

ELECTRONIC COUNTERS

100 MHz Universal counter

Model 5328A

- 100 MHz, 512 MHz and 1300 MHz
- 100 ns or 10 ns time interval
- T.I. averaging to 10 ps resolution
- "armed" measurements
- DVM options
- HP-IB interface option



HP-IB Model 5328A

Description

The 5328A, thru the use of the latest technology (such as a ROM controlled measurement cycle) and a modular design, provides you with the optimum in universal counter price/performance. Optional modules allow you to tailor the performance of the 5328A to meet your particular measurement needs. In many instances, however, the standard 5328A offers all the capability you're ever likely to need:

Burst and CW measurements to 100 MHz: special gating circuits start a measurement only when the input signal is present, allowing burst frequencies to be made as easily as CW measurements. The option 030 channel C extends this capability to 512 MHz; option 031, to 1300 MHz.

Single shot time interval measurements: the standard universal module's 100 ns single shot resolution meets or exceeds the requirements for a wide range of applications such as mechanical and electromechanical device timing (relays), time of flight measurements (ballistics), sonar ranging, radio ranging and navigation.

Time interval averaging: resolution better than 10 ps (10^{-11} seconds) for repetitive time intervals as short as 100 ps.

Period, period average, ratio, totalize, scale: extra problem solving power for your special requirements.

Armed measurements: versatile arming modes (controlled by a rear panel switch) allow the real time control over when a measurement begins. Useful for measurements such as frequency burst profile and frequency sweep linearity.

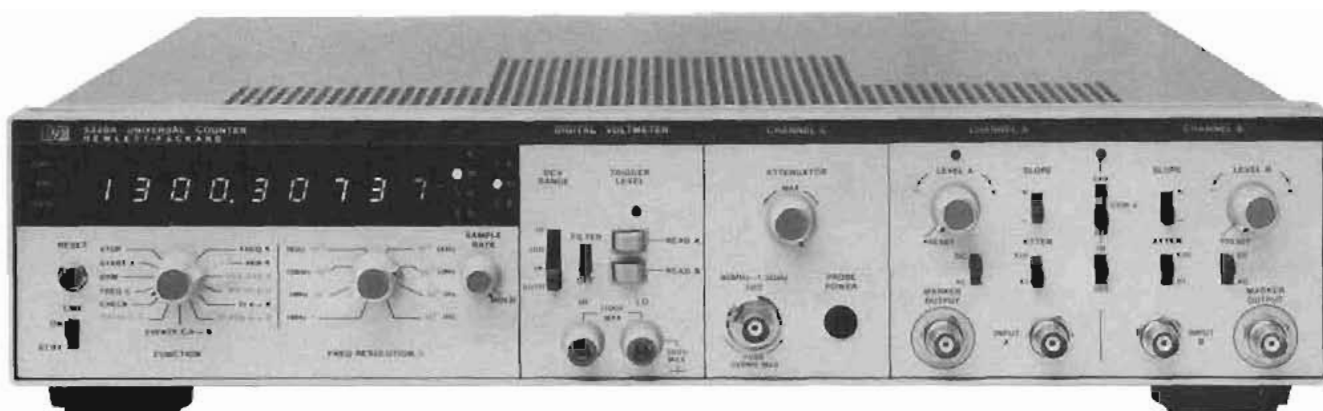
Trigger lights: trigger light blinks when channel is triggering; light is ON when input is above trigger level; OFF when input is below trigger level. Simplifies trigger level adjustments.

High performance marker outputs: marker outputs (operational to 100 MHz) indicate where channel is triggering in real time for oscilloscope monitoring applications. Provides measurement feedback to the operator for greatly simplified measurement set-ups.

These features and capabilities make the 5328A an excellent choice for general purpose lab use, electronic service, and production test. For more demanding applications, a variety of options offer extended performance at a modest increase in price.

Summary of characteristics

Model No.	Description	Features
5328A	Universal Counter	Frequency to 100 MHz; 100 ns single shot T.I.; T.I. averaging; Period, Period Avg; ratio; totalize; Oven oscillator with aging rate $< 5 \times 10^{-10}$ /day
Opt. 010	High Stability Time Base	Allows 5328A to output data and be controlled via the HP Interface Bus.
Opt. 011	HP-IB Interface	Single ended DVM for trigger level and external voltage measurements.
Opt. 020	DVM	Floating DVM for trigger level and high accuracy external voltage measurements.
Opt. 021	High Performance DVM	Frequency measurements to 512 MHz; 9 digit display.
Opt. 030	512 MHz Channel C	Frequency measurements to 1300 MHz; 9 digit display.
Opt. 031	1300 MHz Channel C	Same as standard 5328A but with 10 ns single shot T.I.; improved T.I. averaging; improved T.I. accuracy; measurements with delay; T.I.A.—8 marker; hysteresis compensation; switchable input impedance (1 M Ω /50 Ω).
Opt. 040	High Performance Universal Module	Full remote programming of all universal module controls thru opt. 011; 10 ns single shot T.I.; switchable 1 M Ω /50 Ω input impedance.
Opt. 041	Programmable Input Module	



5328A with Opt 021, 031, 041

5328A Option descriptions

High stability time base (Opt 010)

The standard time base for the 5328A is a room temperature 10 MHz crystal providing a long term aging rate of less than 3 parts in 10^6 per month. The option 010 oven oscillator offers excellent short term and temperature stability which can contribute to higher measurement accuracy. The low aging rate of $<5 \times 10^{-10}$ /day permits reduced intervals between time base calibrations.

HP Interface bus for systems use (Opt 011)

The option 011 HP-IB Interface brings the full capability and power of the HP Interface Bus. The 5328A can accept program code words over the HP-IB which remotely program various front and rear panel controls. In addition, measurement results may be output over the bus to HP-IB compatible instruments, calculators, or computers.

Remotely programmable controls include FUNCTION selection, RESOLUTION selection, ARMING, SAMPLE RATE (max, or manual), RESET, measurement modes, output modes, and display modes. Option 041 adds programming of channel A and B input signal conditioning controls.

Digital voltmeters (Opt 020, 021)

The unique combination of an integrating digital voltmeter with a universal counter produces a superb general purpose measuring instrument. By using a voltage to frequency conversion technique, the incremental cost of adding DVM capability to the 5328A is very low.

Two DVM options are available: the option 020 DVM with single-ended input and the option 021 High Performance DVM with floating input. You can use these DVMs to measure channel A and B trigger levels and external voltages. Since a built-in DVM greatly simplifies time interval measurement set-ups, it is highly recommended that one of the DVM options be selected, particularly if time interval measurements are one of your major applications.

High frequency channel C (Opt 030, 031)

With a high frequency channel C module the 5328A is ideally suited for use in a wide variety of communications measurements. Option 030 gives direct count measurements to 512 MHz with 15 mV rms sensitivity; option 031 counts to a full 1300 MHz with 20 mV rms sensitivity. Typical applications include servicing, maintaining,

calibrating, and monitoring communications transmitters and receivers such as found in two-way radio, radio and television broadcasting, mobile radio, and common carrier multiplexing and transmission.

Extended capability universal modules (Opt 040, 041)

Options 040 and 041 give extended performance for time interval measurements. Option 040 is designed for bench use and includes "delay" capability for increased measurement versatility. Option 041 adds full programming of the input signal conditioning controls.

Both of these options generate a 100 MHz clock to give 10 ns single shot resolution for time interval measurements. This resolution is useful in applications such as computer/peripheral timing measurements, logic timing measurements, RADAR ranging, and optical ranging.

For improved time interval averaging performance, the options have input channels adjusted for delay matching to better than 2 ns. Additionally, options 040 and 041 use a jittered clock in T.I. AVG. function to give averaging even for those cases when the input repetition rate is synchronous with the counter's internal timebase.

Selectable input impedance adapts the counter to the measurement environment: 50 Ω for fast signals in a 50 Ω environment, 1 M Ω to reduce circuit loading or to use with scope probes.

The "delay" feature of option 040 allows you to disable the inputs from triggering for selected periods of time (20 μ s to 20 ms). Delay is useful for ignoring high amplitude noise such as from chattering relays or ignoring stop pulses in multiple stop T.I. measurements.

Option 041 allows remote programming of input trigger level, slope, coupling, and attenuator setting. Under remote control, the input impedance is independently selectable on the A and B channels. Also, a remote "Invert" function switches the A and B channel signals internally. "Invert" gives exceptional flexibility for two channel time interval measurements.

Retrofit kits

Retrofit kits, available for all options, allow you to upgrade the performance of your 5328A in response to your changing measurement requirements.

The condensed specifications on the following pages highlight some of the important performance characteristics of the 5328A and its options. Complete specifications and detailed applications information are available in the 5328A data sheet.

Model 5328A (cont.)

Opt 020
DVMOpt 021
High Performance DVMOpt 030
512 MHz
Channel COpt 031 1300 MHz
Channel C

10855A Preamp

Digital voltmeter modules

Digital voltmeter measurements†

DVM (Opt 020 and 021): trigger levels of input channels A and B and external voltages may be measured.

Maximum sensitivity	Opt 020	Opt 021
Meas. time: 10 s (N = 10 ²) 1 s (N = 10 ³) 0.1 s (N = 10 ⁴) 10 ms (N = 10 ⁵) 1 ms (N = 10 ⁶)	1 mV 1 mV 2 mV 20 mV 200 mV	10 μ V 100 μ V 1 mV 10 mV 100 mV
Range	0 to ± 125 V dc	± 10 , ± 100 , ± 1000 V dc, and Autorange
Accuracy (20 min. warm-up)	$\pm 0.5\%$ reading ± 4 mV	$\pm 0.03\%$ reading $\pm 0.004\%$ range; for 1000 V range: $\pm 0.087\%$ reading $\pm 0.004\%$ range
Input terminals	Single ended	Floating pair
Input impedance	10 M Ω	10 M Ω
Normal mode rejection ratio	>60 dB at 60 Hz 150 Hz) $\pm 0.1\%$	>80 dB at 50 Hz or greater with filter on
Effective common mode rejection ratio (1 k Ω unbalance)		DC: >120 dB AC: >120 dB for multiples of 60 Hz (50 Hz) with filter on
Maximum input	± 500 V	HI to LO: ± 1100 V all ranges, LO to chassis ground: ± 500 V
Trigger level Measurements	2 mV display resolution	1 mV display resolution, trigger level reading automatically multiplied by setting of attenuator switch if using Opt 040 or 041 universal modules

†Performance: 60 days at 23°C $\pm 5^\circ$ C and RH $< 80\%$

Channel C modules

Input characteristics	Opt 030	Opt 031
Sensitivity	15 mV rms	20 mV rms
Coupling	dc	ac
Trigger level	0 V, fixed	0 V, fixed
Impedance	50 Ω	50 Ω
Maximum input	5 V rms	5 V rms, ± 5 V dc
Input protection	fused	fused
Attenuator	No	Variable for optimum noise suppression on signals to 5 V rms

Frequency C measurements

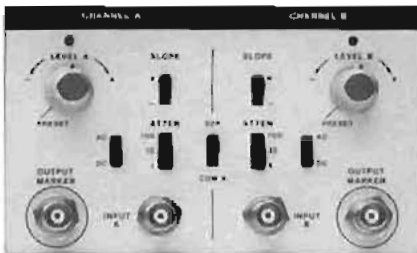
Range	5–512 MHz (direct count)	90–1300 MHz (prescaled, $\times 4$)
Resolution	1 MHz to 0.1 Hz in decade steps	1 MHz to 0.1 Hz in decade steps
Accuracy	± 1 count ± 1 timebase error	± 1 count ± 1 timebase error

Ratio C/A measurement

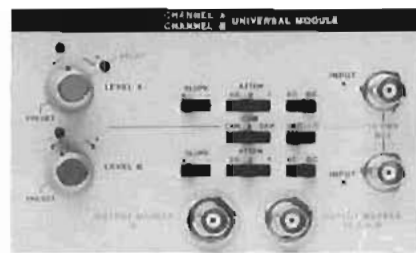
Range: A C	0–10 MHz 5–512 MHz	0–10 MHz 90–1300 MHz
General		
Probe power	No	Power to operate 10855A Preamp or HP active probe

Events C, A to B (with Opt 030 only)

the number of events at the C input are totaled during the synchronized time interval defined by inputs to channels A and B. The synchronized time interval is a multiple of 100 ns with the standard universal module; a multiple of 10 ns with Opt 040 or 041 universal modules.



Standard
Universal Module



Opt 040
High Performance
Universal Module



Opt 041
Programmable Input
Universal Module

Accessories

10855A Preamp: (for use with Opt 031): gives >22 dB gain with ± 1 dB flatness over the entire frequency range of the Opt 031 1300 MHz Channel C. For more details see page 286.

Universal modules, channels A and B

Input characteristics	Standard	Opt 040, Opt 041
Sensitivity: 0-40 MHz (ac coupled)	25 mV rms	25 mV rms
20 Hz-40 MHz (dc coupled)	25 mV rms	25 mV rms
40-100 MHz	50 mV rms	50 mV rms
Min pulse width	5 ns, 140 mV p-p	
Coupling	ac or dc, switchable	
Impedance	1 M Ω , 40 pF shunt	1 M Ω or 50 Ω , switchable
Trigger level	variable ± 2.5 V times atten. setting	
Trigger slope	independent selection of + or - slope	
Attenuators	X1, X10, X100	Opt 040: X1, X2, X20 Opt 041: X1, X10
Dynamic range	25 mV to 1 V rms times attenuator setting for 0-40 MHz; 50 mV to 500 mV times attenuator setting for 40-100 MHz	
Channel Input	Separate or Common A	Separate, Common A, or Check
Delay	No	Opt 040 only: 20 μ s to 20 ms
Programmable Controls	No	Opt 041 only: level, slope coupling, atten, impedance, SEP-CQM-CHK
Frequency A measurement		
Range	0-100 MHz, direct count	
Resolution	1 MHz to 0.1 MHz in decade steps	
Accuracy	± 1 count, ± 1 timebase error	
Period A measurement		
Range	0-10 MHz	
Resolution	100 ns to 1 s in decade steps	10 ns to 0.1 s in decade steps
Accuracy	± 1 count $\pm$ time base error $\pm$ trigger error*	

Period Average A measurements		
Range	0-10 MHz	
Resolution	100 ns to 0.01 ps in decade steps	10 ns to 0.01 ps in decade steps
Accuracy	± 1 count displayed $\pm$ timebase error $\pm$ trigger error* $\frac{\pm 1}{N}$	
Time Interval A to B measurements		
Range	100 ns to 10 ⁶ s	10 ns to 10 ⁶ s
Resolution	100 ns to 1 s in decade steps	10 ns to 0.1 s in decade steps
Accuracy	± 1 count $\pm$ timebase error $\pm$ trigger error*	
Time Interval average A to B		
Range	0.1 ns to 10 s	0.1 ns to 1 s
Resolution	$\pm 100 \text{ ns} \pm \text{trigger error}^*$ $\frac{\pm 100 \text{ ns} \pm \text{trigger error}^*}{\sqrt{N}}$ $\pm 10 \text{ ps}$	$\pm 10 \text{ ns} \pm \text{trigger error}^*$ $\frac{\pm 10 \text{ ns} \pm \text{trigger error}^*}{\sqrt{N}}$ $\pm 10 \text{ ps}$
Accuracy	$\pm$ resolution $\pm 4 \text{ ns}$ $\pm$ timebase error	$\pm$ resolution $\pm 2 \text{ ns}$ $\pm$ timebase error
Min. pulse width	25 ns	10 ns
Min. dead time (from each stop event to next start event)	150 ns	40 ns
Ratio B/A measurements		
Range: A	0-10 MHz	
Range: B	0-100 MHz	
Totalizing and scaling, Start A The number of counts at the A input are totalized for N = 1 on the resolution switch. For N > 1, A/N is totalized and the scaled output (A/N) is available at the Timebase Out rear panel connector.		
Range: N = 1	0-100 MHz	
Range: N > 1	0-10 MHz	

* Trigger error is <0.3% of one period for sinewaves of 40 dB S/N or better and amplitude equal to sensitivity of counter. For any waveshape, trigger error is less than

$$\pm 2 \times \frac{\text{peak noise voltage}}{\text{signal slope}}$$

$$\left(\text{or } \frac{\pm 0.025 \mu\text{s}}{\text{signal slope in V}/\mu\text{s}} \text{ for 40 dB S/N.} \right)$$



Model 5328A (cont.)

Measurements with delay (Opt 040)

Delay mode is activated by the inner concentric knob on Level A control of option 040 Universal Module. A red LED indicates delay is activated. In delay mode, Channel A triggers and is then disabled from triggering again until the delay times out (disabled state occurs within 1 μ s after triggering.) Channel B is continuously disabled until the delay times out. After the delay, both A and B are enabled. The delay time may be measured by placing the counter in T.I. A B and the Universal Module in check (CHK).

Delay range: 20 μ s to 20 ms continuously adjustable.

Minimum dead time: 1 μ s between stop and next start (T.I. average measurements only).

General

Display: 9 digit LED display, Ninth digit used only with channel C functions (FREQ. C, Ratio C/A, Events C, A B).

Blanking: suppresses display of unwanted zeros to left of most significant digit.

Storage: holds reading between samples; can be overridden by rear panel switch.

Sample rate: variable from less than 2 ms between measurements to HOLD which holds display indefinitely.

Gate output: rear panel output, TTL levels; high when counter gate open.

Timebase output: rear panel output; TTL levels.

Check signal: with function switch in CHECK, counter should display 10 MHz $\pm$ 1 count. With options 040 and 041, place function switch in FREQ A and universal module in CHECK (CHK). Counter should display 100 MHz $\pm$ 1 count.

Trigger lights: light is ON when input is above trigger level; OFF when input is below trigger level; BLINKING when channel is triggering. Operate over full frequency range of 0–10 MHz.

Marker outputs: indicate actual change of state of input Schmidt trigger for channels A and B with <20ns delay. Output levels into 50 Ω are 0 to –100 mV for the standard universal module, 0 to –50 mV for option 040, and 0 to +1 V for option 041. Outputs are protected from inadvertently applied voltage to $\pm$ 5 V dc.

Arm: rear panel switch turns arming ON or OFF. With arming ON the measurement is armed by an input other than the input involved in the measurement. The following are armed by an event at B: Freq A, Period A, Period Avg A, Freq C, DVM, Ratio C/A; the following are armed by an event at C: T.I. A $\rightarrow$ B, Events C, A $\rightarrow$ B, Ratio B/A.

Operating temperature: 0° to 50°C.

Power requirements: 100/120/220/240 V rms, $\pm$ 5%, $\pm$ 10% (switch selectable), 48–66 Hz; 150 VA max.

Timebase oscillators**Standard crystal oscillator**

Frequency: 10 MHz.

Aging rate: $<3 \times 10^{-7}$ /month.

Temperature: $<2.5 \times 10^{-6}$ /° to 50°C.

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

Opt 010 oven oscillator

Frequency: 10 MHz.

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

Short term: $<1 \times 10^{-10}$ rms/s.

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

Line Voltage: $\pm 5 \times 10^{-6}$ for 10% variation.

Warm-up: within 5×10^{-6} of final value in 20 min.

Ext. freq. std. Input: 30 kHz to 10 MHz signal of amplitude >1.0 V rms into 1 k Ω . Maximum input: 5 V p-p. Correct readings. With options 040 and 041 the following constraints apply: ext. freq. std. must be 10 MHz for Period Avg., T.I. Avg., Period (N=1), and T.I. (N=1).

HP-IB Interface (Opt 011)

Option 011 provides digital output of measurement data ("talker") as well as input for remote program control ("listener").

Programmable features: function, resolution, sample rate (max or manual control), arming, display modes, measurement cycle modes, output modes, and reset commands. Option 041 adds control of channel A and B trigger level, slope, attenuator, coupling, input impedance, and SEP-COM-CHECK selection.

HP-IB commands: responds to the following bus commands (see HP-IB Users Guides for definitions)—Unlisten, Untalk, Local Lockout, Device Clear, Serial Poll Enable, Serial Poll Disable, Go to Local, Selected Device Clear, and Group Execute Trigger.

Service request (SRQ): if enabled, indicates end of measurement.

Maximum data output rate: 500 readings/sec.

Accessories

5363A Time Interval Probe: solve many of the "hidden" problems of precision time interval measurements. The 5363A Time Interval Probes minimize circuit loading, give calibrated trigger level settings, increase input dynamic range, and allow differential channel delay calibration. See opposite page for more details.

Options and accessories

	Price
010: High Stability Timebase	\$525
011: HP-IB Interface	\$350
020: DVM	\$200
021: High Performance DVM	\$500
030: 512 MHz Channel C	\$400
031: 1300 MHz Channel C	\$600
040: High Performance Universal Module	\$350
041: Programmable Input Controls Module	\$950
907: Front Handle Kit	\$15
908: Rack Flange Kit	\$10
909: Rack Flange and Front Handle Combination Kit	\$20
10855A Preamp	\$225
5363A Time Interval Probes	\$1900

5328A Universal Counter

\$1300