

# FREQUENCY, FUNCTION & WAVEFORM SYNTHESIZERS

## 1 mHz-50 MHz Pulse/Function Generator

Model 8116A

- Sine, triangle, square, haversine and dc
- 1 mHz-50 MHz, 32 Vpp for all waveforms
- Variable (10 ns min) pulse width, 6 ns transitions
- Wide range of operating capability
- Self-prompting operating concept
- Error recognition and self test



Picture shows 8116A with Option 001, Burst and Logarithmic Sweep.

The fully programmable HP 8116A features pulse as well as function generator capabilities in one small unit. A broad 1 mHz-50 MHz band for all waveforms and a wide choice of operating and modulating modes assure high flexibility. These factors, plus good repeatability, make the HP 8116A a sound, long-term investment.

### Unique Operating Concept Saves Engineering Time

HP's custom IC's have made it feasible to put the many HP 8116A capabilities into such a small volume. Handling is simplified by a unique, microprocessor-controlled, operating concept which ensures a clear overview of the compact front panel at all times. When the mode and waveform have been selected, illuminated labels show which parameters must be set. There's no clutter, no confusion.

**Auto vernier.** In normal mode, the HP 8116A's auto-vernier increments any desired parameter continuously until a stop signal is applied. This means that thresholds can be measured automatically, without a controller.

**Level or amplitude programming.** The HP 8116A's output can be programmed in terms of high and low levels or in terms of amplitude and offset. Consequently a direct, automatic, conversion is always feasible so that the HP 8116A can be programmed in the same terms as the device is specified.

**Safe limit.** Devices can be protected by the limit feature. This prevents the output from exceeding a given magnitude.

### Rectangular Waveforms

For applications such as laser diodes or dc motors, square waves can be programmed for constant duty cycles from 10% to 90%. For digital test, or for simulating very low duty-cycle events, pulse width can be programmed down to 10 ns. Square wave and Pulse modes provide clean 6 ns edges that are ideal for many technologies. Pulse width modulation and pulse recovery capability are available in Pulse mode.

### Sine and Triangle Functions

10% to 90% duty cycle, programmable in 1% steps, provides ramps and asymmetrical sine waves for testing VCO's, servos, amplifier linearity and industrial process control systems. Haversine functions,

available in External Trigger, Gate and Burst modes, extend the applications to areas such as telephone line and vibration testing.

### Modulation

All waveforms can be amplitude or frequency modulated. VCO operation allows frequency variation over two decades with an external voltage; consequently transducer output can be conditioned for mag tape recording, or frequency-shift keying or linear sweep can be carried out.

### Option Option001

**10 1/2-decade log sweep.** Sweep mode covers the wide 1 mHz - 50 MHz band in a single up sweep. Test setups require no more than an X-Y recorder or scope because all necessary control signals are available. The HP 8116A sweeps can be internally triggered, if desired.

**Accurate, counted bursts.** A preprogrammed number of cycles of any waveform can be generated in Burst mode. With sine, triangle and square functions, bursts can be triggered internally as well as externally.

**Hold capability.** For material stress testing, low frequency functions can be held at instantaneous levels. Hold is controlled by an external signal.

### Low-Cost Automation for Test and Systems

Powerful capability, small size and wide specified temperature range make the HP 8116A a good choice for automatic test systems. Also, the low cost means that it's now realistic to automate those routine bench jobs and leave more time for design. Comfortable software features such as easy syntax and flexible format contribute to rapid system design.

### Operating Confidence

There's reliance in the HP 8116A's output because proper operation is always ensured by the instrument's error detector. This helps the user to recover from an incorrect front panel or programming operation by indicating the offending parameter. Also, the built-in test and diagnosis feature verifies correct function each time the instrument is switched on.

## Specifications

Specifications apply with 50-ohm load and temperatures in the range 0°C to 55°C.

## Functions

Sine, triangle, ramp, square, pulse, haversine, havertriangle, dc.

## Timing

### Frequency

**Range:** 1 mHz to 50 MHz (3-digit resolution).

**Accuracy**<sup>1</sup> (pulse mode, 50% d/c):  $\pm 3\% \pm 0.3$  mHz below 100 kHz,  $\pm 5\%$  above 100 kHz.

**Jitter** (pulse mode, 50% d/c):  $< 0.1\% + 100$  ps.

**Stability:**  $\pm 2\%$  (1 hour),  $\pm 5\%$  (24 hours).

**Duty cycle:** (sine, triangle, square, haversine, havertriangle).

**Range:** 10% to 90% (20% to 80% above 1 MHz), 2-digit resolution.

**Accuracy:**  $\pm 0.5$  digits ( $\pm 3$  digits above 1 MHz).

### Pulse Width

**Range:** 10.0 ns to 999 ms (3-digit resolution).

**Accuracy**<sup>1</sup>:  $\pm 5\% \pm 2$  ns.

**Jitter:**  $< 0.1\%$  ( $0.2\% + 200$  ps for width  $< 10 \mu$ s).

## Output Characteristics

(voltages double into high impedance).

### Amplitude

**Range:** 10.0 mVpp to 16.0 Vpp (3-digit resolution).

**Accuracy**<sup>1</sup>:  $\pm 5\%$  (at 1 kHz for sine and triangle).

**Flatness (sine):**  $\pm 3\%$  ( $\pm 5\%$  above 1 MHz,  $+5 -15\%$  above 10 MHz).

**Flatness (triangle):**  $\pm 3\%$  ( $\pm 5\%$  above 1 MHz,  $+5 -25\%$  above 10 MHz).

### Offset and dc Mode

**Range:** 0.00 to  $\pm 7.95$  V (0 to  $\pm 795$  mV for amplitude  $< 100$  mVpp).

**Resolution:** 3 digits.

**Accuracy**<sup>1</sup>: 0.5% of setting  $\pm 1\%$  of ampl  $\pm 40$  mV ( $+2$  mV if ampl  $< 100$  mVpp,  $\pm 20$  mV in dc mode).

**Distortion** (sine, normal mode, 50% duty cycle).

**Total harmonic distortion (10 Hz 50 kHz):**  $< 1\%$  ( $-40$  dB)\*.

**Harmonic related signals (50 kHz 1 MHz):**  $< -34$  dB,  
(1 MHz 50 MHz):  $< -23$  dB\*.

\*May increase by 3 dB below 10°C and above 45°C.

**Non-linearity** (triangle, ramp, 100 mHz-1 MHz):  $< \pm 3\%$ .

## Pulse and Square Wave Characteristics

**Transitions:**  $< 7$  ns.

**Pulse perturbations:**  $< \pm 5\% \pm 2$  mV.

**Output impedance:** 50 ohm  $\pm 5\%$ .

## Operating Modes

Normal, trigger\*, gate\*, external width

## Additional Modes in HP 8116A Option 001

**Logarithmic Up Sweep** (for all waveforms).

**Range:** Start and stop frequencies selectable up to full range (1 mHz-50MHz).

**Sweep time:** selectable in 1-2-5 sequence from 10 ms to 500 seconds per decade.

**Sweep repetition:** continuous sweeps (internal sweep) or externally triggered.

**Counted Burst\*** (for all waveforms).

**Burst length:** 1 to 1999 cycles.

**Burst repetition:** internally triggered at selectable intervals from 100 ns to 999 ms (except in Pulse mode), or externally triggered, up to 40 MHz.

\*Selectable ( $-90^\circ$ ) start-phase for haversine, havertriangle.

## Control Modes

**Frequency modulation:**  $\pm 5\%$  max deviation.

**Sensitivity:** 1 V for 1% deviation.

**Modulating frequency:** dc to 20 kHz.

## Amplitude Modulation

**Sensitivity:**  $\pm 2.5$  V for 100% mod. ( $+2.5$  V to  $-7.5$  V for DSBSC).

**Modulating frequency:** dc to 1 MHz.

<sup>1</sup>Applies from 15°C to 35°C, %-error increases 0.05 per °C outside this range.

## Pulse Width Modulation

**Range:** 10 ns to 1 s in 8 non-overlapping decade ranges.

Max. width ratio: 10:1.

**Sensitivity:**  $\pm 9$  V for 1:10 ratio.

## Voltage-Controlled Oscillator

**Range:** 2 decades in range 1 MHz-50 MHz.

**Sensitivity:** 0.1 V to 10 V for 2 decades.

**Modulating frequency:** dc to 1 kHz.

## Auxiliary Modes

**Manual:** simulates external input.

**1 cycle (option 001):** triggers single output cycle in Trigger, Gate and Ext Burst modes.

**Auto vernier:** continuous vernier which can be remotely or manually stopped.

**Limit:** programmable maximum output levels to protect DUT.

**Complement:** selectable normal/complement output.

**Disable:** relay disconnects output.

## Auxiliary Inputs and Outputs

External Input

**Threshold:**  $\pm 10$  V adjustable.

**Max input voltage:**  $\pm 20$  V.

**Sensitivity:** 500 mVpp.

**Min pulse width:** 10 ns.

**Input impedance:** 10 k typ.

**Trigger slope:** positive, negative and off.

Control Input

**Max input voltage:**  $\pm 20$  V.

**Input impedance:** 10 k typ.

Trigger Output

**Output levels:** 0/2.4 V typ.

**Output impedance:** 50 ohm typ.

**X-Output** (Option 001) for sweep X-Y recording (rear panel).

**Output levels:** 0 V (= start frequency) to 10 V max.

**Slope:** 1.5 V per sweep decade.

**Marker Output** (Option 001) for sweep (rear panel).

**Output levels:** TTL

**Leading edge:** positive at selected marker frequency.

**Hold Input** (Option 001), rear panel.

**Input levels:** TTL

**Leading edge:** positive transition causes HP 8116A output (f  $< 10$  Hz) to hold at instantaneous level. Output droop 0.01% per second.

**Max input voltage:**  $\pm 20$  V

## HP-IB Capability

All manual key operations are programmable. Talk mode provides learn, status byte and error report capabilities.

## Memory

Battery-backup RAM retains current operating state.

## General

**Repeatability:** factor 4 better than accuracy.

## Environmental

**Storage temperature:**  $-40^\circ\text{C}$  to  $+70^\circ\text{C}$ .

**Operating temperature:**  $0^\circ\text{C}$  to  $55^\circ\text{C}$ .

**Humidity:** 95% RH,  $0^\circ\text{C}$  to  $40^\circ\text{C}$ .

**Power:** 100/120/220/240 V rms;  $+5\%$ ,  $-10\%$ ; 48 to 440 Hz; 120 VA max.

**Weight:** net, 5.9 kg (13 lb). Shipping, 8.0 kg (18 lb).

**Size:** 89 H x 212.3 W x 422 mm D (3.5" x 8.36" x 16.6").

## Ordering Information/Prices

HP 8116A Programmable Pulse/Function Generator*	\$3775
Opt. 001: Burst and Logarithmic Sweep	add \$510
Opt. 910: Extra Operating & Service Manual	add \$41
HP 5061-9701: Bail Handle Kit	\$38
HP 5061-9672: Rack Mount Kit (single HP 8116A)	\$51
HP 5061-9674: Rack Mount Kit (two instruments)	\$31
HP 5061-9694: Lock Link Kit (for use with HP 5061-9674)	\$25

\*HP-IB cables not supplied, see page 569.

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