Table 1-1. Model 5316A Specifications

INPUT CHARACTERISTICS (Channel A and Channel B)

Range:
DC coupled, 0 to 100 MHz.
AC coupled, 30 Hz to 100 MHz.

Sensitivity:
10 mV rms sine wave to 10 MHz.
25 mV rms sine wave to 100 MHz.
75 mV peak-to-peak pulse at minimum pulse width of 5 ns.
Sensitivity can be varied continuously up to 500 mV rms **NOMINAL** by adjusting sensitivity control. In sensitivity mode, trigger level is automatically set to 0V **NOMINAL**.

Dynamic Range:
30 mV to 5V peak-to-peak, 0 to 10 MHz.
75 mV to 5V peak-to-peak, 10 to 100 MHz.

Signal Operating Range: +2.5V dc to -2.5V dc.

Coupling: AC or DC, switchable.

Filter: Low pass, switchable in or out of Channel A.
3 dB point of **NOMINALLY** 100 kHz.

Impedance:
1 MΩ **NOMINAL** shunted by less than 40 pF.

Attenuator: X1 or X20 **NOMINAL**.

Trigger Level: Variable between +2.5V dc and -2.5V dc.

Slope: Independent selection of + or - slope.

Common Input: All specifications are the same for Common A except the following:
Sensitivity: 20 mV rms sine wave to 10 MHz.
50 mV rms sine wave to 100 MHz, 150 mV peak-to-peak.
Dynamic Range: 60 mV to 5V peak-to-peak 0-10 MHz,
150 mV to 5V peak-to-peak 10-100 MHz.
Impedance: 500 kΩ **NOMINAL** shunted by less than 70 pF.

Damage Level:

AC & DC × 1:	
DC to 2.4 kHz	250V (DC + AC rms)
2.4 kHz to 100 kHz	(6 × 10⁵V rms × Hz)/FREQ
>100 kHz	6V rms
AC & DC × 20:	
DC to 28 kHz	500V (DC + AC peak)
28 kHz to 100 kHz	(1 × 10⁷V rms × Hz)/FREQ
>100 kHz	100V rms

FREQUENCY (Channel A)

Range: .1 Hz to 100 MHz.

LSD Displayed: 10 Hz to 1 nHz depending upon gate time and input signal. At least 7 digits displayed per second of gate time.

†Resolution:
For FREQ <10 MHz;

$$\pm LSD\dagger\dagger \pm 1.4 \times \frac{\text{Trigger Error}}{\text{Gate Time}} \times FREQ.$$

For FREQ ≥10 MHz; ±LSD††

Accuracy: ± Resolution ± (time base error) × FREQ.

RATIO

Range: .1 Hz to 100 MHz, both channels.

LSD:

$$\frac{2.5 \times \text{Period}}{\text{Gate Time}} \times \text{Ratio (rounded to nearest decade).}$$

where "Period" is the period of the highest frequency input signal.

Resolution:
FREQ A > FREQ B

$$\pm LSD \pm \frac{\text{B Trigger Error}}{\text{Gate Time}} \times \text{Ratio.}$$

FREQ B > FREQ A

$$A = \frac{2.5 \times \text{Period A}}{\text{Gate Time}} \times \text{Ratio}$$

(Rounded to nearest decade)

$$\pm A \pm \frac{\text{B Trigger Error}}{\text{Gate Time}} \times \text{Ratio}$$

Accuracy: Same as resolution.

TOTALIZE

Manual:
Range: 0 to 100 MHz.

A Gated By B:
Totalizes input A between two events of B. Instrument must be reset to make new measurement. Gate opens on A slope, closes on B slope.

Range: 0 to 100 MHz.

Resolution: ±1 count.

Accuracy: ±1 count ± B Trigger Error × Frequency A.

PERIOD

Range: 10 ns to 10^5 s.

LSD Displayed: 100 ns to 1 fs depending upon gate time and input signal. At least 7 digits displayed per second of gate time.

Resolution:
For PER >100 ns;

$$\pm LSD\dagger\dagger \pm 1.4 \times \frac{\text{Trigger Error}}{\text{Gate Time}} \times PER.$$

For PER ≤100 ns; ± LSD††

Accuracy: ± Resolution ± (time base error) × PER.

†Best Case Resolution for 1 Second Gate

	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz	100 MHz
50 mV rms	±.0004 Hz	±.00048 Hz	±.0014 Hz	±.01 Hz	±1 Hz	±1 Hz	±10 Hz
100 mV rms	±.0002 Hz	±.00029 Hz	±.0012 Hz	±.01 Hz	±1 Hz	±1 Hz	±10 Hz
500 mV rms	±.00005 Hz	±.00014 Hz	±.0011 Hz	±.01 Hz	±1 Hz	±1 Hz	±10 Hz
1V rms	±.00003 Hz	±.00012 Hz	±.0010 Hz	±.01 Hz	±1 Hz	±1 Hz	±10 Hz

This chart shows best case frequency resolution versus input sine wave rms amplitude. This is best case because noise from the signal source is assumed to be zero; the trigger error is produced only by the counter's noise (i.e., 120 µV rms).

††Due to arithmetic truncation, quantization error will be ±1 or ±2 counts of the LSD (Least Significant Digit) as follows:

±2 counts of LSD if $\frac{\text{LSD}}{\text{FREQ or PER}} < 1 \times 10^{-7}$, FREQ <10 MHz.

±2 counts of LSD if $\frac{\text{LSD}}{\text{FREQ or PER}} < \frac{1/(\text{Gate Time})}{\text{FREQ}}$, FREQ ≥10 MHz.

±1 count of LSD for all other cases.

Table 1-1. Model 5316A Specifications (Continued)

TIME INTERVAL

Range: 100 ns to 10^5 s.
LSD Displayed: 100 ns.
Resolution: ± LSD ± Start Trigger Error ± Stop Trigger Error.
Accuracy: ± Resolution ± (time base error) × T.I.

TIME INTERVAL AVERAGE

Range: 0 ns to 10^5 s.
LSD Displayed: 100 ns to 10 ps depending upon gate time and input signal. See table in Definitions section.
Resolution:

$$\pm \text{LSD} \pm \frac{\text{Start Trigger Error}}{\sqrt{N}} \pm \frac{\text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy: ± Resolution + (time base error) × T.I. ±4 ns.
Number of Intervals Averaged (N): N = Gate Time × FREQ
Minimum Dead Time (stop to start): 200 ns.

TIME INTERVAL DELAY (Holdoff)

Front panel gate time knob inserts a variable delay of **NOMINALLY** 500 μs to 20 ms between START (Channel A) and enabling of STOP (Channel B). Electrical inputs during delay time are ignored. Delay time may be measured by simultaneously pressing T.I. Average, T.I. Delay, and Blue Shift key. Other specifications of T.I. Delay are identical to Time Interval.

TIME BASE

Frequency: 10 MHz.
Aging Rate: $<3 \times 10^{-7}$/mo.
Temperature: $\leq 5 \times 10^{-6}$, 0 to 50°C.
Line Voltage: $\leq 1 \times 10^{-7}$ for ±10% variation.
Oscillator Output: 10 MHz, 50 mV p-p into 50Ω.
External Frequency Standard Input: 1, 5, 10 MHz, 1V rms into 500Ω, on rear panel; 6V rms maximum.

GENERAL

Trigger Level Output: ±5% ±15 mV, over ±2.0V dc range at front panel test connectors.
Check: Counts internal 10 MHz reference frequency over gate time range NOMINALLY 500 μs to 30 ms.
Error Light: LED warning light activated if logic error is found during instrument turn-on self-check.
Display: 8-digit LED display, with engineering units annunciator.
Overflow: Only frequency and totalize measurements will overflow. In case of overflow, eight least significant digits will be displayed and front panel overflow LED will be actuated. All other measurements which would theoretically cause a display of more than eight digits will result in the display of the eight most significant digits.
Gate Time: Continuously variable, NOMINALLY from 60 ms to 10 s or 1 period of the input, whichever is longer. For FREQ A, a shorter gate time of 500 μs–30 ms is selectable by simultaneously pressing T.I. Delay and Totalize keys.
Sample Rate: Up to seven readings per second NOMINAL except in time interval mode, where it is continuously variable NOMINALLY from four readings per second to 1 reading every 10 seconds via Gate Time control.
Operating Temperature: 0° to 50°C.
Power Requirements: Selectable 100, 120, 220, or 240V (+5%, −10%) 48–66 Hz; 30 VA maximum.
Dimensions: 212 mm W × 88 mm H × 415 mm D (8⅜ × 3½ × 16½ in.).
Weight: Net, 3.9 kg (8 lbs. 10 oz.); Shipping, 6.3 kg (14 lbs.). Rack and stack metal case with rear panel, switchable AC power line module.
Rack Mount Kit: 5061-0072 recommended.

HP INTERFACE BUS (HP-IB)

Data Output
- **Format:** (alpha character) ± (Reading) (Exponent) ± (2 digits).
- **Data Output Rate:** ~7 Readings/second max. (10 in short G.T.)
- **Talk Only Mode:** Selectable by rear panel switch.

Operating Commands
- **5316A:** Reset, Initialize (to FREQ A), Wait State ON/OFF, Service Request Enabled/Disabled, Gate Time Range.
- **HP-IB:** Group Execute Trigger, Device Clear, Selected Device Clear, Interface Clear, Local, Remote, Local Lockout, Read Status (Serial Poll Enable).

Programmable Controls and Functions
- **Frequency Functions:** FREQUENCY A, FREQ A ARMED BY B, TOTALIZE, A GATED BY B, RATIO A/B, and FREQ C.
- **Period Function:** Period A.
- **Time Interval Functions:** Time Interval A→B, Time Interval Average A→B, Time Interval Delay.
- **Trigger Level Commands:** Set Channel A Slope (±), set Channel B Slope (±), A Trigger Level: ±X.XX, B Trigger Level: ±X.XX.
- **Gate Time Command:** Sets Gate Time Range.
- **Miscellaneous Functions:** Gate Time Check, Display Test, 10 MHz Check, Interface Test.

OPTIONS

OPTION 001: High Stability Time Base (TCXO)
- **Frequency:** 10 MHz.
- **Aging Rate:** $<1 \times 10^{-7}$/mo.
- **Temperature:** $\pm 1 \times 10^{-8}$, 0° to 40°C referenced to 25°C if offset frequency is used.
- **Line Voltage:** $<1 \times 10^{-8}$ for ±10% variation.

OPTION 003: C Channel
- **Input Characteristics**
  - **Range:** 50 to 1000 MHz, prescaled by 10.
  - **Sensitivity:** 15 mV rms sine wave (-23.5 dBm) to 650 MHz. 75 mV rms sine wave (-9.5 dBm) to 1000 MHz. Sensitivity can be decreased continuously by up to 20 dB NOMINAL, 50 to 500 MHz and 10 dB NOMINAL, 500 to 1000 MHz by adjusting sensitivity control. Trigger level is fixed at 0V NOMINAL.
  - **Dynamic Range:** 15 mV to 1V rms (36 dB), 50 to 650 MHz. 75 mV to 1V rms (20 dB), 650 to 1000 MHz.
  - **Signal Operating Range:** +5V dc to -5V dc.
  - **Coupling:** AC
  - **Impedance:** 50Ω **NOMINAL (VSWR, [2.5:1 TYPICAL).**
  - **Damage Level:** ±8V (DC + AC peak), fuse protected. Fuse located in BNC connector.
- **Frequency**
  - **Range:** 50 to 1000 MHz.
  - **LSD Displayed:** 100 Hz to 1 Hz depending upon gate time. At least 7 digits per second of gate time.
  - **LSD, Resolution and Accuracy:** Same formulas as for Frequency A except "Gate Time" term becomes "(Gate Time)/10".

Table 1-1. Model 5316A Specificatons (Continued)

OPTIONS (Continued)

OPTION 004: Oven Oscillator
Frequency: 10 MHz.
Aging Rate: $<5 \times 10^{-8}$/month after 7 days of continuous operation. $<3 \times 10^{-7}$/year after 180 days continuous operation.
Warm-up: $\pm 5 \times 10^{-8}$ of final value after 20 minutes.
Temperature: $\pm 2 \times 10^{-8}$, 0° to 50°C.
Oscillator Output: 50 mV p-p into 50Ω.

DEFINITIONS:

Resolution: Smallest discernible change of measurement result due to a minimum change in the input.
Accuracy: Deviation from the actual value as fixed by universally accepted standards of frequency and time.
Least Significant Digit (LSD) Displayed:

Frequency:

$$\frac{2.5 \times 10^{-7}}{\text{Gate Time}} \times \text{FREQ, for FREQ} < 10 \text{ MHz.}$$

$$\frac{2.5}{\text{Gate Time}} \quad \text{for FREQ} \geq 10 \text{ MHz.}$$

Period:

$$\frac{2.5 \times 10^{-7}}{\text{Gate Time}} \times \text{PER, for PER} > 100 \text{ ns.}$$

$$\frac{2.5}{\text{Gate Time}} \times \text{PER}^2, \text{ for PER} \leq 100 \text{ ns.}$$

All above calculations should be rounded to nearest decade (i.e., 5 Hz will become 10 Hz and .4 ns will be .1 ns).

NOTE

Time Interval Average is a statistical process. LSD displayed is calculated for 1 standard deviation (σ) confidence level.

Trigger Error:

$$\frac{\sqrt{(120 \times 10^{-6}\text{V})^2 + e_n^2}}{\text{(Input slew rate in V/s at trigger point)}} \text{ seconds rms,}$$

Typical where e_n is the rms noise voltage of the input for a 100 MHz bandwidth.

Time Interval Average:

	LSD
1 to 25 intervals	100 ns
25 to 2500 intervals	10 ns
2500 to 250,000	1 ns
250,000 to 25,000,000 intervals	100 ps
>25,000,000 intervals	10 ps

1-11. OPTIONS

1-12. The options available for the 5316A are listed below. There are no field retrofit kits available for these options. All options should be requested at the time of the initial order. However, Section II contains the necessary information required to install Option 001 TCXO, Option 004 Oven Oscillator, and Option 003, Channel C. Options 001 and 004 require the standard A7 assembly be replaced by the appropriate option (Option 004 adds an A13 assembly). Option 003 requires the addition of the A9 assembly and a new front panel. All parts must be ordered as separate items and then installed as described in Section II. Option 006 is described in its own manual. Full descriptions of Options 001, 003, and 004 begin with paragraph 3-62.

Option	Description
001	High Stability Time Base (TCXO)
003	Channel C 1 GHz
004	Oven Oscillator
006	Offset/Normalizer

1-13. Option 001 TCXO is a Temperature Compensated Crystal Oscillator that directly replaces the standard A7 oscillator assembly. Option 004 Oven Oscillator provides increased temperature stability over the TCXO. Specifications are listed in *Table 1-1*.

1-14. Option 003 Channel C allows frequency measurements to 1 GHz. Specifications are listed in *Table 1-1*.

1-15. Option 006 Offset/Normalizer allows the operator to make active mathematical modifications to the display of the 5316A. Option 006 is described in its own operation and service manual, HP Part Number 05315-90011, plus Addendum 05315-90019.

1-16. SAFETY CONSIDERATIONS

1-17. The 5316A Universal Counter is a Safety Class I instrument, designed according to International Safety Standards. This operating manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and keep the instrument in safe condition.

1-18. INSTRUMENT IDENTIFICATION

1-19. Hewlett-Packard instruments have a 2-section, 10-character serial number (0000A00000), which is located on the rear panel. The four-digit serial prefix identifies instrument changes. If the serial prefix of your instrument differs from that listed on the title page of this manual, there are differences between this manual and your instrument. Instruments having higher serial prefixes are covered with a "Manual Changes" sheet included with this manual. If the change sheet is missing, contact the nearest Hewlett-Packard Sales and Service Office listed at the back of this manual. Instruments having a lower serial prefix than that listed on the title page are covered in Section VII.

1-20. ACCESSORIES

1-21. *Table 1-2* lists accessory equipment supplied and *Table 1-3* lists accessories available.

Table 1-2. Accessories Supplied

Description	HP Part Number
Detachable Power Cord, 229 cm (7½ feet)	8120-1378