accurate with the HP 8904A Option 002.

#### Complex Signal Generation

By adding three more (total of four) internal synthesizers which can modulate or be summed with synthesizer A (channel A), Option

001 is the key to complex signal generation for the HP 8904A Multifunction Synthesizer. All four internal synthesizers can be set to generate different waveforms, frequencies, amplitudes, and phase offsets at the same time. These signals then can be DIGITALLY summed before routing to the output. In addition to summing, Option 001 allows channels B, C, and D to be used as modulation sources for channel A. The allowable modulation types for channel A are: AM, FM, 0M, DSBSC (Double Sideband Suppressed Carrier) and pulse modulation. Using summation and modulation, the HP 8904A Option 001 can generate precise VOR composite, ILS composite, and FM Stereo Multiplex composite signals. Only your imagination limits the possibilities for signal generating with the HP 8904A Multifunction Synthesizer.

#### Communication Signaling

In addition to the extra channels, Option 001 also adds three sequence modes to the HP 8904A: tone sequence mode, DTMF sequence mode, and digital sequence mode. These modes make the HP 8904A a powerful tool for generating sequences used in communications signaling. Tone sequence mode allows entry of sixteen unique sine wave tones, each with an "on-time" and "off-time". From these sixteen tones, sequences can be built up to a length of 250 tones. The minimum on and off time duration is 800  $\mu$ s with 10 $\mu$ s resolution while the maximum value is 655.35 ms. Digital sequence mode can generate digital bit streams up to 1000 bits in length. Minimum period in the digital mode is 100 $\mu$ s with 10 $\mu$ s resolution. On and off "levels" in the digital mode can be set to any value for simulating different logic families and asserted "high" or asserted "low" logic conventions. For ease of entry, data may be entered in binary, octal, or hexadecimal formats. All three modes contain extensive sequence-editing features and three control modes: single sequence, continuously repeat sequence, and manual step-through the sequence.

#### Fast Hop

Option 003 adds the ability to hop the HP 8904A in frequency, phase, and/or amplitude. Up to 16 frequency/phase/amplitude states can be entered into the "HOP RAM" memory. To hop, an external device must address the four-bit TTL-level address bus provided on the digital port connector on the rear panel. As the address supplied to the bus is varied, the HP 8904A will hop to the frequency/phase/amplitude state that corresponds to that address of the HOP RAM memory. Fast hop can be performed only on channel A. Phase continuous frequency switching can be done in as little as 8 $\mu$ s.

## HP 8904A Specifications

### Frequency

#### Range:

**Sinewave:** 0 Hz to 600 kHz.

**Square, triangle, ramp:** 0 Hz to 50 kHz.

**Resolution:** 0.1 Hz.

#### Accuracy:

**Internal 10 MHz timebase:**  $\pm 50$  ppm.

### AC Amplitude

**Range:** 0 to 10V p-p into a 50  $\Omega$  load.

**Resolution:** 3 1/2 digits.

**Accuracy (>40 mV p-p into 50  $\Omega$ ):**

**Sine:** 1%, 0.1 Hz to 100 kHz; 3%, 100 kHz to 600 kHz.

**Flatness (>630 mV p-p into 50  $\Omega$ ):**  $\pm 0.1\%$  ( $\pm 0.009$  dB), 0.1 Hz to 100 kHz.  $\pm 1.0\%$  ( $\pm 0.09$  dB), 100 kHz to 600 kHz.

### DC Amplitude

**Range:** 0 to  $\pm 10$ V open circuit.

**Resolution:** 3 1/2 digits.

**Accuracy:**  $\pm 6$  mV or  $\pm 0.6\%$ , whichever is greater.

### Spectral Purity (sinewave)

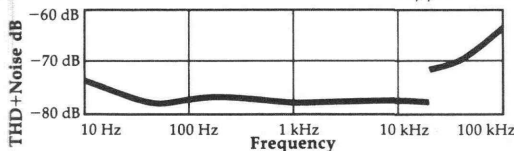
**THD+N (including spurs, amplitude >50 mV rms):**

-63 dBc rms (0.07%), 20 Hz to 7.5 kHz, 30 kHz BW.

-63 dBc rms (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW.

-55 dBc rms (0.18%), 20 kHz to 100 kHz, 750 kHz BW.

Typical THD+Noise in 80kHz measurement BW at 5V<sub>rms</sub> into a 50  $\Omega$  Load.



### Phase (sine wave)

**Range:** 0° to 359.9°.

**Resolution:** 0.1°.

**Increment accuracy (relative to 0° for a fixed frequency):**  $\pm 0.05^\circ$ , 0.1 Hz to 100 kHz.

### Gaussian Noise

**Spectral characteristic:** Equal energy per unit bandwidth ("white").

**Flatness (>100 mV p-p into 50  $\Omega$ ):** typically

$\pm 0.5$  dB, 0.1 Hz to 100 kHz.

$\pm 1.0$  dB, 100 kHz to 600 kHz.

### Option 001 Specifications

Modulation for channel A ONLY, and specified for sinewave carrier and modulation. Internal channels B, C, and D can be used to modulate channel A either collectively with one modulation type, or to provide simultaneous modulation of channel A with any of the available modulation types. External modulation is NOT possible.

#### Amplitude Modulation (with Option 001)

**Rate:** 0 Hz to 600 kHz.

**Depth range:** 0% to 100% of carrier amplitude.

**Resolution:** 0.1% of carrier amplitude.

#### Frequency Modulation (with Option 001)

**Range:** 0 Hz to 600 kHz.

**Deviation range:** 0 Hz to 600 kHz.

**Resolution:** 0.1 Hz or 3/2 digits, whichever is less.

#### Phase Modulation (with Option 001)

**Rate:** 0 Hz to 600 kHz.

**Range:** 0° to 179.9°/channel, except:

[(mod. freq. X deviation/57.3) + carrier freq.]  $\leq$  600 kHz.

**Resolution:** 0.1° or 0.001 radians.

#### Pulse or DSBSC Modulation (with Option 001)

**Rate:** 0 Hz to 50 kHz (up 600 kHz for DSBSC).

### Summation (with Option 001)

Two, three or four channels may be summed into a single output. Two or three channels may be summed for modulation of channel A. All combinations of channels are acceptable, EXCEPT FOR: [A+C and B+D at the same time] or [A+D and B+C at the same time].

**FM stereo multiplex separation (L-R):** typically >65 dB, audio frequency 20 Hz to 15 kHz.

**Channel to channel phase accuracy (equal amplitude sinewaves summed to one output):**  $\pm 0.1^\circ$  or 30 ns, 0.1 Hz to 100 kHz, whichever is greater.

### Tone Sequence (with Option 001)

**Number of different frequencies:** 16 user-definable tones each with an individual on time and off time.

**On/off time duration:** 0 ms, 0.80 ms to 655.35 ms.

**Sequence length:** 250 tones, user-definable from front panel or HP-IB programmable.

### DTMF Sequence (with Option 001)

**Number of tone pairs:** 16 standard DTMF tone pairs (0-9, A-D, #, \*).

**On/Off time duration:** 0 ms, 1.0 ms to 655.35 ms.

**Sequence length:** 250 DTMF tones, user-definable from front panel or HP-IB programmable.

### Digital Sequence (with Option 001)

**User definable:** On level, Off level, and period.

**Sequence entry:** Binary, Octal, or Hexadecimal.

**Sequence length:** up to 1000 bits.

**Period duration:** 0.10 ms to 655.35 ms.

### General

**Output impedance:** 50  $\pm 3\%$  typically, 0.1 Hz to 600 kHz.

**Output type:** floating or grounded, HP-IB programmable.

**Maximum float voltage (signal+float):** 10V peak maximum from high or low side to chassis ground.

**Operating temperature range:** 0° C to 50° C.

**Storage temperature range:** -20° C to 70° C.

**Humidity range:** 95% RH, 0° C to 40° C.

**Remote operation:** HP-IB. All functions except the line switch are remotely controllable.

**HP-IB functions:** SH1, AH1, T6, TEO, L4, LEO, SR1, RL1, PPI, DC1, DT0, C0.

**Power requirements:** 100V, 120V;  $\pm 10\%$ ; 48 to 440 Hz.

220V, 240V;  $\pm 10\%$ ; 48 to 66 Hz. 80 VA max.

**Weight:** Net, 5.9 kg (12.8 lb); shipping, 13 kg (28.6 lb).

**Size:** 133H X 213W X 513 mmD (5.25" X 8.36" X 20.2").

### Ordering Information

	Price
<b>HP 8904A</b> Multifunction Synthesizer (one output standard) <sup>1</sup>	\$2,750
<b>Opt 001</b> Add three (two when ordered with option 002) internal channels, Channel A modulation, summation, and sequence capability	+\$1,575
<b>Opt 002</b> Add second internal synthesizer and output	+\$1,250
<b>Opt 003</b> Add fast hop and digital modulation capability	+\$525
<b>Opt 004</b> Connectors on rear panel only	+\$50
<b>Opt 910</b> Provides an additional operation and calibration manual (08904-90007) and two service manuals (08904-90008)	+\$123
<b>Opt 915</b> Add service manual (08904-90008)	+\$36
<b>Opt W30</b> Extended repair service. See page 725.	+\$65
<b>08955-60014</b> 560 feedthrough barrel for 600 output impedance	\$170
<b>5061-9657</b> Rack Mount Adapter Kit (for rack mounting a single HP 8904A)	\$60
<b>5061-9697</b> Support Shelf Kit (for rack mounting two HP 8904s side by side)	\$195
<b>HP 8904A</b> Retrofit Kits (customer retrofittable):	
<b>HP 11816A</b> Retrofit Kit for Option 001	\$1,905
<b>HP 11817A</b> Retrofit Kit for Option 002	\$1,520
<b>HP 11818A</b> Retrofit Kit for Option 003	\$620

<sup>1</sup>HP-IB cables not included. For description and price, see page 569.