QUARTZ OSCILLATOR
model 105A/B

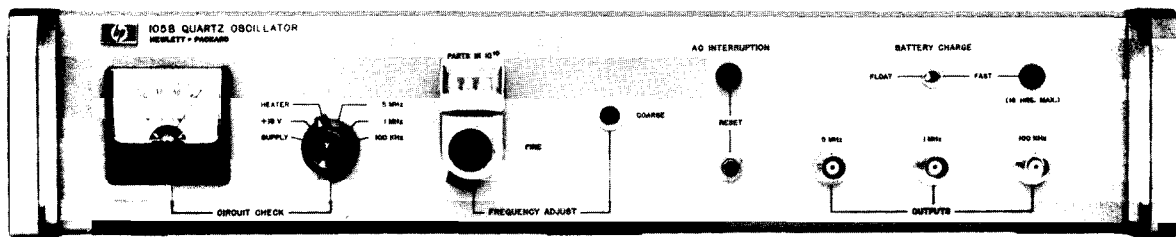## HIGH PERFORMANCE ECONOMICAL FREQUENCY STANDARD

Excellent Short-term Stability and Spectral Purity
Fast Warm-up and Stabilization
Aging $<5 \times 10^{-10}/24$ Hours
Well Buffered Outputs
Compact, Light, and Rugged

Hewlett-Packard Models 105A/B Precision Quartz Oscillators are rugged, light weight frequency standards, offering high performance at an economical price. They generate a precision frequency that is suitable for use in shipboard and mobile environments as well as fixed installations.

The 105A/B 5 MHz output has excellent short-term stability and spectral purity with a signal-to-noise ratio of better than 90 dB. In these performance areas, the 105A/B is comparable to the finest of primary standards, and at a favorable economic level. Tables 1 and 2 show frequency stability in both the time and frequency domain. This quality of performance qualifies the 105A/B for use in doppler measurements, microwave spectroscopy, and similar applications where the reference must be multiplied by a large factor and still maintain good spectral purity. Other uses for the 105A/B are as a frequency and time standard in advanced communication and navigation systems, and as a reference in analyzing spectra of oscillators and multipliers. The added capability of using an externally applied voltage to control the output frequency over a limited range makes the 105A/B useful in phase-locked systems applications.

The key factor in the performance of these oscillators is a very stable 5 MHz, fifth overtone quartz crystal specially designed and manufactured by HP's Crystal Laboratories. A new crystal mounting technique allowing high bakeout and a cold-weld package have resulted in a cleaner crystal, which, in turn, reduces the stabilization time. The warm-up and return-to-previous-frequency performance is greatly improved over previously available units. The guaranteed aging rate of $\pm 5 \times 10^{-10}/$day is typically reached within 24 hours

of turn-on (after 24 hours off). The aging rate after three months of continuous on-time is typically $\pm 1 \times 10^{-10}/24$ hours. Ambient temperature effects are reduced by enclosing the quartz-crystal oscillator and AGC circuits in a proportionally controlled oven assembly. For calibration, frequency adjustment is controlled from the front panel, and changes are easily read on a dial calibrated in parts in 10^{10}.

Each frequency output of the 105A/B is buffered to provide an output stable to within ± 2 parts in 10^{11}, regardless of load changes occurring in any other output frequency. Buffering between the outputs, in addition to the excellent stability of the 5 MHz crystal, makes the 105A and 105B ideal for application in frequency standard systems requiring use of multiple frequency outputs. The 105A and 105B may be used in complex systems with complete assurance that loading changes, such as accidental shorts or disconnections in other outputs, will not affect frequency of the output of primary concern.

Both models may be operated from an ac line (115/230 V 50-400 Hz) or from an external 22-30 V dc supply. The 105B is equipped with a sealed, Ni-Cad battery, which supplies uninterrupted standby power for over eight hours, should the ac power fail. A Fast Charge/Float Charge switch permits rapid battery recharge after extended periods of battery use.

The complete oscillator assembly (K07-105A) including oven is available as a separate item. It requires 22-30 V and 20 V regulated dc. The oscillator provides a 5 MHz signal of 1 V into 50 ohms with the same spectral purity specification as the 105A/B.

FREQUENCY STABILITY

Aging Rate: $<5 \times 10^{-10}$ per 24 hours.

► **Short-Term Stability:*** For 5 MHz output only. Refer to tables below.

TABLE 1   Time Domain Stability

τ(sec)	$\sigma_{\frac{\Delta f}{f}}(2,\tau)$	$\sigma_{\Delta t}(2,\tau)$sec
10^{-3}	7.5×10^{-10}	7.5×10^{-13}
10^{-2}	1.5×10^{-10}	1.5×10^{-12}
10^{-1}	1.5×10^{-11}	1.5×10^{-12}
10^{0}	5×10^{-12}	5×10^{-12}
10^{1}	5×10^{-12}	5×10^{-11}

TABLE 2   Frequency Domain Stability
(Measurement bandwidth = 1 Hz)

Offset from Frequency (Hz)	SSB**/SIG (dB)
10^{-2}	— 50
10^{-1}	— 80
10^{0}	—110
10^{1}	—120
10^{2}	—126
10^{3}	—146
10^{4}	—150
10^{6}	—160

** SSB = Single Sideband Phase Noise.

► **As a Function of Ambient Temperature:** Frequency change is less than 2.5×10^{-9} total from 0°C to +50°C.

As a Function of Load: $\pm 2 \times 10^{-11}$ from open circuit to short, 50 Ω R, L, or C load change.

As a Function of Supply Voltage: $\pm 5 \times 10^{-11}$ for 22-30 V dc from 26 V dc reference (battery operation, 105B) and for 115/230 V $\pm 10\%$.

FREQUENCY ADJUSTMENTS

Fine Adjustments: Front-panel control with 5×10^{-8} range, with digital dial reading parts in 10^{10}.

Coarse Adjustments: 1×10^{-6}, coarse control is screwdriver adjustment at front panel.

PHASE LOCKING CAPABILITY: An external +5 V to —5 V applied to EFC connector allows >2 parts in 10^8 frequency control for locking to an external source.

► **WARM-UP** (at 25°C): To within 1×10^{-7} in 15 min., 1×10^{-8} in 20 min., 1×10^{-9} in 30 min.

OUTPUTS

Frequencies: 5 MHz, 1 MHz, 100 kHz; 1 MHz or 100 kHz clock drive.

Voltage Levels: 1 V rms into 50 Ω; clock drive ≥ 0.5 V rms into 1000 Ω.

Connectors: 5 MHz, 1 MHz, 100 kHz front and rear-panel BNC connectors, clock drive and electrical frequency control rear-panel BNC connectors.

Harmonic Distortion: (5 MHz, 1 MHz, 100 kHz) Down more than 40 dB from rated output.

Nonharmonic Components: (5 MHz, 1 MHz, 100 kHz) Down more than 80 dB from rated output.

► **Signal-to-Noise Ratio:** For 1 and 5 MHz, >90 dB at rated output (in a 30 kHz noise bw, 5 MHz output filter bw is approximately 100 Hz).

ENVIRONMENTAL

Temperature, Operating: 0°C to +50°C.

Temperature, Storage: —40°C to +75°C (manufacturer specifies —40°C to +50°C limit for 105B battery storage).
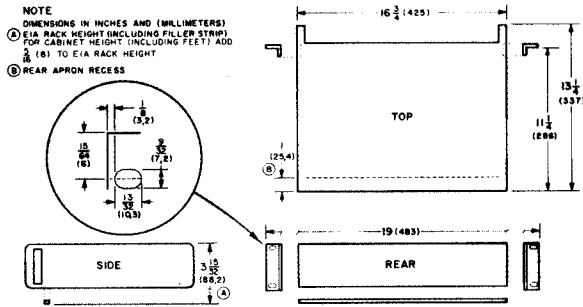
► **Altitude:** 50,000 ft.

► **Shock:** MIL-T-21200 (30 G's).

► **Vibration:** MIL-STD-167 and MIL-T-21200.

► **Electromagnetic Compatibility (EMC):** MIL-I-6181D.

MONITOR METER: Front-panel meter and associated selector switch monitors: supply voltage, +18 V, oven, 5 MHz output, 1 MHz output, 100 kHz output.

STANDBY SUPPLY CAPACITY: (Model 105B only) 8 hours at +25°C ambient temperatures.

► **POWER REQUIREMENTS:** 115/230 V $\pm 10\%$ at 17 W (70 W warm-up) for 105A; 18 W (71 W warm-up) for 105B float charge. Add 12 W for fast charge. 22 to 30 V dc at 6.4 W (10.3 W warm-up).

DIMENSIONS:

WEIGHT: 105A—Net, 16 lb (8 kg). Shipping, 23 lb (10,5 kg). 105B —Net, 24 lb (11 kg). Shipping, 31 lb (14 kg).

ACCESSORIES FURNISHED: Rack mounting kit, ac power cord, 2 extender boards, 15-pin: HP 5060-0099, 22-pin: HP 5060-0630.

PRICE
105A, $1,500.00.
105B, $1,800.00.

COMPLEMENTARY EQUIPMENT: Model 5085A Standby Power Supply with battery for extending standby power capability by 40-70 hours, $1,700.00.

*DEFINITION OF TERMS

In the time domain, short-term stability is defined as the standard deviation of the average fractional frequency fluctuations, $\sigma_{\frac{\Delta f}{f}}(2,\tau)$. It can also be expressed as the standard deviation of the time intervals, $\sigma_{\Delta t}(2,\tau)$, which is the product of the averaging time and $\sigma_{\frac{\Delta f}{f}}(2,\tau)$. System bandwidth = 100 kHz.

In the frequency domain, short-term stability is defined as the single sideband phase noise-to-signal ratio on a per Hertz basis. This ratio is equal to the two-sided phase-spectral density.

See Statistics of Atomic Frequency Standards by David W. Allen, Proceedings of IEEE, February 1966, p. 221, and HP Application Note 116 for measurement details.

► Indicates change from prior specifications