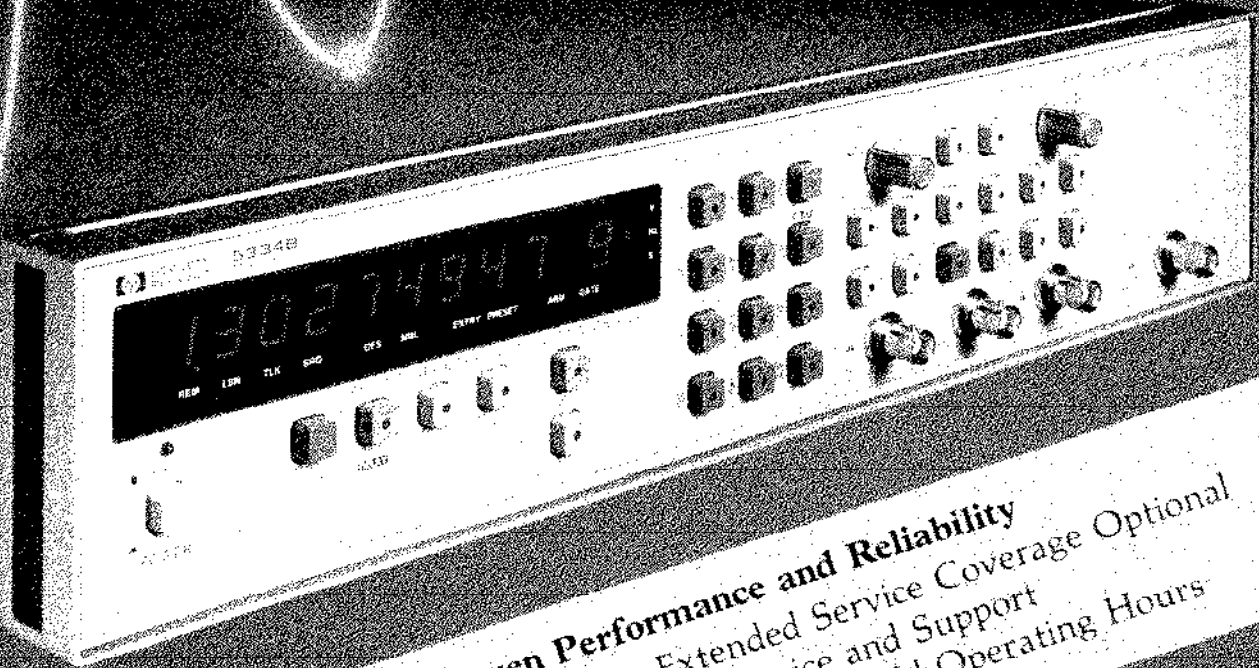


HP 5334A/B Universal Counters

 HEWLETT
PACKARD

Delivering More Value and Convenience in
Timing and Frequency Measurements

Technical Data



Proven Performance and Reliability

- Two-year Extended Service Coverage Optional
- Worldwide Service and Support
- Over 10 Million Field Operating Hours

Remarkable Universal Counter Performance . . .

- 9 Digits of resolution in one second of gate time, 1 Hz to 1.3 GHz
 - 200 ps Time Interval average resolution, 2 ns single shot resolution
 - 100 MHz A and B Channels; 1.3-GHz C Channel option
 - Frequency, Period, Ratio, Totalize, and TI Delay
 - External Arm for increased measurement capability
 - MATE Interface and High Stability Oven Time Base options

Hewlett-Packard offers 28 counters that cover frequencies from RF to microwave and millimeter-wave. The HP 5334A/B are HP's medium-priced, high-performance universal counters for systems and bench. The HP 5334B is a value-engineered, lower-priced version of the HP 5334A and has all of its most valued features. The HP 5334A is available for customers who also require a front-panel setup memory and optional DVM (see page 9).

. . . Plus Added Measurement Capability and Convenience

Measure Rise/Fall Time, Pulse Width and AC/DC Voltage at the push of a button or with a single HP-IB command.

Automatic Rise/Fall Time

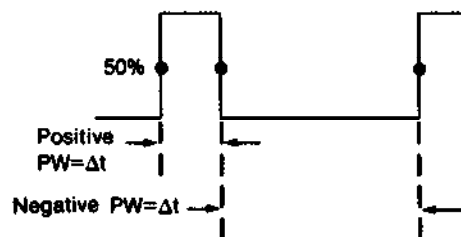
Measure Rise/Fall Time down to 30 ns on repetitive input signals automatically. The HP 5334A/B measure the signal peaks and set trigger points. A Rise Time measurement is made if the SLOPE A switch is set to positive, Fall Time if the SLOPE A switch is negative.



Measure transition times to 2 ns resolution with one push of a button.

Automatic Pulse Width

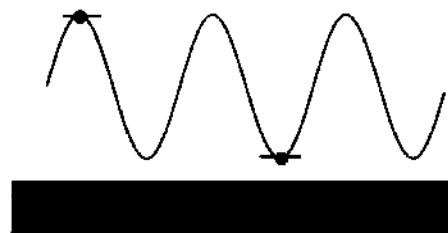
Automatically measure the positive or negative width of a repetitive pulse down to 5 ns with 2 ns resolution, 200 ps with 100 Gate Averaging. The SLOPE A switch defines whether a negative or positive width is measured.



Make preset pulse-width measurements to 200 ps resolution with 100 Gate Averaging.

AC and DC Voltage

The AC and DC Voltage function adds a new dimension to universal counter applications because it reduces the need for additional test equipment and gives you a more complete picture of your input signal. For signals up to 20 MHz, the HP 5334A/B measure not only time and frequency, but also the peak amplitudes of the input signal. DC voltages at the inputs are also measured to 20 mV resolution.



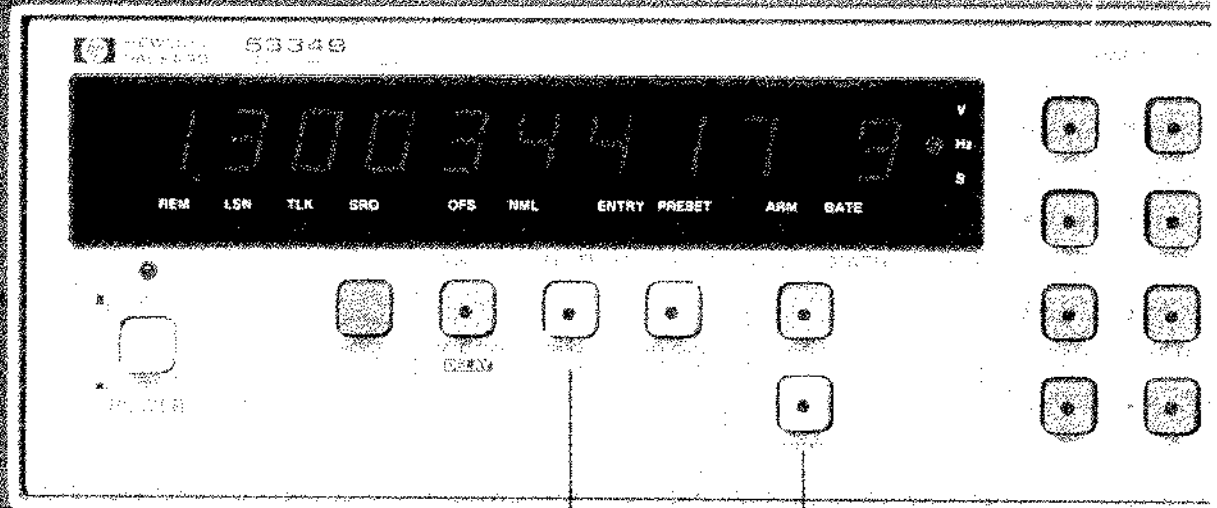
Make AC and DC Voltage measurements to 20 mV resolution.

The HP 5334B Universal Counter

More Performance Than You Expect
in a Universal Counter

U.S. Air Force MATE
internal CBIT interface
optional

A full complement of standard
universal counter functions
plus rise/fall time and
pulse width.

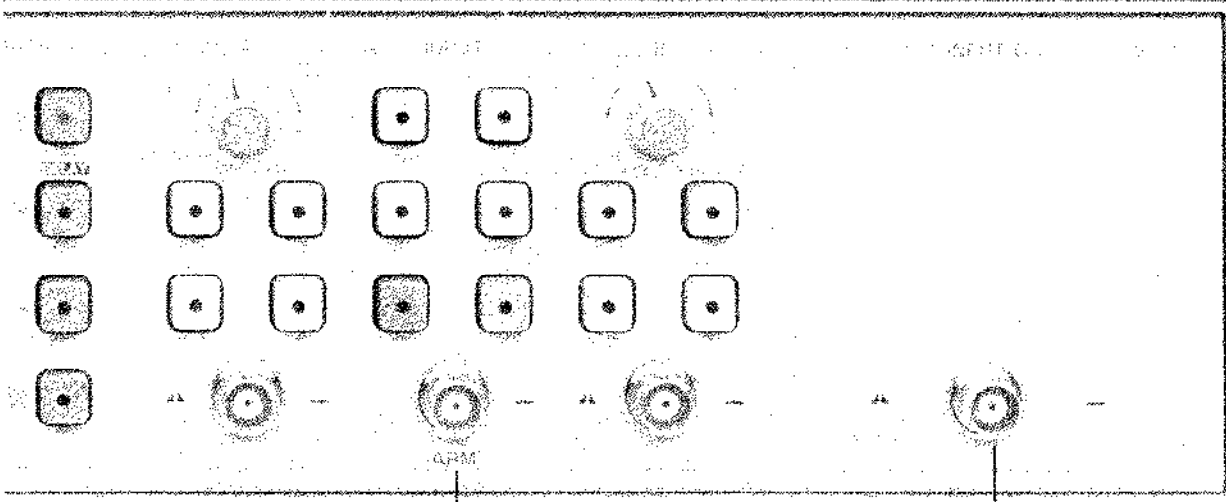


Select optimum resolution and
measurement time for your
application.

Enter **Offset** value for deviation
measurements. Enter **Normalize** value
to display measurement in familiar units.

Versatile selection of input signal conditioning for your application.

Display Channel A and B AC/DC Voltage and Trigger Levels without any extra cables or equipment.



Externally gate or arm the measurement for increased capability.

Extend Frequency to 1.3 GHz for communication and navigation applications with Channel C option.

For Bench Applications

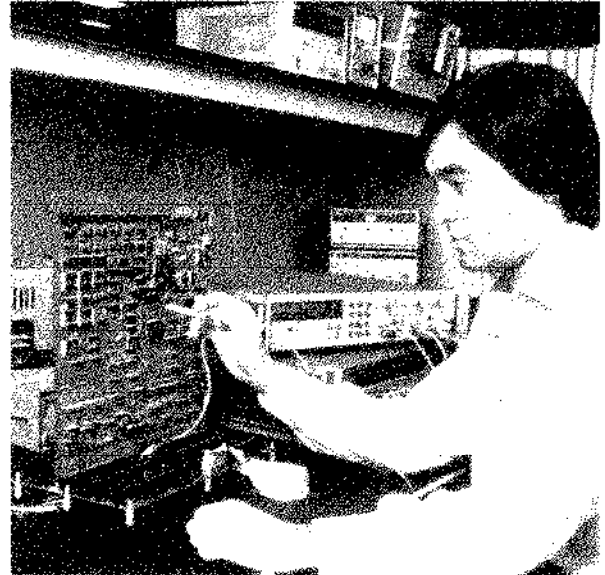
Automatic Trigger/Attenuator

The HP 5334A/B automatically adjust trigger level and attenuator settings, guaranteeing triggering on virtually any input signal.

Auto Trigger finds the optimum trigger point for **guess-free and accurate measurements**. Auto Attenuator ensures correct counting by selecting the X10 attenuator when the input signal amplitude is greater than the input signal operating range.

Display Results in YOUR Units

The HP 5334A/B's Math functions harness the power of internal processors to compute and display results in your units. Simply divide (normalize) or add (offset) the measurement by a constant to display results such as velocity, flow or ppm.



Automatic Trigger/Attenuation provide adjustment-free measurements while the Math function displays them in your units.

And Systems Use

Complete HP-IB Programmability Standard

More measurement control and signal information than ever before is available over the Hewlett-Packard Interface Bus (HP-IB*). All front-panel controls are programmable, including input signal conditioning and trigger levels.

The HP 5334A/B follow guidelines for code and format conventions in the IEEE 728-1982 and IEC 652-2 Standards.

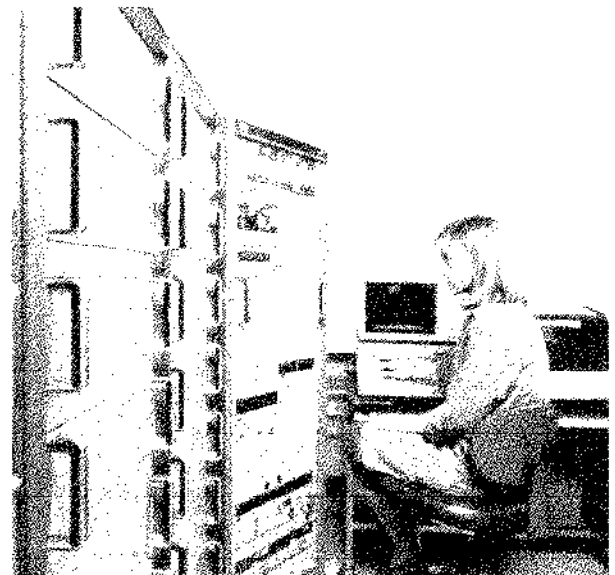
High-Speed Data Output Mode

Typical data output rate is 10 readings/second, dependent on the function and resolution required. For applications which require faster output, unprocessed data at rates up to **140 readings/second** is available.

MATE** Interface Option

For U.S. Air Force automatic-test equipment applications, the Option 700 Internal CIIL Interface

responds to all applicable CIIL commands for a MATE frequency/time interval generic module. This provides the full measurement complement of Frequency, Period, Time Interval, Pulse Width, Rise/Fall Time, Totalize, Ratio, and AC/DC Voltage.

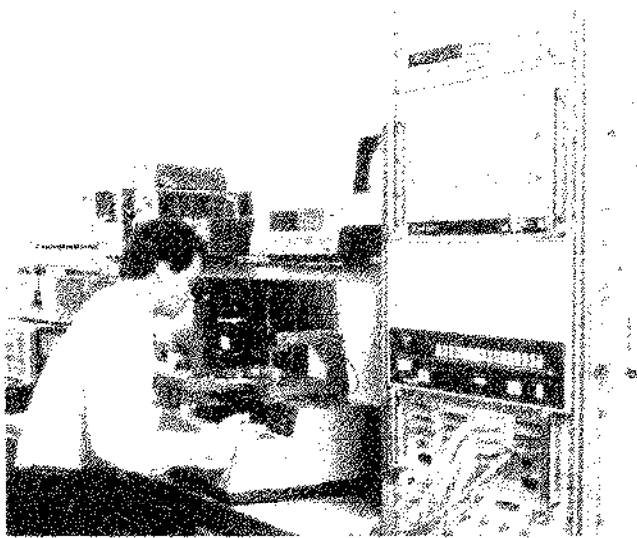


Complete HP-IB programmability combined with high-level mnemonics speed software development in ATE applications. Optional rear-terminal inputs simplify cabling.

**HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.*

***MATE (Modular Automatic Test Equipment) is a U.S. Air Force (USAF) standard that defines the interface and programming language for all automatic test equipment the USAF purchases. CIIL (Control Interface Intermediate Language) is the programming/control language used by MATE systems.*

High-Resolution Measurement Power



IC timing measurements demand the 2 ns single-shot time-interval resolution of the HP 5334A/B.

200 ps-Time Interval Resolution

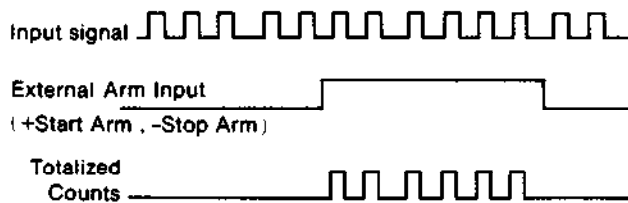
Important for applications such as IC access time and propagation delay, single-shot time-interval resolution is a remarkable 2 ns. Precise trigger levels can be set easily using the Read Levels function while matched amplifiers minimize differential channel delay. This yields a more accurate time-interval measurement.

100 Gate Averaging extends time-interval resolution to 200 ps. True time-interval averaging under all conditions is ensured by the interpolation technique.

Use Time Interval Delay to ignore spurious signals which would normally cause the counter to trigger. Time Interval Delay inhibits the stop trigger by a delay time from 1 ms to 99.999 seconds.

Ratio and Totalize

Ratio A/B uses the full 100-MHz bandwidth, sensitivity, and input-signal conditioning of the A and B Channels.



Make manual and gated totalize measurements — For manual control, you can start and stop measurements using Totalize Start A and Totalize Stop A keys. For electronically gated totalize, the External Arm input may be used.

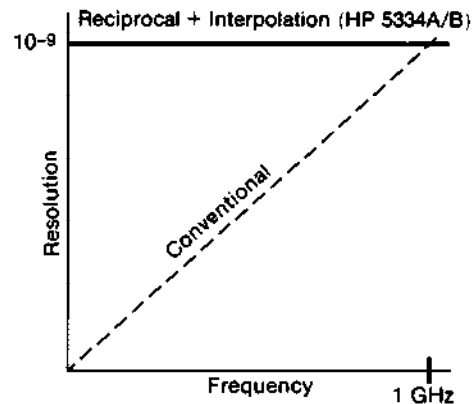
9-Digit Frequency and Period Resolution

Measure Frequency A, Period A, and Frequency B to 100 MHz. Digital gate time selection makes it easy to tradeoff resolution and measurement time. Gate time is selectable in 1 ms increments from 1 ms to 99.999 seconds.

Resolution is at least 9 digits/second from 0.001 Hz to 1300 MHz, made possible by the HP 5334A/B's reciprocal and interpolation capabilities.

The reciprocal technique is implemented with Hewlett-Packard's Multiple Register Counter (MRC) and microprocessor design. In this technique, the counter measures the input signal's period and then calculates the frequency. This achieves higher resolution than conventional methods using the same gate time.

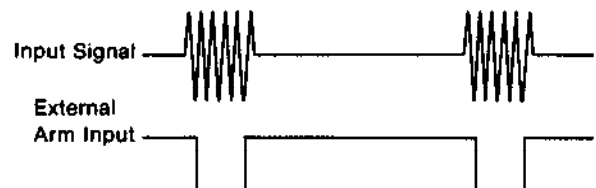
Powerful interpolation technology effectively raises the HP 5334A/B's timebase from the typical 100 MHz to 1 GHz for extremely high measurement resolution over the entire frequency range.



Compared with conventional counting, the HP 5334A/B deliver exceptional resolution, regardless of frequency, using interpolation and reciprocal counting.

Increase your frequency range to 1.3 GHz by adding a C-Channel option for communications and navigation applications. And you can use the HP 10855A Broadband Preamplifier to improve sensitivity to 1.5 mV for low signal level applications.

You can easily **make pulsed RF communications and radar-signal measurements** to 1.3 GHz using the external arming capability of the HP 5334A/B. Using 100 Gate Average, you can increase resolution by a factor of ten.



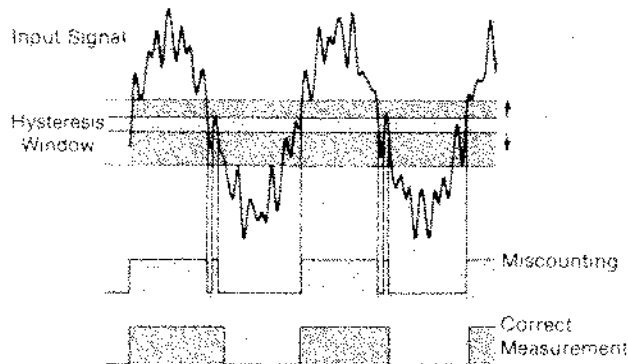
Make externally-armed frequency measurements, using averaging to increase resolution.

Flexibility For Your Toughest Measurement Problems

Versatile Input Signal Conditioning

In addition to automatic capability, independent selection of input signal conditioning for both A and B Channels provides flexibility for your application. Accurate triggering is ensured by attenuation, low pass filter and variable sensitivity. AC coupling is useful for frequency measurements on signals with large dc offsets. DC coupling and 50Ω input impedance minimize pulse distortion.

The sensitivity control widens the hysteresis band for measurements on noisy input signals. Push the SENS button and the trigger level control becomes a variable sensitivity control (trigger levels set to 0V nominal). Sensitivity can be continuously varied from 15 mV rms to 150 mV rms.



Vary the sensitivity to prevent miscounting of a noisy signal.

The HP 5334A/B also include a 100 kHz low pass filter for the A Channel to eliminate miscounting caused by high-frequency noise on a low-frequency signal.

Simple and Flexible Triggering

The HP 5334A/B offer three alternatives for trigger level selection. The PRESET light indicates when the front-panel trigger controls are inactive, such as in Automatic Trigger.

Use **Automatic Trigger** for maximum convenience. The minimum and maximum peaks of the input signal are found automatically, and the optimum trigger point calculated.

Set trigger levels manually from -5.1 to +5.1V (+51V in $\times 10$). Use Read Levels to display A and B Channel trigger levels to 20 mV resolution. The trigger light "blinks" when the counter is triggering, is "off" when the trigger level is too high, and is "on" when the trigger level is too low.

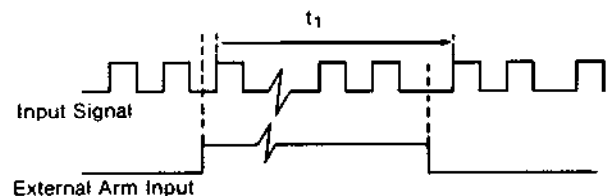
Program trigger levels over the HP-IB. Channel A and B trigger levels can be set independently over the bus. Also, with the Read Levels Function, manually set trigger levels can be sent back to the controller.

Measure When and What You Want with External Arming

Control the measurement start and/or stop point to synchronize a measurement to a real time event(s). Start arm is used alone to enable the start of a measurement, stop arm to enable the stop of a measurement. External gating is accomplished by arming both the start and stop of a measurement. Gate widths as narrow as 50 ns may be used.

A few application examples:

- Synchronize measurements to an external random event.
- Measure frequency within a pulsed RF signal, averaging bursts for increased resolution.
- Select a specific time interval within a pulse train.
- Select a portion of a pulse train to totalize.



The HP 5334A/B's external arming lets you measure a specific time interval (t_1) within a pulse train. External Arm display shows start arm on positive edge and stop arm on negative edge of the external arm input.

The arm input and slope selection controls are conveniently located on the front panel. And the arming trigger point is preset to a convenient 1.5 volts for TTL signals.

Proven Reliability

You'll enjoy a minimal cost of ownership with the HP 5334A/B because of their low initial and maintenance costs. These low costs result from a value-engineered design and efficient production processes.

A few examples:

- LSI design resulted in fewer components and an internal heat rise so low that the HP 5334A/B run cool enough to operate without a fan.
- Standard timebase's calibration adjustment is accessible from the rear panel — no need to remove the top cover.



Every HP 5334A/B is tested on an automatic test system to stringent in-house standards. These standards ensure conformance to specifications over the entire environmental range.

Hewlett-Packard's commitment to excellence and **over 10 million field operating hours** have proven the reliability of the HP 5334A. This same reliability has been designed into the HP 5334B. The HP 5334A's **annual failure rate of less than 3%*** assures you that its proven performance will be there when you need it most.

In the event of failure, however, extensive self-tests at power-up and constant monitoring during instrument operation spot failures quickly. Fast repair is aided by failure messages, diagnostic modes, signature analysis, and a 10-year parts and service commitment after obsolescence.

Excellent RFI Protection for Your Toughest Measurement Environments

The HP 5334A/B have high-quality metal cases designed to meet strict standards for electromagnetic compatibility (radiated and conducted emissions and susceptibility). This makes them well suited for applications such as low-level receiver or high-power transmitter testing. They are also ideal for systems environments where interference with adjacent equipment is a concern.



All circuit board adjustments and test points are accessible with only the top cover removed for reduced maintenance costs and improved serviceability. (Options 010, 030, 060, and 700 shown.)

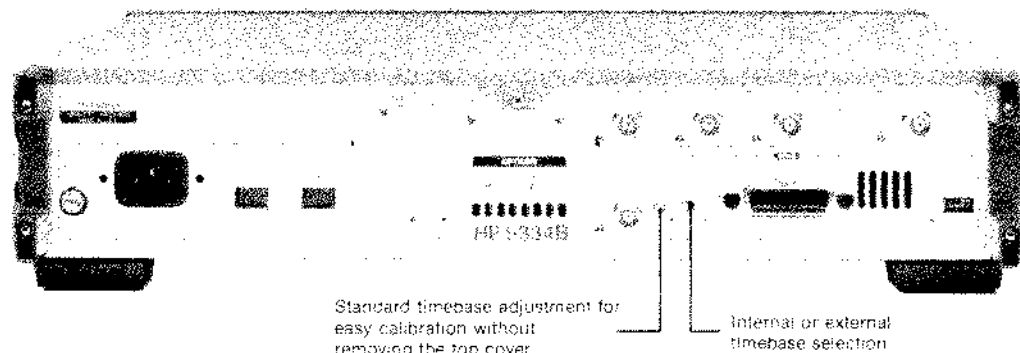
Add Capability

Increase Your Frequency Range to 1.3 GHz

The Option 030 C Channel can extend your frequency range to 1.3 GHz with 15 mV rms (-23.5 dBm) sensitivity from 90 MHz to 1000 MHz.

Improve Accuracy and Reduce Calibration Needs

The Option 010 substitutes a **high-stability oven oscillator** for the standard oscillator. This provides an extremely low aging rate, better short-term stability, and excellent temperature stability. This results in improved measurement accuracy and repeatability, along with greater time between calibrations.



The HP 5334B rear panel with option 060 Rear Terminals.

*Based on failures reported in the first year.

Convenient and Guaranteed Worldwide Service and Support

Should you ever need assistance, you have the confidence of being backed by the industry's best service and support organization. Hewlett-Packard has **over 100 service and support offices in the U.S. and 275 offices in 75 countries internationally.**

HP is so confident in the reliability of these counters that you can buy **two additional years of "return to HP" service and support at nominal cost**

by specifying Option W30 at the time of purchase. This is in addition to the one-year warranty service that HP normally provides on all of its instruments, thus giving you a full three years of guaranteed HP service and support.

The HP 5334A

Memory

Don't waste time setting up repetitive measurements. Simply store the front-panel settings, including trigger levels, and conveniently recall them. Set-up time and operator errors are eliminated. Sequencing through several complicated set-ups is simplified, resulting in quick, repeatable measurements.

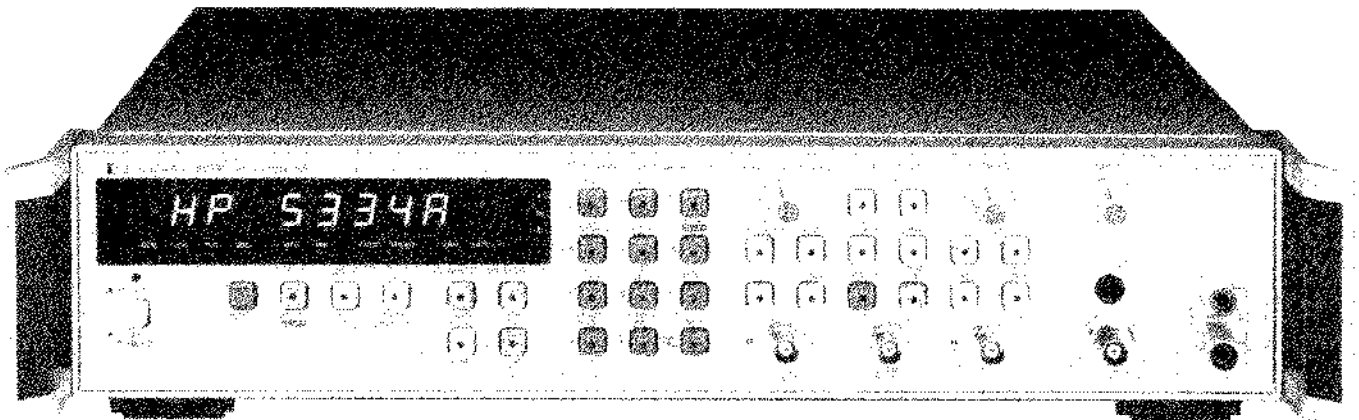
DC Voltage Measurements

Option 020 Digital Voltmeter gives you a +1000V autoranging, autopolarity DC DVM with a floating input. By using a voltage-to-frequency

conversion technique, the incremental cost of adding a voltmeter is small. It also means less space on the bench or in a rack.

Increased Frequency Range

Option 030 C Channel extends the frequency range to 1.3 GHz with 15 mV rms (-23.5 dBm) sensitivity from 90 MHz to 1000 MHz. For very small signals, the probe power output allows easy use of the HP 10855A Broadband Preamplifier to improve sensitivity to 1.5 mV, while the sensitivity adjustment will decrease sensitivity by up to 20 dB for very large signals.



The HP 5334A with DVM and C-Channel (Option 050).

Specifications

(Apply to both HP 5334A and B unless otherwise noted.)

INPUT CHARACTERISTICS

CHANNEL A and CHANNEL B

Range:

dc coupled: 0 to 100 MHz.
ac coupled: 1 M Ω , 30 Hz to 100 MHz.
50 Ω , 1 MHz to 100 MHz.

Sensitivity:

15 mV rms sine wave to 20 MHz.
35 mV rms sine wave to 100 MHz.
100 mV peak-to-peak at a minimum pulse width of 5 ns.
Sensitivity can be continuously varied to 150 mV rms, (NOMINAL) using the TRIGGER LEVEL/SENS control in sensitivity mode. In this mode, trigger levels are automatically set to 0V NOMINAL.

Dynamic Range (X1):

45 mV to 5V peak-to-peak, to 20 MHz.
100 mV to 2.5V peak-to-peak, to 100 MHz.

Signal Operating Range, DC: $\pm 5V$ dc (X ATTN).

Trigger Level:

Range:

Manual (Auto Trigger OFF): Continuously adjustable over $\pm 5.1V$, displayed by Read Levels in 20 mV steps. In X10, $\pm 51V$ displayed in 200 mV steps.

Preset: 0V NOMINAL in Sensitivity Mode.

Auto Trigger: See Automatic Measurements Section.

Accuracy (Read Levels):

X1: ± 30 mV $\pm 1\%$ of trigger level reading.
X10: ± 300 mV $\pm 1\%$ of trigger level reading.

Coupling: ac or dc, switch selectable.

Trigger Slope: Independent selection of + or - slope.

Impedance \ddagger : 1 M Ω NOMINAL shunted by <60 pF or 50 Ω NOMINAL, switch selectable.

Attenuator:

Manual: X1 or X10 NOMINAL, switch selectable.

Auto: Attenuator automatically switched when in Auto Trigger mode. See Automatic Measurements Section.

Low Pass Filter: 100 kHz NOMINAL, switchable in or out of Channel A.

Damage Level:

50 Ω : 5V rms.
1 M Ω , X1:
0 to 3.5 kHz: 200V (dc + peak ac).
3.5 kHz to 100 kHz: $5 \times 10^6 V$ rms Hz/FREQ.
>100 kHz: 5V rms.

1 M Ω , X10:

0 to 35 kHz: 200V (dc + peak ac).
35 kHz to 100 kHz: $5 \times 10^6 V$ rms Hz/FREQ.
>100 kHz: 50V rms.

Common Input: All specifications are the same as for separate operation except for the following:

Sensitivity:

15 mV rms sine wave to 20 MHz.
75 mV rms sine wave to 100 MHz.
210 mV peak-to-peak at a minimum pulse width of 5 ns.

Dynamic Range (X1):

45 mV to 5V peak-to-peak to 20 MHz.
210 mV to 2.5V peak-to-peak to 100 MHz.

Impedance \ddagger : 500 k Ω NOMINAL shunted by <85 pF or 50 Ω NOMINAL.

EXTERNAL ARM

Front panel ARM input can be used to determine Start and/or Stop point of a measurement. External Arm can be used with all measurements except DVM (HP 5334A) and Read Levels.

Minimum Start to Stop Time: 50 ns.

Maximum Transition Time: 1 μ s.

Sensitivity: 500 mV peak-to-peak.

Signal Operating Range: -5 Vdc to +5 Vdc.

Dynamic Range: 500 mV to 10V peak-to-peak.

Arm Trigger Level:

HP 5334A: Adjustable from -4V to +4V by rear panel control.

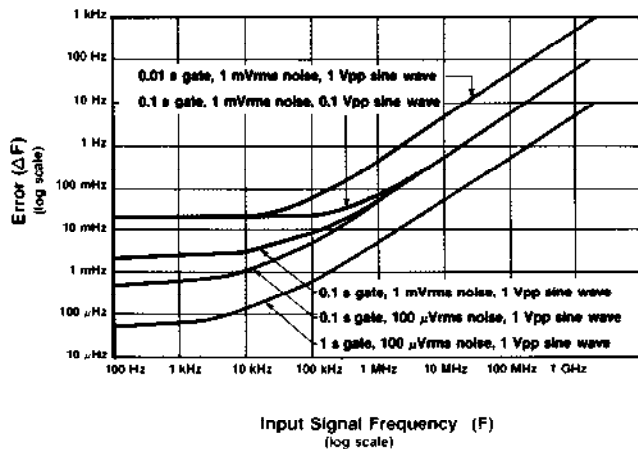
HP 5334B: Fixed at 1.5V.

Slope: Independent selection of START and STOP ARM slopes: +, -, or OFF.

Arm Set-up Time: Typically 20 ns for all measurements except Totalize. Typically 100 ns for Totalize.

Impedance \ddagger : dc Coupled, 1 k Ω NOMINAL shunted by <30 pF.

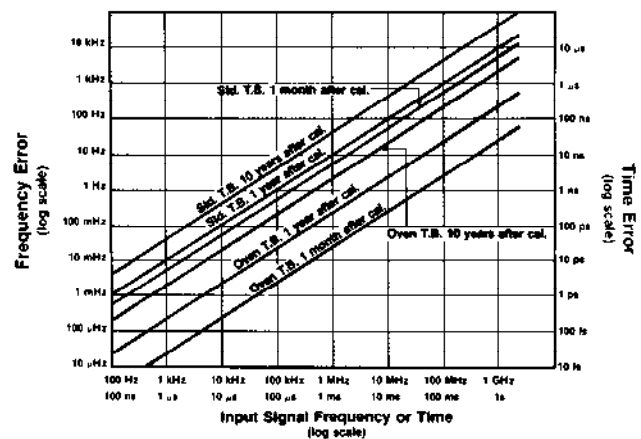
Damage Level: ± 15 V (dc + peak ac).



Graph 1. Frequency Resolution Error: Noise on the input signal and internal uncertainties affect Frequency and Period measurements. For Period, invert the period (P) of

the input signal ($F = \frac{1}{P}$), and find frequency

error (ΔF). Period error (ΔP) = $(\frac{\Delta F}{F}) \times P$.



Graph 2. Timebase Error: Crystal environment and aging affects all measurements.

\ddagger Resistance values are measured at dc and capacitance values at 10 MHz.

FREQUENCY A and FREQUENCY B

Range: .001 Hz to 100 MHz.

LSD ①: $\frac{4 \text{ ns}}{\text{Gate Time}} \times \text{FREQ.}$

Resolution: (see Graph 1)

$\pm \text{LSD} \pm \frac{(1.4 \times \text{Trigger Error } \textcircled{1} + 1 \text{ ns rms})}{\text{Gate Time}} \times \text{FREQ.}$

Accuracy: $\pm \text{Resolution} \pm \text{Timebase Error } \textcircled{2}$.

PERIOD A

Range: 10 ns to 10³ s.

LSD ①: $\frac{4 \text{ ns}}{\text{Gate Time}} \times \text{PER.}$

Resolution: (see Graph 1)

$\pm \text{LSD} \pm \frac{(1.4 \times \text{Trigger Error } \textcircled{1} + 1 \text{ ns rms})}{\text{Gate Time}} \times \text{PER.}$

Accuracy: $\pm \text{Resolution} \pm \text{Timebase Error } \textcircled{2}$.

TIME INTERVAL A to B

Range: -1 ns to 10³s (single-shot), 10s (100 GATE AVERAGE).

LSD ①: 1 ns (100 ps using 100 GATE AVERAGE).

Resolution: $\pm \text{LSD} \pm \text{Start Trigger Error } \textcircled{3} \pm \text{Stop Trigger Error } \textcircled{3} \pm 1 \text{ ns rms.}^{**}$

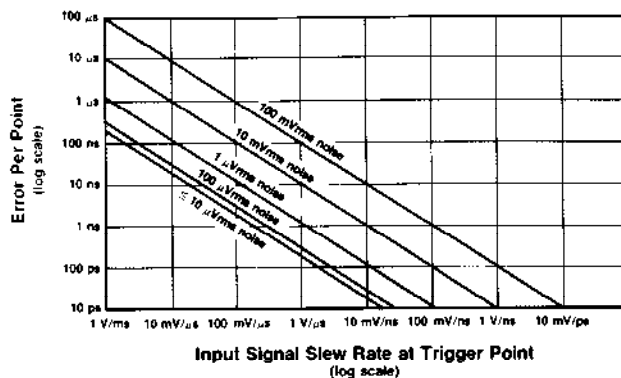
Accuracy: $\pm \text{Resolution} \pm \text{Timebase Error } \textcircled{2} \pm \text{Trigger Level Timing Error } \textcircled{4} \pm \text{Trigger Level Setting Error } \textcircled{5} \pm 2 \text{ ns}^*.$

TIME INTERVAL DELAY

Used with Time Interval A to B, a selectable delay can be inserted between START (Channel A trigger) and STOP (Channel B trigger). Electrical inputs during delay are ignored. Specifications are the same as for Time Interval A to B.

Delay Range: 1 ms to 99.999 s (1 ms steps).

Delay Accuracy: $\pm 100 \mu\text{s} \pm 0.05\% \times \text{DELAY TIME.}$



Graph 3. Input Noise Trigger Error: Noise on the input signal affects both the Start and Stop points of all time interval measurements.

* This is a systematic error due to differential channel delay (mismatch Channel A and B) which can be eliminated by proper measurement technique; i.e., numerical offset or different cable lengths.

RATIO A/B

Range: .001 Hz to 100 MHz both channels.

LSD ①: $4 \times \text{RATIO}/(\text{FREQ A} \times \text{Gate Time}).$

Resolution:

$\pm \text{LSD} \pm \frac{\text{B Trigger Error } \textcircled{1}}{\text{Gate Time}} \times \text{RATIO.}$

Accuracy: Same as Resolution.

Specified for higher frequency input connected to Channel A.

TOTALIZE A

Range: 0 to 10¹²-1.

LSD Displayed: 1 count of input signal.

Resolution: $\pm \text{LSD.}$

Accuracy: $\pm \text{LSD.}$

AUTOMATIC MEASUREMENTS

These features are specified from 100 Hz to 20 MHz unless noted. Minimum width at peak of signal: 5 ns. Auto Trigger and Auto Attenuation automatically engaged for Rise/Fall Time, Pulse Width, and AC/DC Voltage measurements.

AUTO ATTENUATION

Enabled simultaneously with Auto Trigger. (Voltage values are NOMINAL, measured with 50Ω termination).

X10 attenuator enabled when: either peak is greater than $\pm 5.1\text{V}$ OR difference between maximum and minimum peaks exceeds 5.1V.

X1 attenuator enabled when: maximum and minimum peak amplitudes are less than $\pm 4.6\text{V}$ AND difference between maximum and minimum peaks is less than 4.4V.

AUTO TRIGGER

DC Coupled: 100 Hz to 100 MHz.

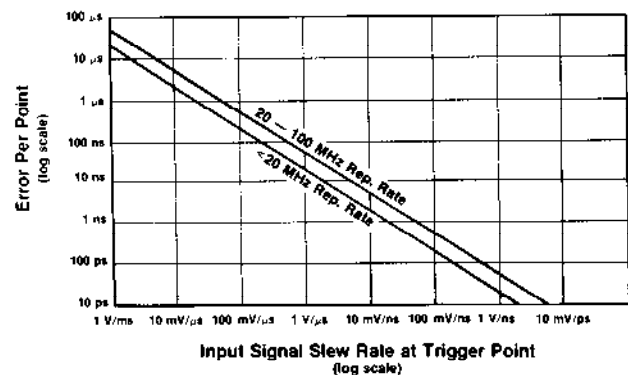
AC Coupled: 1 MΩ: 100 Hz to 100 MHz.
50 Ω: 1 MHz to 100 MHz.

Minimum Amplitude: 100 mV rms sine wave, 280 mV peak-to-peak.

Trigger Level Accuracy: $\pm 30 \text{ mV}$ (X ATTN).

For Rise/Fall Time, $\pm 40 \text{ mV}$ (X ATTN).

Auto Trigger is disabled for Totalize, Frequency C, DVM (HP 5334A), and Read Trigger Levels.



Graph 4. Trigger Level Timing Error: Affects the Start and Stop points of all time interval measurements. Total error is the larger of the two trigger point errors.

** 100 ps rms using 100 GATE AVERAGE.

RISE/FALL TIME A

Range: 30 ns to 10 ms.

Minimum Amplitude: 500 mV peak-to-peak.

Dynamic Range: 500 mV to 40V peak-to-peak.

LSD ①: 1 ns (100 ps using 100 GATE AVERAGE).

Resolution: \pm LSD \pm Start Trigger Error ③ \pm Stop Trigger Error ④ \pm 1 ns rms.**

Accuracy:

- \pm Resolution \pm Trigger Level Timing Error ④
- \pm Trigger Level Setting Error at 10% point ③
- \pm Trigger Level Setting Error at 90% point ④
- \pm Timebase Error ② \pm 2 ns.*

Typically within 3% for triangular, trapezoidal, and pulse waveforms, 1V to 5V (X ATTN) peak-to-peak.

PULSE WIDTH A

Range: 5 ns to 10 ms.

LSD ①: 1 ns (100 ps using 100 GATE AVERAGE).

Resolution: \pm LSD \pm Start Trigger Error ③ \pm Stop Trigger Error ④ \pm 1 ns rms.**

Accuracy:

- \pm Resolution \pm Trigger Level Timing Error ④
- \pm Trigger Level Setting Error ③
- \pm Timebase Error ②.

Typically within 2% for triangular and pulse waveforms, 1V to 5V (X ATTN) peak-to-peak.

AC/DC VOLTAGE

AC maximum and minimum peaks or dc level of Channel A or Channel B input are displayed by Read Level function.

Frequency Range: dc, 100 Hz to 20 MHz.

Dynamic Range: ac: 0V to 40V peak-to-peak, dc: \pm 51 volts.

Resolution: X1: 20 mV, X10: 200 mV.

AC Accuracy: \pm Resolution \pm 10% of difference between maximum and minimum peak displayed.

Typically within 3% for a sine wave >500 mV peak-to-peak.

DC Accuracy (mean value of display):

X1: \pm 35 mV \pm 0.5% of reading.

X10: \pm 300 mV \pm 2% of reading.

MATH

All measurements except for Totalize and Read Levels may be operated upon by MATH functions. Math values are toggled on or off using the DISABLE key. Offset and Normalize may be used independently or together as follows:

Display = (Measurement/Normalize) + Offset.

Entry Range: \pm 1 X 10⁻¹⁰ to \pm 9.9999999999 X 10⁹.

At power-up, Offset = 0 and Normalize = 1.

GENERAL

TIMEBASE

Standard Crystal:

Frequency: 10 MHz.

Aging Rate: $<3 \times 10^{-7}$ per month.

Temperature: $<5 \times 10^{-6}$, 0° to 50°C.

Line Voltage: $<1 \times 10^{-7}$ for 10% change.

High Stability Crystal: See Option 010.

External Input: Rear panel BNC accepts 10 MHz, 500 mV to 5V rms into 1 k Ω NOMINAL shunted by <20 pF.

Timebase Output: 10 MHz, >500 mV rms sine wave into 50 Ω via rear panel.

GATE TIME

Range: 1 ms to 99.999 seconds in 1 ms increments. Automatically set to 300 ms at power up.

LSD: 1 ms.

Resolution: \pm LSD.

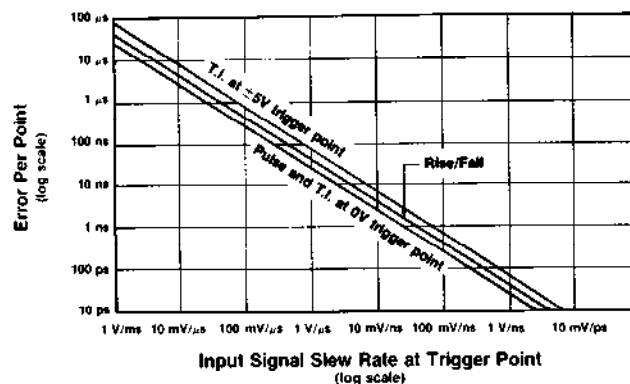
Accuracy: $\pm 100 \mu\text{s} \pm (0.05\% \times \text{GATE TIME})$ + up to one period of input signal.

TIME BETWEEN MEASUREMENTS:

Auto Trigger on: 1s NOMINAL.

Auto Trigger off: 80 ms NOMINAL.

100 GATE AVERAGE: 100 gates accumulated and average displayed. This adds an additional digit of resolution. It can be used with all functions except Totalize, DVM (HP 5334A), and Read Levels.



Graph 5. Trigger Level Setting Error: Affects both the Start and Stop points of all time interval measurements.

SINGLE CYCLE: When enabled, one measurement is taken with each push of RESET key.

MEMORY (HP 5334A only): Ten measurement set-ups, including trigger levels, may be stored in memory and subsequently recalled. When a measurement set-up has been recalled, the trigger level equals the stored value (trigger level controls are inactive). The trigger level can be toggled between the stored value and front panel trigger level control using DACS ON/OFF function. With instrument in STBY or ac power removed, the internal battery will supply the nonvolatile memory for typically 60 days.

RESET: Begins a new measurement cycle, clears front panel data entry modes and error and failure messages.

PRESET: PRESET LED indicates that front panel trigger level/sensitivity controls are inactive.

GATE OUTPUT (HP 5334A only): Rear panel BNC drives TTL levels into 1 k Ω . Level is high while gate is open during all measurements except Totalize, DVM, and Read Levels.

DISPLAY: 9-digit LED display in engineering format plus one digit exponent. Range is $\pm 10^{-17}$ to $\pm 9.99999999 \times 10^{19}$.

OPERATING TEMPERATURE: 0 to 50°C.

POWER REQUIREMENTS: 47.5 - 440 Hz, 90 - 126.5V;
47.5 - 66 Hz, 198 - 252V; 50 VA maximum.

WEIGHT: Net, 5.3 kg (11 lb 12 oz); Shipping, 8.1 kg (17 lb 12 oz).

DIMENSIONS: 89 mm H \times 422 mm W \times 346 mm D (3 1/2 in. \times 16 5/8 in. W \times 13 5/8 in. D), excluding bottom feet, front handles, and rear feet.

HEWLETT-PACKARD INTERFACE BUS

PROGRAMMABLE CONTROLS: All front panel controls and functions, except Option 030 Channel C sensitivity and power on/stby switch.

TRIGGER LEVEL: Set Channel A or B from -5.1V to +5.1V in 20 mV steps (X ATTN).

Accuracy:

X1: ± 30 mV $\pm 1\%$ of trigger level reading.

X10: ± 300 mV $\pm 1\%$ of trigger level reading.

OTHER: Initialize, Transmit Error, High-Speed Output, Transmit Calibration Data, Device ID, and SRQ Mask.

DATA OUTPUT:

Normal Operation: Format: 19 characters plus CR and LF.

Max. Rate: 10 readings/second.

High Speed Output Mode: Format: 8 bytes of count data and Interpolator Start and Stop counts.

Max. Rate: 140 readings/second, 55 readings/second with Opt. 700.

Talk Only Mode: Selected by entering an address of 50 (HP 5334A), 31 (HP 5334B).

INTERFACE FUNCTIONS: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2.

OPTIONS

OPTION 010: High Stability Timebase (Oven)

Frequency: 10 MHz.

Aging Rate: $< 5 \times 10^{-10}$ /day after 24 hour warm up.

Short Term Stability: $< 5 \times 10^{-10}$ rms for a 1 second average.

Temperature: $< 7 \times 10^{-9}$, 0 to 50°C.

Line Voltage: $< 5 \times 10^{-10}$ for 10% change (2 minutes after change).

Warm Up: Within 5×10^{-9} of final value in 20 minutes.

OPTION 020 (HP 5334A only): DC Digital Voltmeter.

Range: 4 digits, autoranging, and autopolarity in ± 10 V, ± 100 V, ± 1000 V ranges.

Sensitivity: 100 μ V for ± 1 V reading, 1 mV for ± 10 V reading, 10 mV for ± 100 V reading, 100 mV for ± 1000 V reading.

LSD: Same as Sensitivity.

Accuracy: 60 days, 24° \pm 5°C.

10V Range: $\pm 0.045\%$ of reading ± 8 mV.

100V Range: $\pm 0.045\%$ of reading ± 80 mV.

1000V Range: $\pm 0.060\%$ of reading ± 200 mV.

(20 minute warmup and RH $< 80\%$.)

Temperature Coefficient:

10V Range: $\pm (0.0055\%$ of reading ± 0.5 mV)/°C.

100V Range: $\pm (0.0055\%$ of reading ± 5 mV)/°C.

1000V Range: $\pm (0.008\%$ of reading ± 5 mV)/°C.

Input Type: Floating Pair.

Input Resistance: 10 M Ω $\pm 1\%$.

Maximum Input: High to low: ± 1000 V in all ranges.

Low to chassis ground: ± 500 V in all ranges.

Response Time: 800 ms to within 1% of final value, within one range.

Normal Mode Rejection: 30 dB at 50/60 Hz.

Effective Common Mode Rejection (1 k Ω unbalance): ≥ 110 dB at 50/60 Hz.

Filter: Single pole from 10 Hz NOMINAL.

OPTION 030: 1300 MHz C Channel.

Input Characteristics:

Range: 90 MHz to 1300 MHz.

Sensitivity:

15 mV rms (-23.5 dBm) sine wave,

90 MHz to 1000 MHz.

75 mV rms (-9.5 dBm) sine wave,

1000 MHz to 1300 MHz..

HP 5334A only: Sensitivity can be decreased continuously by up to 20 dB NOMINAL from 90 MHz to 1000 MHz, and 14 dB NOMINAL from 1000 MHz to 1300 MHz using the sensitivity control.

Dynamic Range:

HP 5334A:

15 mV rms to 500 mV rms (30.5 dB), 90 MHz to 200 MHz.
15 mV rms to 1V rms (36.5 dB), 200 MHz to 1000 MHz.
75 mV rms to 1V rms (22.5 dB), 1000 MHz to 1300 MHz.

HP 5334B:

15 mV rms to 5V rms (50.5 dB), 90 MHz to 1000 MHz.
75 mV rms to 5V rms (36.5 dB), 1000 MHz to 1300 MHz.

Signal Operating Range:

HP 5334A: -5 Vdc to +5 Vdc.

HP 5334B: -50 Vdc to +50 Vdc.

Trigger Level: Fixed at 0V. NOMINAL.

Impedance: ac coupled, 50Ω NOMINAL.

Damage Level:

HP 5334A: ±8V (dc + peak ac), fuse protected. Fuse located in BNC connector.

HP 5334B: ±50 Vdc + 5 Vrms.

Frequency C:

Range: 90 MHz to 1300 MHz.

LSD, Resolution, and Accuracy are the same as Frequency A.

Probe Power (HP 5334A only): Compatible with HP 10855A Preamp.

OPTION 050 (HP 5334A only): Both DC Voltmeter, Option 020, and 1300 MHz C Channel, Option 030. Specifications are the same as for options ordered separately.

OPTION 060: Rear Inputs.

Channel A and B, and Arm inputs are rear terminals in parallel with front inputs. Option 020 (HP 5334A only), 030 and 050 (HP 5334A only) inputs are at the rear panel only. Channel A and B separate input capacitance is increased by 50 pF. Arm input capacitance is increased by 45 pF. Channel A and B input sensitivity is decreased to 50 mV rms from 20 MHz to 100 MHz (measured at rear panel with front panel terminated in 50Ω or front panel with rear panel terminated in 50Ω).

OPTION 700 (HP 5334B only): Internal CIL Interface.

Measurement Functions Provided:

Frequency A, B, and C; Period A, Time Interval A to B, Ratio A/B, Totalize A, Rise/Fall Time A, Pulse Width A, Read Levels A and B (AC/DC Voltage and Trigger).

Programmable Controls:

Channel A and B: Trigger Level, Auto Trigger, Coupling, Trigger Slope, Impedance, Attenuator, Common. External Arm: External Arm Select, Slope. General: Gate Time.

Maximum Data Output Rate:

2.5 readings/second.

CIL Operating Codes:

FNC, SET, SRX, SRN, INX, FTH, CLS (+), OPN(+), RST, CNF, IST, STA, GAL.

MATE Interface Standard:

2806763 Rev. B.

(+) Since the HP 5334B input channels are always internally connected, the OPN and CLS codes are accepted but no action is taken.

DEFINITIONS

① **LSD:** Unit value of Least Significant Digit. Calculations should be rounded to the nearest decade (i.e. 5 Hz becomes 10 Hz and 4 ns becomes 1 ns).

LSD Displayed: There is a 9 digit mantissa maximum for the front panel display. If truncation is required the most significant digits are displayed. Up to a 12 digit mantissa is available over HP-IB.

② **Timebase Error:** Maximum fractional frequency change in timebase frequency due to all errors; (e.g., aging, temperature, line voltage, etc.) multiplied by the measurement result (see Graph 2).

③ **Trigger Error:** (see Graph 3).

$$\frac{\sqrt{e_i^2 + e_n^2}}{\text{Input Slew Rate in V/s at Trigger point}} \text{ seconds rms}$$

Where e_i = Effective rms noise of counter's input channel. (250 μV TYPICAL)

e_n = rms noise of the input signal for a 100 MHz bandwidth.

④ **Trigger Level Timing Error:** (see Graph 4).

$$\frac{1/2 \text{ hysteresis band}}{\text{Input slew rate at start trigger point } \textcircled{6}} \text{ or } \frac{1/2 \text{ hysteresis band}}{\text{Input slew rate at stop trigger point } \textcircled{6}} \text{ whichever is the larger error.}$$

⑤ **Trigger Level Setting Error:** (see Graph 5)

Rise/Fall Time measurements:

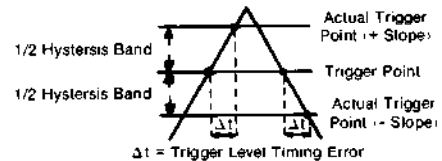
$$\pm 40 \text{ mV} / \text{Input slew rate at trigger point } \textcircled{6}$$

Pulse Width and Time Interval measurements:

$$\pm \frac{30 \text{ mV} \pm 1\% \text{ of trigger level reading (TI only)}}{\text{Input slew rate at start trigger point } \textcircled{6}}$$

$$\pm \frac{30 \text{ mV} \pm 1\% \text{ of trigger level reading (TI only)}}{\text{Input slew rate at stop trigger point } \textcircled{6}}$$

⑥ **Trigger Point and Hysteresis:**



Auto trigger disabled: trigger point = trigger level reading.

Auto trigger enabled:

For all measurements except Rise/Fall Time, trigger points =

$$\frac{\text{Maximum peak} + \text{Minimum peak}}{2} \text{ (X ATTN)}$$

For Rise/Fall Time, 10% trigger point =

$$(.1 \text{ (maximum peak)} + .9 \text{ (minimum peak)}) \text{ (X ATTN)}$$

90% trigger point =

$$(.9 \text{ (maximum peak)} + .1 \text{ (minimum peak)}) \text{ (X ATTN)}$$

(AC/DC Voltage function is used to measure peaks.)

Ordering Information

- HP 5334A Universal Counter*
- HP 5334B Universal Counter*

*See page 2 for differences.

Options

HP 5334A:

- Option 010 High Stability Oven Timebase
- Option 020 DC Digital Voltmeter*
- Option 030 1.3 GHz C Channel*
- Option 050 (Options 020 and 030 together)
- Option 060 Rear Terminals
- Option 908 Rack Mount Kit for use with the front handles removed (5061-9674)
- Option 910 One additional set of operating and service manuals
- Option 913 Rack Mount Kit for use with the supplied front handles (5061-9769)
- Option W30 Two additional years of "return to HP" service and support

*To order both Option 020 and 030, specify Option 050 instead of both options separately.

HP 5334B:

- Option 010 High Stability Oven Timebase
- Option 030 1.3 GHz C Channel (not retrofittable)
- Option 060 Rear Terminals (not retrofittable)
- Option 700 Internal CIIL Interface (not retrofittable)
- Option 907 Front Handles Kit (5061-9688)
- Option 908 Rack Mount Kit for use with the front handles removed (5061-9674)
- Option 909 Front Handles and Rack Mount Kit (5061-9675)
- Option 910 One additional set of operating and service manuals
- Option W30 Two additional years of "return to HP" service and support

Accessories

- HP 10855A Broadband Preamplifier
- HP 1122A Probe Power Supply (four outputs)



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