

# FREQUENCY & TIME STANDARDS

## Atomic Frequency Standards

### Models 5061B

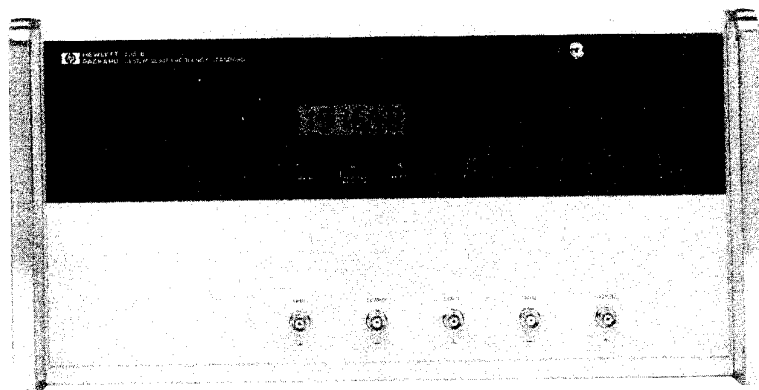
463

#### HP 5061B

- Improved accuracy  $\pm 3 \times 10^{-12}$
- Primary standard
- Proven reliability

#### HP 5061B, Opt 004

- Accuracy  $\pm 2 \times 10^{-12}$
- Settability  $\pm 1 \times 10^{-12}$
- Time domain stability  $5 \times 10^{-12}$  (1 s avg)



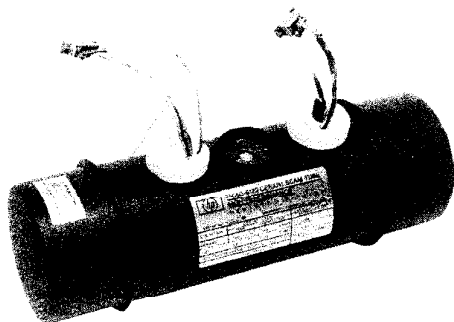
HP 5061B

#### HP 5061B Cesium Beam Standard

The first Hewlett-Packard Cesium Beam Standard, the HP 5060A, was introduced in 1964. This was followed in 1967 with the improved HP 5061A, in 1973 with the high performance beam tube option for the HP 5061A and in 1986 with the 5061B. Since this time the accuracy and reliability of Hewlett-Packard cesium beam standards continues to be demonstrated and these standards have become the world-wide standard for frequency and time keeping. The HP 5061B has provision for an optional digital divider and reliable, easy-to-read LCD clock (Option 003) and for a battery with ¼ hour standby power capacity with automatic charging.

**Reliability and warranty:** over 100 million operation hours have proven the performance and reliability of Hewlett-Packard cesium beam standards in various world-wide applications. The units have provided dependable microsecond accuracy in aircraft, ship and fixed environments.

A five-year warranty on the HP 5061B standard cesium beam tube is provided as a result of proven field reliability. This warranty includes replacement of the cesium beam tube if it should fail within the warranty period.



Option 004, High Performance Cesium Beam Tube with three-year warranty

#### HP 5061B with Opt 004, High Performance Cesium Beam Tube

The Hewlett-Packard 5061B primary frequency standard with the Option 004 Cesium Beam Tube offers increased stability and accuracy in the instrument which has become the worldwide standard of frequency and time keeping since its introduction in 1967. Improvements in magnetic shielding, ruggedization and environmental performance permit improved performance and expansion of navigation and communication systems.

The design concept of the high-performance beam tube includes unique HP designed dual-beam optics with higher beam intensity to accomplish better short-term stability and greater immunity to effects of shock and vibration. A 50 percent increase in resonance cavity length without change in the overall beam tube size contributes to better accuracy and settability because of the high Q of the narrower resonant line width. This tube retains the unique cesium standard feature of virtually no long term instability or aging.

The intrinsic accuracy is improved to  $\pm 2 \times 10^{-12}$  which provides an excellent reference standard without need of calibration. If desired, as in many timekeeping applications, two or more units may be calibrated to determine the difference in rate or may be adjusted to the same frequency. With the improved settability specifications of  $1 \times 10^{-13}$  small changes in frequency are accomplished rapidly and accurately. A provision for degaussing the tube without adversely affecting the instrument operation allows removal of any residual magnetic field in the tube. This is important in achieving the settability performance.

The short term stability specification is improved by a factor of ten with this tube. The  $5 \times 10^{-12}$  (1 s avg.) performance compares very favorably with that of rubidium type standards which are noted for their excellent short term stability. An important advantage from the better short term stability is the capability to make measurements to 1 sigma precision of  $1 \times 10^{-12}$  in about one minute compared to the two hours required previously. The HP 5061B with the Option 004 High Performance Tube has the same high reliability as the HP 5061B with the standard tube. The new high performance tube is warranted for three years, but is designed to have the same long life as the standard tube.\*

#### HP E21-5061B Flying Clock

The HP E21-5061B consists of a HP 5061B Cesium Beam Standard with Option 003 LCD Clock and Special Option E21, all fastened to an HP 5089A Standby to form a portable unit. The power supply, which can be operated from 11 to 30 V dc, 85 to 255 V ac, will provide approximately 10 hours standby power (from sealed immobilized electrolyte lead calcium batteries) for the HP 5061B Cesium Beam Standard.

This wide range of operating power capabilities enable the HP E21-5061B to operate on local power in virtually any country in the world. The 10 hours standby capability makes it possible to travel where there is no power available and, of course, allows the HP E21-5061B to conveniently be transported between power sources and operated in almost any air or surface vehicle as a "flying clock" (see Hewlett-Packard Journal, August 1966 and December 1967).

The Option 004 tube, because of the improved shielding, offers a significant increase in accuracy under the varying earth's magnetic field conditions experienced by flying clocks and is a desirable addition to the HP E21-5061B. In addition, the better short term stability permits more accurate and rapid comparison of standards.

\*See page 466 for ordering information.

## FREQUENCY & TIME STANDARDS

### Atomic Frequency Standards (cont'd)

Model 5061B



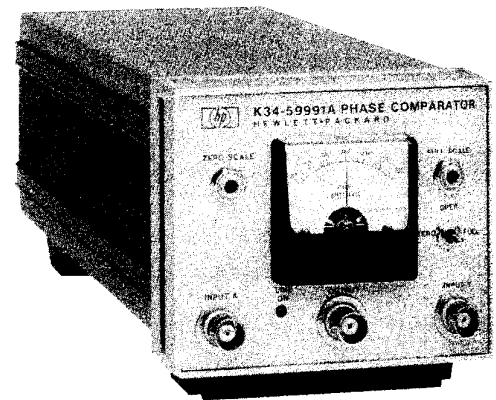
HP 10638A

#### HP 10638A Degausser

The HP 10638A Degausser is designed for use with the Option 004 High Performance Cesium Beam Tube without interrupting normal operation. The degausser removes residual magnetism in the shields of the beam tube which can build up over time, due to a changing magnetic environment, and can cause a frequency offset. Relaxation of the residual magnetism insures a settability of  $\pm 1 \times 10^{-13}$ , allowing stable precise changes in output frequency and a reproducibility of  $\pm 1.5 \times 10^{-12}$ . The degausser should be used when initially setting up the HP 5061B with Option 004 or after the instrument has been moved or adjusted.\*

#### HP 5061B with Option 003, Time Standard and Standby Power Supply

The HP 5061B has provision for an optional digital divider and reliable, easy to read LCD, time-of-day, 24-hour digital clock (Option 003). By including this option, the number of applications and the versatility of the cesium standard is increased. The one-pulse-per-second output can simplify the comparison with other standards (such as portable and secondary standards) as well as GPS and Loran Systems. The techniques for such comparisons are described in Application Note AN-52. Option 003 also includes an internal battery power supply which will provide at least 45 minutes of standby power if the line power should fail. This will prevent phase and frequency interruptions due to intermittent or an extended power failure. Battery power also enables moving the cesium beam standard to locations of other secondary standards without losing time.\*



HP K34-59991A

#### HP K34-59991A Phase Comparator

The HP K34-59991A Broadband Linear Phase Comparator accurately compares the phase relationship of the output signals of two frequency standards having the same nominal frequency. This will enable resolving extremely small differences between precision frequency sources. The Phase Comparator operates over a frequency range of 10 kHz to 50 MHz and input levels between 100 mV and 10 V rms. A linear dc output voltage, proportional to the phase differences between the two standards, is available at both the front and rear panels. This voltage is also monitored on a front-panel meter and is suitable for driving a stripchart recorder, thus allowing longterm monitoring of the frequency standards. By using this comparator, very small frequency differences can be detected and adjustments can be made to frequency standards to correct for timekeeping errors.\*

#### HP J45-5061 Certified Stability of $1 \times 10^{-13}$

The HP J45-5061B is a special option which will certify that the Model HP 5061B with standard Options 003 and 004 has stability performance of better than or equal to  $1 \times 10^{-13}$  in a day, when measured each day for any five consecutive days. This means that the cesium standards absolute deviation from the HP Santa Clara Division House Standard is less than or equal to 8.64 ns per day on each of the five consecutive days during the certification. The certification applies only to original shipments and is performed under calibration laboratory conditions with the cesium beam tube degaussed and operating in a stable magnetic environment and over a restricted temperature range of  $\pm 2.5$  degrees range at any temperature between 15 and 35 degrees C.\*

\* See page 466 for ordering information.

# FREQUENCY & TIME STANDARDS

## Atomic Frequency Standards (cont'd)

Models 5061B, 5065A

### Specifications — Frequency Standards

Instrument:	HP 5061B Option 004	HP 5061B	HP 5065A
Type of Standard:	Cesium	Cesium	Rubidium
Accuracy: maintained in a dc magnetic field to 2 gauss over a temperature range of 0-50°C	$\pm 3 \times 10^{-12}$	$\pm 5 \times 10^{-12}$	$\pm 1 \times 10^{-11}$ /month
Accuracy: limited temp. range (1)	$\pm 2 \times 10^{-12}$	$\pm 3 \times 10^{-12}$	
Reproducibility	$\pm 1.5 \times 10^{-12}$	$\pm 3 \times 10^{-12}$	
Retrace	$\pm 5 \times 10^{-13}$	$\pm 3 \times 10^{-12}$	
Settability (frequency)	$\pm 1 \times 10^{-13}$	$\pm 7 \times 10^{-13}$	$\pm 2 \times 10^{-12}$
Long-term Stability (for life of cesium tube)	$\pm 2 \times 10^{-12}$	$\pm 2 \times 10^{-12}$	
DC Magnetic Field Stability, freq. change, any orientation in a 2 gauss field	$< \pm 2 \times 10^{-13}$	$< \pm 2 \times 10^{-12}$	$< \pm 5 \times 10^{-12}$ (1 gauss field)
Time Constant, quartz OSC. control loop	1s	1s	
Warm-up Time at 25°C	30 min	45 min	$5 \times 10^{-11}$ 4 hrs(2)
Tube Warranty	3 yrs.	5 yrs.	3 yrs.
Sinusoidal Outputs	10 MHz, 5 MHz, 1 MHz, 100 kHz		5 MHz, 1 MHz, 100 kHz
Output Voltage	1 volt into 50 $\Omega$		
Harmonic Distortion	>40 dB (from rated output)		
Non-Harmonic Distortion	>80 dB (from rated output)		
Temperature, Operating	0 50°C		
Temperature, Non-operating	-40 to 70°C(3)		
Power, AC	50, 60 or 400 Hz $\pm 10\%$ , 115/230V $\pm 10\%$ , 44W (Cesium) 49W (Rd)		
Power, DC	22 to 30V, 30W		23 to 30V, 35W
Power, AC/DC with options - add	5 to 16W		0 to 16W
Dimensions (H x W x D): mm:	221 x 425 x 416		133 x 425 x 416
inches:	8.7 x 16.7 x 16.4		5.2 x 16.7 x 16.4
Weight (lb/kg)	70/31.8	67/30.5	34/15.4
Option 001	6/2.7	6/2.7	2/0.9
Option 002			3.5/1.6
Option 003			
Time Standard (Clock)			
1 PPS Outputs: Master:	Front & Rear BNC	Front and Rear BNC	Front BNC
Clock:	$\pm 10V$ Peak into 50 $\Omega$ load		
Amplitude			
Width	20 $\mu s$ min	20 $\mu s$ min.	20 $\mu s$ min.
Rise Time	<50 ns	<50 ns	<50 ns
Fall Time	<50ns	<50 ns	<50 $\mu s$
Jitter, pulse-to-pulse	<1 ns, rms	<1 ns, rms	<5 ns, rms
Synchronization	Automatic, 100 ns $\pm$ 100 ns delay	Automatic, 100 ns $\pm$ 100 ns delay	Automatic, 100 $\pm$ 100 ns delay
Clock Pulse Adjustment Range:	.1 $\mu s$ to 1s		
Clock Display:	LCD	LCD	LED
Standby Power Supply-Capacity at 25°C w/clock	45 min.	45 min.	10 min.
Recharge	Automatic, fast charge	Automatic, fast charge	switch
(1) Static mechanical and atmospheric and electromagnetic environment $\pm 2.5^\circ C$ range at any temperature between 15 and 35°C.			
(2) After 24 hours off @ 25°C.			
(3) If options installed in HP 5065A Non-Op. Temp -40°C to +50°C.			
NOTE: Tubes are intrinsically capable of meeting these specifications when installed in HP 5061B's currently in production.			

#### Ordering Information

**HP 5061B** Cesium Frequency Standard

**Opt 003** Clock and Standby Power Supply

**Opt 004** High Performance Beam Tube

**Opt 908** Rack Flange Kit

**Special Option HPE21-5061B** Flying Clock

**Consists of:** HP5061B, Opt 003, E21, + 5089A.

(The 5061B, + Opt 003 are not included in the E21 price.)

**Weight:** 64 kg (141 lb).

**Size:** 425 H x 405 W x 546 mm D (16.7 in. x 15.9 x 21.5 inches) includes handles.

**HP 10638A** Degausser

#### Price

\$32,500

\$4,400

\$5,200

\$45

+\$6,275

\$1,425

**Special Option K34-59991A** Phase Comparator

**HP 5065A** Rubidium Frequency Standard

**Opt 001** Clock

**Opt 002** Standby Power Supply

**Opt 003** Clock and Standby Power Supply

**Opt 908** Rack Flange Kit

**Special Option HP E21-5065A** Portable Standard

**Consists of:** HP 5065A, E21, Opt 001 + 5089A Standby power supply. (The 5065A, + Opt 001 are not included in the E21 price.)

**Weight:** 50 kg (110 lb).

**Size:** 314 H x 425 W x 546 mm D (8.4 x 16.7 x 21.5 inches) includes handles.

\$1,150

\$25,800

\$3,300

\$770

\$4,100

\$45

-\$6,350