

# ELECTRONIC COUNTERS

## Universal Systems Counter and Preamplifier

HP 5335A, 10855A

- A high-performance 200 MHz/2-ns universal counter
- Built-in automatic rise time, duty cycle, pulse width, slew rate and phase measurements
- Advanced automatic triggering capabilities
- HP-IB plus math and statistics functions standard



HP 5335A



### HP 5335A Universal Counter

Designed for bench or systems applications, the HP 5335A has 20 measurement functions, all automatically selected by push-button or by HP-IB. These functions, plus greatly expanded arming and triggering capability, make the HP 5335A a powerful universal counter. Math and statistics features, matched Channel A and B input amplifiers, and HP-IB are all included in the standard unit.

The HP 5335A can automatically measure waveform characteristics. With a signal source, rise and fall times, output slew rate, and propagation times can be measured with one test setup. Duty cycle can be measured to see the distortion on a square wave through the amplifier due to different rising and falling slew rates. Phase measurements are push-button selectable and performed automatically.

### Advanced Triggering and Full Measurement Capabilities

The HP 5335A offers several powerful features:

**Manual and Automatic Triggering:** In manual, the  $\pm 5$  Vdc range reduces the need for input attenuators. Two auto trigger modes (front-panel or HP-IB control) select 10 to 90% rise/fall-time trigger points, 50% phase trigger points, or a preset value, then track dc offset to remain on the trigger point.

**Trigger Level DVM:** View both input channel trigger levels.

**Frequency:** Measure to 200 MHz on Channel A, 100 MHz on Channel B, and 1.3 GHz on optional Channel C. Resolution is 9 digits per second over the entire frequency range.

**Time Intervals:** Matched custom input amplifiers reduce trigger errors between Channels A and B. Analog interpolation converts the clock to a 1-GHz-equivalent time base, yielding single-shot time-interval measurements better than 2 ns (100 ps with averaging).

**Math and Statistics:** Averaging can extend resolution for all measurements except phase. Sample sizes are selectable: 100 or 1000. The HP 5335A calculates standard deviation. Built-in math functions (scale, offset, and normalize) simplify conversions for viewing flow, speed, pressure, and temperature parameters, and can be set individually for each measurement function.

### HP 10855A 2-1300 MHz Preamplifier

The HP 10855A Preamplifier enhances measurements of very low-level signals. The  $\pm 1.5$  dB flat response reduces distortion in non-sinusoidal waveforms. The HP 10855A operates with instruments having probe power outlets, or with the HP 1122A Probe Power Supply. The HP 5334A/5335A Option 030 and HP 5328B Option 031 counters support the HP 10855A.

### HP 10855A Specifications

**Frequency Range:** 2 MHz to 1300 MHz

**Gain (minimum):** 22 dB; 24 dB typical

**Gain Flatness Across Full Frequency Range:**  $\pm 1.5$  dB

**Noise Figure:**  $< 8.5$  dB typical

Output power for 1 dB gain compression 0 dBm

**Harmonic Distortion:**  $-30$  dB for  $-15$  dBm output, typical;  $-25$  dBm for  $< -66$  dBm output, typical

**VSWR:**  $< 2.9$ , typical

**Impedance:**  $50 \Omega$  nominal

**Reverse Isolation:**  $> 45$  dB

**Maximum Input:** 3.5 V rms ( $+24$  dBm), fuse protected

### HP 5335A Specifications

#### Input Characteristics (Channels A and B)

**Range:** dc-coupled, 0 to 100 MHz;

ac, 1 M $\Omega$ , 30 Hz to 100 MHz; 50  $\Omega$ , 200 kHz to 100 MHz

Note: Channel A range 200 MHz in Frequency A and Ratio modes.

**Sensitivity (X1):** 25 mV rms sinewave.

75 mV peak-to-peak pulse, minimum pulse width of 5 ns

**Dynamic Range (X1):** 75 mV to 5 V peak-to-peak, to 100 MHz;

75 mV to 2.5 V peak-to-peak,  $> 100$  MHz

**Signal Operating Range (X1, dc):**  $-5$  to 5 Vdc

**Trigger Level Range (X1)**

**Auto Trigger OFF**

Preset: Set to 0 Vdc nominal; adjustable:  $-5$  to  $+5$  Vdc

**Auto Trigger ON**

Preset: Set to nominal 50% point of input signal.

Adjustable: Nominally between  $+$  and  $-$  peaks of input signal.

**Auto Trigger (X1), (Requires Repetitive Signal)**

**Range (50% duty cycle):** dc-coupled, 30 Hz to 200 MHz

ac: 1 M $\Omega$ , 30 Hz to 200 MHz; 50  $\Omega$ , 200 kHz to 200 MHz

**Minimum signal:** 100 mV rms

**Duty cycle range:** 10% to 90%

**Response time:** 3 s, typical

**Coupling:** ac or dc, switchable

**Impedance:** 1 M $\Omega$ , nominal, shunted by  $< 35$  pF or 50  $\Omega$  nominal,

switchable. In Common A, 1 M $\Omega$  is shunted by  $< 50$  pF.

**Attenuator:**  $\times 1$  or  $\times 10$  nominal, switchable

**Slope:** Independent selection of  $+$  or  $-$  slope

**Channel Input:** Separate or Common A, switchable

#### Frequency A

**Range:** 0 to 200 MHz, prescaled by 2

**LSD Displayed:**  $\frac{1 \text{ ns}}{\text{gate time}} \times \text{freq. (e.g. 9 digits in a second)}$

**Resolution:**  $\pm (2 \times \text{LSD}) \pm 1.4 \times \frac{\text{trigger error}}{\text{gate time}} \times \text{freq}$

**Accuracy:**  $\pm (\text{resolution}) \pm (\text{timebase error}) \times \text{freq}$

#### Period A

**Range:** 10 ns to  $10^7$  s

**LSD Displayed:**  $\frac{1 \text{ ns}}{\text{gate time}} \times \text{PER. (e.g. 9 digits in a second)}$

**Period Average:** Select MEAN function, and  $n = 100$  or  $1000$

#### Time Interval A $\rightarrow$ B

**Range:** 0 ns to  $10^7$  s

**LSD Displayed:** 1 ns (100 ps using MEAN)

**Resolution:**  $\pm (2 \times \text{LSD}) \pm (\text{START trigger error}) \pm (\text{STOP trigger error})$

**Accuracy:**  $\pm (\text{resolution}) \pm (\text{timebase error}) \times \text{TI} \pm (\text{trigger level timing error}) \pm (2 \text{ ns})$

**Gate Mode:** MIN only

**Time Interval Average:** Select MEAN function, and  $n = 100$  or  $1000$

#### Time Interval Delay (Holdoff)

Front panel Gate Adjust control inserts a variable delay between START and enabling of STOP. Electrical inputs during delay are ignored. Delay ranges are same as gate time ranges (100  $\mu$ s to 4 s, nominal) for gate modes of Fast, Norm, and Manual.

#### Inverse Time Interval A $\rightarrow$ B

**Range:**  $10^{-7}$  to  $10^9$  units/second

LSD Displayed, Resolution, and Accuracy are inverse of Time Interval A  $\rightarrow$  B specifications.

#### Rise and Fall Time A

**Range:** 20 ns to 10 ms transition with 50 Hz to 25 MHz repetition rates (50% duty cycle)

**Minimum Pulse Height:** 500 mV peak-to-peak

**Minimum Pulse Width:** 20 ns

**Duty Cycle Range:** 20% to 80%

LSD Displayed, Resolution: See Time Interval A  $\rightarrow$  B specifications.

#### Pulse Width A

**Range:** 5 ns to  $10^7$  s

**Trigger Point Range:** 40% to 60% of pulse height

LSD Displayed, Resolution: See Time Interval A  $\rightarrow$  B specifications.



**Duty Cycle A** (Constant Duty Cycle Required)**Range:** 1% to 99%, 0 to 100 MHz**Trigger Point Range:** 40% to 60% of pulse height**LSD Displayed:**  $\frac{1 \text{ ns}}{\text{period}} \times 100\%$ **Slew Rate A****Range:** 50 V/s to  $10^8$  V/s slew rate with 50 Hz to 25 MHz repetition rates (50% duty cycle). Minimum pulse height, width, and duty cycle range are same as Rise and Fall Time A**Input Mode:** Automatically set to COMMON A with 10% and 90% trigger levels**Ratio A/B****Range:** Channel A: 0 to 200 MHz (prescaled by 2);  
Channel B: 0 to 100 MHz.**LSD Displayed:**  $\frac{\text{Ratio}}{\text{Freq} \times \text{Gate Time}}$  where Freq is higher frequency after prescaling**Totalize A****Range:** 0 to 100 MHz**LSD Displayed:** 1 count of input**HP-IB Output:** At end of gate**Manual****Count reset:** Via RESET key**HP-IB output:** Totalize data on-the-fly sent if Cycle mode set to Single. Input frequency range in this mode is 0 to 50 Hz nominal.**Gated****Count reset:** Automatic after measurement**Phase A Rel B****Range:**  $-180^\circ$  to  $360^\circ$  (Range Hold OFF) or  $0^\circ$  to  $360^\circ$  (Range Hold ON) with signal repetition rates of 30 Hz to 1 MHz.**Minimum Signal:** 100 mV rms**LSD Displayed:**  $0.1^\circ$ **Gate Time****Range:** 100  $\mu$ s to  $10^7$  s**LSD Displayed:** Up to 3 digits with Ext. Arm Enable OFF, 100 ns when ON. MIN Gate Mode display zero.**Trigger Level****Range:**  $\times 1$ ,  $+5$  to  $-5$  V;  $\times 10$ ,  $+50$  to  $-50$  V**Resolution:**  $\times 1$ , 10 mV;  $\times 10$ , 100 mV**Accuracy ( $\times 1$ ):**  $\pm 20$  mV,  $\pm 0.5\%$  of reading**Timebase****Standard Crystal** (see page 196)**Frequency:** 10 MHz**Aging rate:**  $< 3 \times 10^{-7}$ /month**Temperature:**  $< 5 \times 10^{-6}$ , 0 to  $50^\circ$  C**Line voltage:**  $< 1 \times 10^{-7}$  for 10% change**High-Stability Crystal:** See Option 010**External Timebase Input:** Rear-panel BNC accepts 5 or 10 MHz, 200 mV rms into 1 k $\Omega$ ; 5 V rms maximum**Timebase Out:** 10 MHz,  $> 1$  V peak-to-peak into 50  $\Omega$  via rear panel**Statistics****Sample Size:** Selectable,  $n = 100$  to 1000 samples**Functions:** Std. dev., mean, and smooth (weighted running average)**Math**

All measurement functions, except GATE TIME, Totalize in Scale Mode, and TRIG LVL, may be operated upon by Math functions. Offset, Normalize, and Scale may be used independently or together:

$$\text{Display} = \frac{\text{measurement} + \text{offset}}{\text{normalize}} \times \text{scale.}$$

**Number Value Range:**  $\pm 1 \times 10^{-9}$  to  $\pm 9 \times 10^9$ **Last Display:** Causes value of previous display to Offset (negative value), Normalize, or Scale all subsequent measurements**Measurement t-1:** Causes each new measurement to be Offset, Normalized, or Scaled by immediately preceding measurement**Hewlett-Packard Interface Bus (See Option 040)****Programmable Controls:** All measurement functions, Math, Statistics, Reset, Range Hold, Ext. Arm Enable/Slope, Check, Gate Adj. ( $\sim 1$  ms to 1 s), Gate Open/Close (gate times to  $\infty$ ), Gate Mode, Cycle, Preset, Slope, Common A, Auto Trigger**Special Functions:** FREQ B, PULSE B, TIME B  $\rightarrow$  A, TOT A-B, LEARN, MIN, MAX, all internal diagnostic routines**Interface Functions:** SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0 (see page 101)**Data Output:** Fixed format consisting of 19 characters plus CR and LF output typically in 8 ms**General****Gate:** Minimum, manual, or continuously variable (NORM/FAST) via Gate Adj. control**NORM:** 20 ms to 4 s nominal**FAST:** 100  $\mu$ s to 20 ms nominal**MIN:** Minimum gate time. Actual time depends on function.**MANUAL:** Each press opens or closes gate.**Cycle:** Determines delay between measurements**NORM:** No more than a 4 readings per second, nominal**MIN:** Updates display as rapidly as possible ( $\sim 15$  readings per second, depending on function)**SINGLE:** One measurement taken with each press of button.**Arming:** Ext. Arm Enable key allows rear-panel input to determine Start and/or Stop point of a measurement. External gate defined by both Start and Stop armed. All measurements are armable except Manual Totalize, Phase, and Trigger Level.**Start arm:**  $+$  or  $-$  slope of arm input signal starts measurement.**Stop arm:**  $+$  or  $-$  slope of arm input signal stops measurement.

When used, Start Arm must occur before Stop Arm.

**Ext. arm input:** Rear-panel BNC accepts TTL into 20 k $\Omega$ . Minimum Start to Stop Time: 200 ns.**Trigger Level Out:** dc output into 1 M $\Omega$  via rear panel BNCs for Channel A and B; not adjusted for attenuators.**Accuracy at dc ( $\times 1$ ):**  $\pm 15$  mV  $\pm 0.5\%$  of TRIG LVL reading**Gate Out:** TTL level into 50  $\Omega$ ; goes low when gate open; rear panel BNC**Range Hold:** Freezes decimal point and exponent of display.**Display:** 12-digit LED; exponent range of  $+18$  to  $-18$ **Operating Temperature:**  $0^\circ$  to  $50^\circ$  C**Power Requirements:** 100, 120, 220, 240 Vac ( $+5\%$ ,  $-10\%$ ), 48 to 66 Hz; 130 VA max**Weight:** Net, 8.8 kg (19 lb 8 oz); shipping, 13.6 kg (30 lb)**Size:** 425.5 mm W  $\times$  132.6 mm H  $\times$  345.4 mm D (16 1/2 in  $\times$  5 1/4 in  $\times$  13 1/2 in), not including removable handles**Options****Opt 010: High Stability Timebase Oven** (see page 196)**Frequency:** 10 MHz.**Aging rate:**  $< 5 \times 10^{-10}$ /day after 24-hour warmup**Short term:**  $< 1 \times 10^{-10}$  rms for 1s average**Temperature:**  $< 7 \times 10^{-9}$ ,  $0^\circ$  to  $50^\circ$  C**Line voltage:**  $< 1 \times 10^{-10}$  for 10% change**Warmup:** within  $5 \times 10^{-9}$  of final value in 20 minutes**Opt 020: dc Digital Voltmeter****Range:** 4 digits, autoranging, autopolarity, in  $\pm 10$ ,  $\pm 100$ ,  $\pm 1000$  V ranges**Sensitivity:** 100  $\mu$ V, 1 mV, 10 mV, 100 mV for  $\pm 1$  V,  $\pm 10$  V,  $\pm 100$  V,  $\pm 1000$  V readings**LSD displayed:** Same as sensitivity**Input type:** Floating pair**Input frequency impedance:** 10 M $\Omega \pm 1\%$ **Opt 030: 1.3 GHz C Channel****Input range:** 150 MHz to 1.3 GHz prescaled by 20**Input sensitivity:** 10 mV rms sinewave ( $-27$  dBm) to 1 GHz; 100 mV rms sine wave ( $-7$  dBm) to 1.3 GHz**LSD displayed, resolution, accuracy:** Same as Frequency A**Ratio C/A Range:** Channel A, 0 to 200 MHz

Channel C, 150 to 1300 MHz

**Opt 040: Complete Systems Programmability**

Adds remote selection of low-pass filter, ac/dc coupling, attenuator, dc trigger level, and input impedance for Channels A and B

**Ordering Information**

	Price
<b>HP 5335A</b> Universal Counter (with front handles)	\$5,250
<b>Opt 010</b> Oven Oscillator	+\$990
<b>Opt 020</b> DVM	+\$730
<b>Opt 030</b> C Channel	+\$1,015
<b>Opt 040</b> Expanded HP-IB Control	+\$950
<b>Opt 908</b> Rack Flange Kit for Use Without Handles	+\$50
<b>Opt 913</b> Rack Flange Kit for Use With Supplied Front Handles	+\$70
<b>Opt W30</b> Extended Repair Service (see page 636)	\$110
<b>Opt W32</b> Calibration Service (see page 636)	\$525
<b>HP 10855A</b> 2 MHz to 1300 MHz Preamplifier	\$1,150

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.