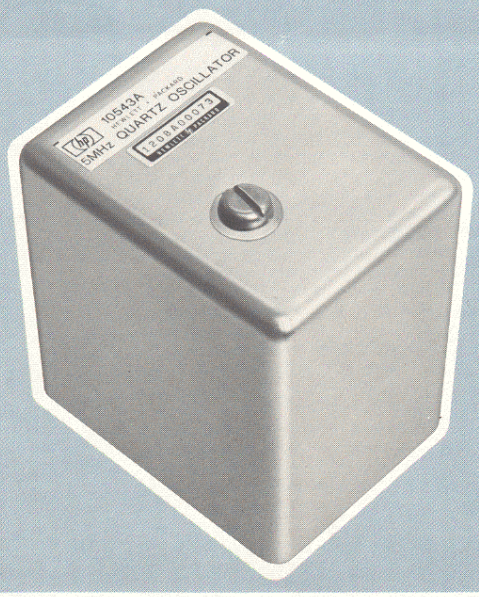
HEWLETT hp PACKARD

10543A 5 MHz COMPONENT OSCILLATOR

NOV. 1972

5 x 10^{-10}/day aging-rate **Excellent short-term stability** **Fast warm-up** **Rugged**



The HP Model 10543A Quartz Crystal Oscillator combines excellent short and long term stability, low power consumption and fast warm-up in a compact rugged package suitable for use under a wide variety of environmental conditions. Conservative design with high quality components and construction contribute to the reliability and superior performance of this oscillator.

A 5 x 10^{-10}/day aging rate is achieved using a precision cut 5 MHz crystal supported by a rugged mounting in a cold-welded, high bake-out enclosure. The crystal enclosure is contained in a massive housing which has high thermal conductivity. This contributes to rapid warm-up and excellent temperature stability. The crystal, along with the oscillator, AGC amplifier and oven control circuits are enclosed within a thermally insulated proportional control oven.

With rugged construction, a sealed enclosure, and precise oven control, the 10543A has the high stability and reliability which are essential requirements for portable communication and navigation equipment. The low aging-rate minimizes periodic frequency calibration to maintain the desired accuracy and to stay within FCC requirements. This represents real savings to the end user in reduced calibration cost and equipment down-time.

Excellent spectral purity of the 10543A output is an important advantage in applications where the signal is multiplied to a high frequency for use in narrow bandwidth communication systems.

Design of the 10543A into a system is simplified by the versatility of the unit. Any dc source from 16 to 30 volts with ±10% regulation will power the oscillator. An internal regulator, protected from polarity reversal by a diode, supplies precise oscillator, amplifier and oven controller voltages. This regulated voltage is available externally for use as an electronic frequency control (EFC) reference voltage. Heater voltage can be monitored to indicate status of the crystal oven.

Fine frequency control with a range of 1 x 10^{-7} (0.5 Hz) can be achieved by use of the EFC input.

An 18-turn screwdriver control provides coarse adjustment over a range of 5 Hz, yet is sensitive enough to permit frequency adjustment to better than 2 x 10^{-10} (.001 Hz).

Mechanically rugged construction is achieved through use of rigid plastic foam with very low thermal conductivity around the crystal enclosure and circuit boards. The sealed housing eliminates effects of atmospheric pressure and humidity.

Thorough in-process and final testing includes computer controlled tests to set oven temperature and to determine aging-rate thus assuring uniform high quality. All oscillators meet the 5 x 10^{-10}/day aging-rate specification prior to release for shipment.

10543A SPECIFICATIONS

FREQUENCY: 5 MHz①
AGING RATE: $<5 \times 10^{-10}$/day②
$<1.5 \times 10^{-7}$/year
SHORT TERM STABILITY:③

τ (sec)	$\sigma_{\Delta f/f}(2,\tau)$
100 µs	2×10^{-9}
1 ms	5×10^{-10}
10 ms	5×10^{-11}
100 ms	1×10^{-11}
1 s	1×10^{-11}
10 s	1×10^{-11}
100 s	1×10^{-11}

TEMPERATURE COEFFICIENT: $<2 \times 10^{-9}$ frequency change over a 0 to 71°C temperature range. $<5 \times 10^{-9}$ over -55°C to +71°C range.

LOAD: $<2 \times 10^{-10}$ frequency change for ±10% change of 50 ohm load.

VOLTAGE COEFFICIENT: $<\pm 1 \times 10^{-10}$ for 10% voltage change.

WARMUP: Within 2×10^{-9} of final④value 30 minutes after turn-on at 25°C.

OUTPUT 5 MHz:

Voltage: 1V rms ±10% into 50 ohms. Short circuit protected.

Harmonic Distortion: Down more than 30 dB from rated output.

Nonharmonic Components: Down more than 100 dB from rated output.

Signal-to-Single Sideband Phase-Noise Ratio: (1 Hz Measurement Bandwidth):

Offset from: 5 MHz (Hz)	Ratio (dB)
10	120
100	135
1,000	145
10,000	145

ADJUSTMENT:

Coarse Frequency Range: $>1 \times 10^{-6}$ (>5 Hz) with 18-turn control.

Electronic Frequency Control (EFC): $>1 \times 10^{-7}$ (>1 Hz), control range 20 Vdc maximum.

CONNECTORS: 9-pin. Mates with standard 9-pin miniature tube socket. (50 ohm RF output connector available on special order.)

INPUT:

Voltage: 16 to 30 Vdc with less than 10% ripple.

Power: Warmup — 8 watts at 20 volts.
25°C — 3.5 watts typical.

ENVIRONMENTAL:

Temperature: operating -55°C to +71°C.
storage -55°C to +75°C.

Altitude: 50,000 feet (15,2 km).

Humidity: 95% RH.

Vibration: MIL-STD-167.

SIZE: 2.52" x 3.3" x 3.55" high. See Figure 1. (64 x 83.8 x 90.2 mm).

WEIGHT: 20 oz. (570 gm).

Notes:

① 10 MHz available on special order.

② The specified aging rate is achieved within 24 hours after turn-on for off-times of less than 24 hours. For off-times of more than 24 hours, stabilization takes longer. Typical units stabilize in 3 days or less after one month off.

③ See Statistics of Atomic Frequency Standards by David W. Allen, Proceedings of IEEE, Feb. 1966, p. 221, and HP Application Note 116 for measurement details.

④ Final value is defined as frequency 24 hours after turn-on.

INSTALLATION:

The 10543A 5 MHz Oscillator may be mounted into a 9-pin miniature tube socket in any convenient position. The oscillator is secured with 8-32 nuts and lock washers using the four mounting bolts on its base. (See Figure 1.)

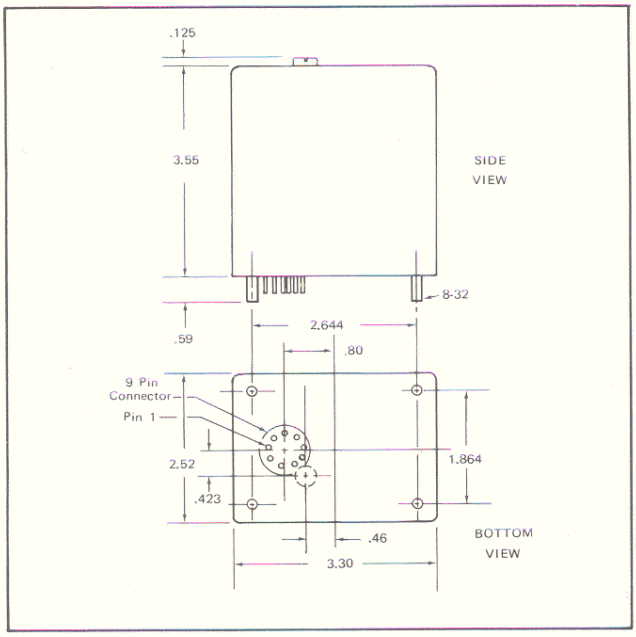


FIGURE 1 Outline Drawing

CONNECTIONS:

Power and signal connections are made through a 9-pin sealed connector into a standard miniature tube socket. Connections are shown in Figure 2 and listed in Table A.

Table A

Pin 1:	+EFC*
Pin 2:	-EFC*
Pin 3:	Ground
Pin 4:	5 MHz Output
Pin 5:	+11.5 to 12.5 Vdc regulator output (may be used for +EFC).
Pin 6:	Regulator input—positive 16 to 30 Vdc, 30 ma.
Pin 7:	Oven monitor
Pin 8:	Oven power — negative
Pin 9:	Oven power — positive 16 to 30 Vdc. Warmup — 8 watts at 20 volts. At 25° C, 3.5 watts typical.

*Maximum EFC voltage across pins 1 and 2 is 20 volts. If EFC is not used, connect pins 1 and 2 to pin 3 (ground).

Input Voltage:

The same 16 to 30 Vdc source may be connected to the oven (pin 9) and to the input to the voltage regulator (pin 6). The oven power-negative should be connected to ground if a common source is used.

Electronic Frequency Control (EFC):

A control range of 20 Vdc is required to vary the frequency over the full range of 1 x 10^{-7} (1/2 Hz). The EFC circuit is isolated from the oscillator circuit by capacitors, and allows the use of a control voltage which may be above or below the oscillator ground level. This permits flexibility in design of phase lock

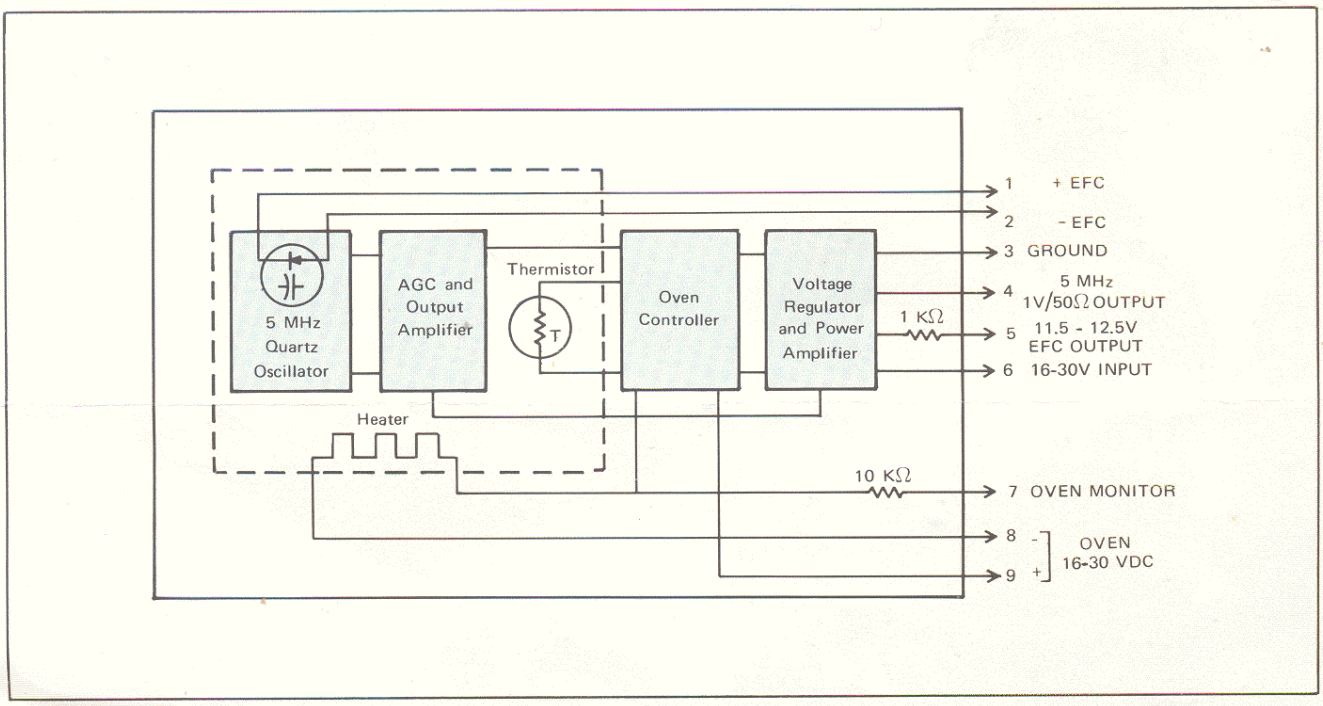


FIGURE 2
Block Diagram

control circuits. The potential applied to pin 1 should never be negative with respect to pin 2.

If the 11.5 to 12.5 Vdc regulator output from pin 5 is used to supply the EFC control voltage and no negative bias voltage is available, the EFC control range will be reduced to approximately 0.6 of the full range.

Oven Monitor:

An output signal is available at pin 7 which indicates the temperature condition of the oscillator oven. The output signal maximum voltage level depends on the value of oven supply voltage at pins 8 and 9. Voltage level at pin 7, when monitored with a high-impedance voltmeter, depends on oven temperature; maximum voltage at turn-on and minimum voltage at operating temperature.

Operation:

Connect the oscillator through a 9-pin connector to the specified input voltages and output load. Allow a 24-hour warm-up time for stabilization before adjusting frequency.

Frequency Adjustment:

Oscillator frequency may be adjusted within a range of $>1 \times 10^{-6}$ (> 5 Hz) by using the 18-turn screwdriver adjustment located on the top of the oscillator case. Access to this adjustment is normally sealed by a gasketed 1/4-28 screw. Fine frequency adjustments may be made within a range of $>1 \times 10^{-7}$ using 0 to 20 Vdc applied across pins 1 and 2 for tuning.

The oscillator frequency may be adjusted against a reference or "house" standard with an oscilloscope or vector voltmeter. For minimum distortion the oscillator output should be terminated with a 50 ohm load.

Aging and Stability Measurement:

Refer to HP Application Note 116 and the "Computing Counter Applications Library" for information regarding methods of making precise measurement of aging and short-term stability of the Model 10543A Oscillator.

Operational Tests:

After applying proper input voltages, allow the output frequency to stabilize for 24 hours. Adjust the output frequency to 5 MHz and check the output voltage with an RF Voltmeter or calibrated oscilloscope. Be sure to terminate the output with a 50 ohm load. If the output voltage or frequency is not within specification, check the input voltage to determine that it is within specification and that noise and ripple are not excessive. If the input power or current are substantially different from those shown in the specifications, return the oscillator to HP for repair.

The oven input power should decrease within a few minutes after turn-on as the oven temperature stabilizes. Continued full input power indicates a malfunction of the oven controller and will damage the oscillator by overheating.

Service:

The 10543A is designed for factory repair only. Field repair should not be attempted. Repairs are handled promptly on an exchange basis through the nearest HP Sales and Service Office.

For more information, call your local HP Sales Office or East (201) 265-5000 • Midwest (312) 677-0400 • South (404) 436-6181 • West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Post Office Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan, Yokogawa-Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

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