Introduction

The specifications of the HP 53181A Frequency Counter are shown in the following table.

Instrument Inputs

Channel 1 Input Specifications

Frequency Range

DC Coupled:	DC to 225 MHz
AC Coupled:	1 MHz to 225 MHz (50 Ω) 30 Hz to 225 MHz (1 MΩ)
FM Tolerance:	25%

Voltage Range and Sensitivity (Sinusoid)[1]

DC to 100 MHz:	20 mVrms to ±5 V ac + dc (75 mVrms with optional rear connectors)[2]
100 MHz to 200 MHz:	30 mVrms to ±5 V ac + dc (75 mVrms with optional rear connectors)[2]
200 MHz to 225 MHz:	40 mVrms to ±5 V ac + dc (75 mVrms with optional rear connectors)[2]

Voltage Range and Sensitivity (Single-Shot Pulse)[1]

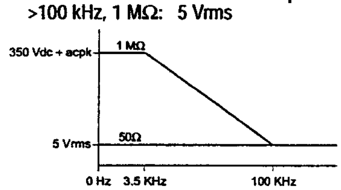
4.5 ns to 10 ns Pulse Width:	100 mVpp to 10 Vpp (150 mVpp with optional rear connectors)[2]
>10 ns Pulse Width:	50 mVpp to 10 Vpp (100 mVpp with optional rear connectors)[2]

Trigger Level[2]

Range:	±5.125 V
Accuracy:	±(15 mV + 1% of trigger level)
Resolution:	5 mV

Damage Level

50 Ω:	5 Vrms
0 to 3.5 kHz, 1 MΩ:	350 V dc + ac pk
3.5 kHz to 100 kHz, 1 MΩ:	350 V dc + ac pk linearly derated to 5 Vrms
>100 kHz, 1 MΩ:	5 Vrms



Channel 1 Input Characteristics

Impedance:	1 MΩ or 50 Ω
1 MΩ Capacitance:	30 pF
Coupling:	AC or DC
Low-Pass Filter:	100 kHz (or disabled) −20 dB at > 1 MHz
Input Sensitivity:	Selectable between Low, Medium, or High (default). Low is approximately 2x High Sensitivity.

Trigger Slope:	Positive or Negative

Auto Trigger Level

Range:	0 to 100% in 10% steps
Frequency:	> 100 Hz
Input Amplitude:	> 100 mVpp (No amplitude modulation)

Attenuator

Voltage Range:	x10
Trigger Range:	x10

[1] Values shown are for X1 attenuator setting. Multiply all values by 10 (nominal) when using the X10 attenuator setting. Note that it may be necessary to recalibrate the input offset in the application environment (especially at high temperature) to achieve maximum sensitivity.

[2] When ordered with optional rear terminals, the Channel 1 input is active on both the front and rear of the counter though the specifications provided only apply to the rear terminal. Performance for the front terminal is degraded, but may be improved by terminating the rear terminal into 50 Ω.

Instrument Inputs (Continued)

Channel 2 Input Specifications[3, 4]

Frequency Range

Opt. 015	100 Mhz to 1.5 Ghz
Opt. 030	100 MHz to 3 GHz
Opt. 050	200MHz to 5 GHz
Opt. 124	200 MHz to 12.4 GHz

Power Range and Sensitivity (Sinusoid)

Option 015

100 MHz to 1.5 GHz:	–27 dBm to +19 dBm

Option 030

100 MHz to 2.7 GHz:	–27 dBm to +19 dBm
2.7 GHz to 3 GHz:	–21 dBm to +13 dBm

Option 050

200MHz to 5 GHz:	–23 dBm to +13 dBm

Option 124

200MHz to 12.4 GHz:	–23 dBm to +13 dBm

Damage Level:

Option 015, 030	5 Vrms
Option 050, 124	+25 dBm

Channel 2 Input Characteristics

Impedance:	50 Ω
Coupling:	AC
VSWR:	< 2.5:1

External Arm Input Specifications

Signal Input Range:

TTL compatible

Timing Restrictions:

Pulse Width:	> 50 ns
Transition Time:	< 250 ns
Start-to-Stop Time:	> 50 ns
Damage Level:	10 Vrms

External Arm Input Characteristics

Impedance:	1 kΩ
Input Capacitance:	17 pF
Start Slope:	Positive or Negative
Stop Slope:	Positive or Negative

Notes:

External Arm available for all measurements except Peak Volts.

External Arm is referred to as External Gate for some measurements.

3 Channel 2 is available as an option.

4 When ordered with optional rear terminals, the Channel 2 connector on the front panel for Options 015 or 030 will be removed. There is no degradation in specifications for this input. Option 050 and Option 124 input connectors are available on the front panel only.

Time Base

Internal Time Base Stability

	Standard (0° to 50°C)	Medium Stability Oven (Option 001)	High Stability Oven (Option 010)	Ultra High Stability Oven (Option 012)
Temperature Stability: (referenced to 25°C)	$< 5 \times 10^{-6}$	$< 2 \times 10^{-7}$	$< 2.5 \times 10^{-9}$	$< 2.5 \times 10^{-9}$
Aging Rate (after 30 days) Per Day: Per Month: Per Year:	$< 3 \times 10^{-7}$	$< 4 \times 10^{-8}$ $< 2 \times 10^{-7}$	$< 5 \times 10^{-10}$ $< 1.5 \times 10^{-8}$	$< 1 \times 10^{-10}$ $< 3 \times 10^{-9}$ $< 2 \times 10^{-8}$
Turn-on stability vs. time: (in 30 minutes)		$< 2 \times 10^{-7}$ (referenced to 2 hours)	$< 5 \times 10^{-9}$ (referenced to 24 hours)	$< 5 \times 10^{-9}$ (referenced to 24 hours)
Calibration:	Manual Adjust	Electronic	Electronic	Electronic

Note that power to the time base is maintained when the counter is placed in standby via the front panel switch. The internal fan will continue to operate under this condition, to maintain long-term instrument reliability.

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External Time Base Input Specifications

Voltage Range: 200 mVrms to 10 Vrms
Damage Level: 10 Vrms

External Time Base Input Characteristics

Threshold: 0 V
Impedance: 1 kΩ
Input Capacitance: 23 pF
Frequency: 1 MHz, 5 MHz or 10 MHz (automatic selection)

Internal vs. External Time Base Selection:

Manual: Select Internal or External
Automatic: Internal used when External not present (default)

Time Base Output Specifications

Output Frequency: 10 MHz
Voltage: > 1 Vpp into 50 Ω (centered around 0 V)

Measurement Specifications

Frequency, Period

Channel 1 Range:	0.1 Hz to 225 MHz	4.44 ns to 10 s
Channel 2 Range:		
Option 015	100 Mhz to 1.5 Ghz	0.67 ns to 10 ns
Option 030	100 MHz to 3 GHz	0.33 ns to 10 ns
Option 050	200 MHz to 5 GHz	0.2 ns to 5 ns
Option 124	200 MHz to 12.4 GHz	80 ps to 5 ns

(Period 2 selectable only via the HP-IB interface)

For Automatic or External Arming:

(and signals < 100 Hz using Timed Arming)

LSD Displayed:

$$\left(\frac{t_{res}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

RMS Resolution:

$$\left(\frac{\sqrt{t_{res}^2 + (2 \times Trigger\ Error^2)}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

t_{res}: 650 ps typical[5]

For Automatic Arming: $Gate\ Time = \frac{N}{Frequency}$

where N = 1 for Ch1 Frequency < 1 MHz
4 for Ch1 Frequency > 1 MHz
128 for Ch2

Systematic Uncertainty: $\left(\pm\ Time\ Base\ Error \pm \frac{t_{acc}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$

t_{acc}: 350 ps typical
1.25 ns worst case

Trigger: Default setting is Auto Trigger at 50%

For Time or Digits Arming:

LSD Displayed:

$$\left(\frac{2\sqrt{2} \times t_{res}}{Gate\ Time \times \sqrt{Number\ or\ Samples}} + \frac{t_{jitter}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

RMS Resolution:

$$\left(\frac{4 \times \sqrt{t_{res}^2 + (2 \times Trigger\ Error^2)}}{Gate\ Time \times \sqrt{Number\ or\ Samples}} + \frac{t_{jitter}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$$

t_{res}: 500 ps typical[5]
t_{jitter}: 50 ps typical[5]

Number of Samples =
Gate Time x Frequency (Frequency < 200 kHz)
Gate Time x 200,000 (Frequency > 200 kHz)

Systematic Uncertainty: $\left(\pm\ Time\ Base\ Error \pm \frac{t_{acc}}{Gate\ Time}\right) \times \begin{matrix} Frequency \\ or \\ Period \end{matrix}$

t_{acc}: 100 ps typical
300 ps worst case

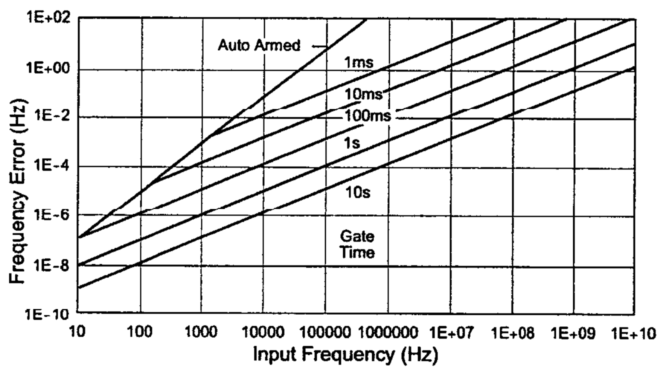
Trigger: Default setting is Auto Trigger at 50%

The following graphs may also be used to compute errors for Period Measurements. To find the Period error (ΔP), calculate the frequency of the input signal ($F = \frac{1}{P}$) and find the frequency error (ΔF) from the chart. Then, calculate the period error as: $\Delta P = \left(\frac{\Delta F}{F}\right) \times F$

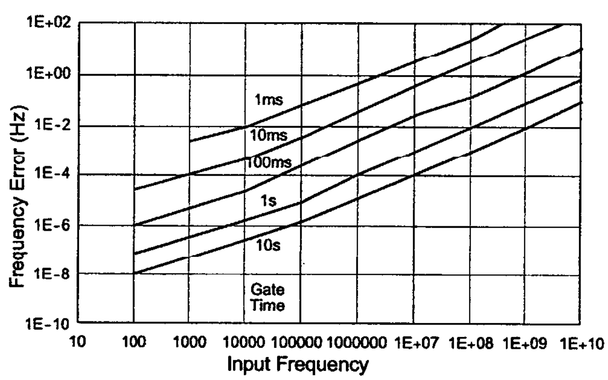
Measurement Specifications (Continued)

HP 53131A—Worst Case RMS Resolution

Automatic or External Arming:



Time or Digit Arming:



The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the frequency error from the appropriate graph and add a trigger error term as follows:

Automatic or External Arming

$$\text{Frequency Error} + \left(\frac{\sqrt{2} \times \text{Trigger Error}}{\text{Gate Time}}\right) \times \begin{matrix}\text{Frequency}\\ \text{or}\\ \text{Period}\end{matrix}$$

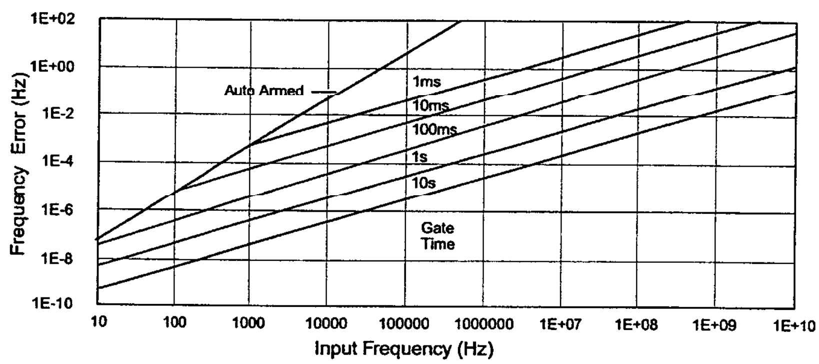
Time or Digit Arming

$$\text{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \text{Trigger Error}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}}\right) \times \begin{matrix}\text{Frequency}\\ \text{or}\\ \text{Period}\end{matrix}$$

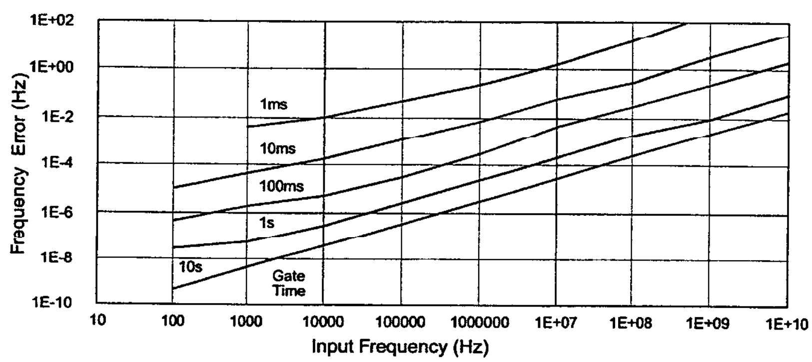
Measurement Specifications (Continued)

HP 53132A—Worst Case RMS Resolution

Automatic or External Arming:



Time or Digit Arming:



The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the frequency error from the appropriate graph and add a trigger error term as follows:

Time or Digit Arming

$$\text{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \text{Trigger Error}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}}\right) \times \text{Frequency or Period}$$

Automatic or External Arming

$$\text{Frequency Error} + \left(\frac{\sqrt{2} \times \text{Trigger Error}}{\text{Gate Time}}\right) \times \text{Frequency or Period}$$

Measurement Specifications (Continued)

Frequency Measurement Example:

Given an HP 53132A with a High Stability Oven that was calibrated 3 days ago, measure a 15 MHz square wave signal (which has negligible trigger error) with a 1 second gate time. Compute the measurement error to within 2-sigma confidence.

$$\text{Measurement Error} = \text{Systematic Uncertainty} \pm 2 \times \text{RMS Resolution}$$

$$= \left(\left(\pm \text{Time Base Error} \pm \frac{t_{acc}}{\text{Gate Time}}\right) \pm 2 \times \left(\frac{4 \times \sqrt{t_{res}^2 + (2 \times \text{Trigger Error}^2)}}{\text{Gate Time} \times \sqrt{\text{Number of Samples}}} + \frac{t_{jitter}}{\text{Gate Time}}\right)\right) \times \text{Frequency}$$

$$\text{Number of Samples} = 200{,}000 \text{ since Frequency is greater than 200kHz and gate time equals 1 second}$$

$$\text{Time Base Error} = \text{Temperature Stability} + 3 \text{ Days} \times \text{Daily Aging Rate}$$

$$= 2.5 \times 10^{-9} + 3 \times (5 \times 10^{-10})$$

$$= 4.0 \times 10^{-9}$$

$$\text{Measurement Error} = \left(\left(\pm 4.0 \times 10^{-9} \pm \frac{1 \times 10^{-11} s}{1s}\right) \pm 2 \times \left(\frac{4 \times \sqrt{(225 \times 10^{-12} s)^2 + (2 \times 0)}}{1s \times \sqrt{200,000}} + \frac{3 \times 10^{-12} s}{1s}\right)\right) \times 15MHz$$

$$= (\pm 4.0 \times 10^{-9} \pm 2 \times (2.01 \times 10^{-12} + 3 \times 10^{-12})) \times 15MHz$$

$$= (\pm 4.0 \times 10^{-9} \pm 1 \times 10^{-11}) \times 15MHz$$

$$= \pm 60.2\ mHz$$

Which is to say that the HP 53132A would display results in the range 15 MHz ±60.2 mHz. Note however that the dominant error is the Time Base Error. If an even higher stability time base is available or if the instrument can be source locked to the 15 MHz signal, then this error term can be substantially reduced. The measurement resolution under these conditions is ±75 μHz (1 sigma) which determines the number of digits displayed.

3

Measurement Specifications (Continued)

Time Interval

Measurement is specified over the full signal ranges[7] of Channels 1 and 2.

Results Range: –1 ns to 10^5 s

LSD:

53131A	53132A
500 ps	150 ps

RMS Resolution: $\sqrt{t_{res}^2 + \text{Start Trigger Error}^2 + \text{Stop Trigger Error}^2}$

t_{res}

53131A	53132A
750 ps	300 ps

Systematic Uncertainty: ± (Time Base Error × TI) ± Trigger Level Timing Error ± 1.5 ns Differential Channel Error (HP 53131A)
± 900 ps Differential Channel Error (HP 53132A)

Time Interval Delay

After a Time Interval Measurement has begun by satisfying the trigger conditions on Channel 1, the instrument will wait for the user-entered delay time to elapse before the end-of-measurement trigger will be accepted on Channel 2. Please refer to Measurement Arming for additional information.

Frequency Ratio: Ch1/Ch2 Ch1/Ch3 Ch2/Ch1 Ch3/Ch1

Measurement is specified over the full signal range of each input.

Results Range: 10^{-10} to 10^{11}

'Auto' Gate Time: 100 ms (or sufficient cycles on Channel 2 or 3 to make a valid measurement, whichever is longer)

LSD:

Ratio 1/2 : $\frac{1}{\text{Ch2 Freq} \times \text{Gate Time}}$

Ratio 1/3 : $\frac{1}{\text{Ch3 Freq} \times \text{Gate Time}}$

Ratio 2/1 : $\frac{\text{Ch2 Freq}}{(\text{Ch1 Freq})^2 \times \text{Gate Time}}$

Ratio 3/1 : $\frac{\text{Ch3 Freq}}{(\text{Ch1 Freq})^2 \times \text{Gate Time}}$

RMS Resolution:

Ratio 1/2 : $\frac{2 \times \sqrt{1 + (\text{Ch1 Freq} \times \text{Ch2 Trigger Error})^2}}{\text{Ch2 Freq} \times \text{Gate Time}}$

Ratio 1/3 : $\frac{2 \times \sqrt{1 + (\text{Ch1 Freq} \times \text{Ch3 Trigger Error})^2}}{\text{Ch3 Freq} \times \text{Gate Time}}$

Ratio 2/1 : $\frac{2 \times \text{Ch2 Freq} \times \sqrt{1 + (\text{Ch1 Freq} \times \text{Ch2 Trigger Error})^2}}{(\text{Ch1 Freq})^2 \times \text{Gate Time}}$

Ratio 3/1 : $\frac{2 \times \text{Ch3 Freq} \times \sqrt{1 + (\text{Ch1 Freq} \times \text{Ch3 Trigger Error})^2}}{(\text{Ch1 Freq})^2 \times \text{Gate Time}}$

To minimize relative phase measurement error, connect the higher frequency signal to Channel 1 when possible.

[7] See Specifications for Pulse Width and Rise/Fall Time measurements for additional restrictions on signal timing characteristics.

3

Measurement Specifications (Continued)

Pulse Width

Measurement is specified over the full signal range of Channel 1. The width of the opposing pulse must be greater than 4 ns (e.g., when measuring the positive pulse width, the negative pulse width must be greater than 4 ns).

Pulse Selection: Positive or Negative
Trigger: Default setting is Auto Trigger[8] at 50%
Results Range: 5 ns to 10^5 s

LSD:

53131A	53132A
500 ps	150 ps

RMS Resolution: $\sqrt{t_{res}^2 + \textit{Start Trigger Error}^2 + \textit{Stop Trigger Error}^2}$

t_{res}

53131A	53132A
750 ps	300 ps

Systematic Uncertainty:

± (Time Base Error × Pulse Width) ± Trigger Level Timing Error ± 1.5 ns Differential Channel Error (HP 53131A)
± 900 ps Differential Channel Error (HP 53132A)

Rise/Fall Time

Measurement is specified over the full signal ranges of Channel 1. The interval between the end of one edge and start of a similar edge must be greater than 4 ns. (e.g., when measuring a rising edge, 4 ns must elapse between the 90% point of one rising edge and the 10% point of the next rising edge).

Edge Selection: Positive or Negative
Trigger: Default setting is Auto Trigger[8] at 10% and 90%
Results Range: 5 ns to 10^5 s

LSD:

53131A	53132A
500 ps	150 ps

RMS Resolution: $\sqrt{t_{res}^2 + \textit{Start Trigger Error}^2 + \textit{Stop Trigger Error}^2}$

t_{res}

53131A	53132A
750 ps	300 ps

Systematic Uncertainty:

± (Time Base Error × Transition Time) ± Trigger Level Timing Error ± 1.5 ns Differential Channel Error (HP 53131A)
± 900 ps Differential Channel Error (HP 53132A)

Phase

Measurement is specified over the full signal range of Channels 1 and 2.

Results Range: −180° to +360°

RMS Resolution: $\sqrt{(t_{res}^2 + (2 \times \textit{Trigger Error}^2)) \times \left(1 + \left(\frac{\textit{Phase}}{360°}\right)^2\right)} \times \textit{Frequency} \times 360°$

t_{res}

53131A	53132A
750 ps	300 ps

Systematic Uncertainty: *(± Trigger Level Timing Error ± 1.5 ns Differential Channel Error) × Frequency (HP 53131A)*
(± Trigger Level Timing Error ± 900 ps Differential Channel Error) × Frequency (HP 53132A)

[8] Restrictions noted on page 3-2 for Auto Trigger apply to the proper operation of these measurements. The Peak Volts measurement is used to determine the signal amplitude and inaccuracies from this, noted on page 3-11, should be included in calculating the Trigger Level Timing Error.

Measurement Specifications (Continued)

Duty Cycle

Measurement is specified over the full signal range of Channel 1. However, both the positive and negative pulse widths must be greater than 4 ns.

Results Range: 0 to 1 (e.g. 50% duty cycle would be displayed as .5)

RMS Resolution: $\sqrt{(t_{res}^2 + (2 \times \text{Trigger Error}^2))} \times (1 + \text{Duty Cycle}^2) \times \text{Frequency}$

	53131A	53132A
t_{res}	750 ps	300 ps

Totalize

Measurement is specified over the full signal range of Channel 1.

Results Range: 0 to 10^{15}

Resolution: ± 1 count

Peak Volts

Measurement is specified on Channels 1 and 2 for DC signals; or for AC signals of frequencies between 100 Hz and 30 MHz with peak-to-peak amplitude greater than 100 mV. (The measurement will continue to operate up to 225 MHz, though results are for indication only.)

Results Range: –5.1 V to +5.1 V

Resolution: 10 mV

Systematic Uncertainty for AC signals: 25 mV + 10% of V

for DC signals: 25 mV + 2% of V

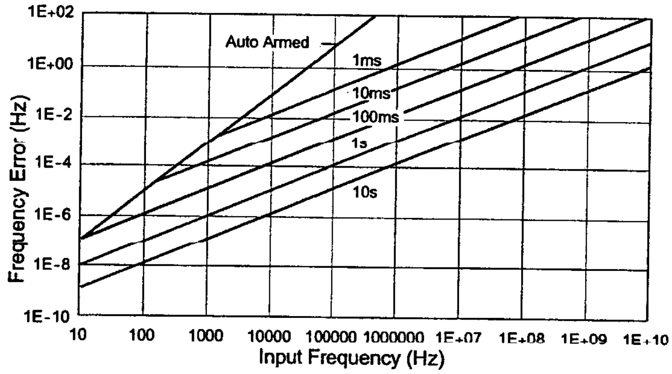
Use of the input attenuator multiplies all voltage specifications (input range, results range, resolution and systematic uncertainty) by a nominal factor of 10. For example with AC signals, the Systematic Uncertainty becomes: 250 mV + 10% of V.

3

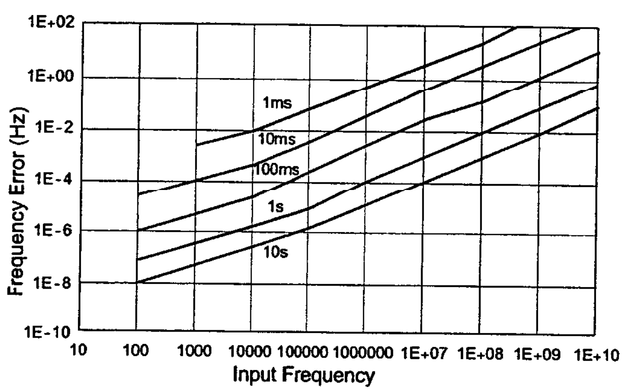
Measurement Specifications (Continued)

Worst Case RMS Resolution

Automatic or External Arming:



Time or Digit Arming:



The preceding graphs do not reflect the effects of trigger error. To place an upper bound on the added effect of this error term, determine the frequency error from the appropriate graph and add a trigger error term as follows:

Automatic or External Arming

$$\textit{Frequency Error} + \left(\frac{\sqrt{2} \times \textit{Trigger Error}}{\textit{Gate Time}}\right) \times \begin{matrix}\textit{Frequency}\\ \textit{or}\\ \textit{Period}\end{matrix}$$

Time or Digit Arming

$$\textit{Frequency Error} + \left(\frac{4 \times \sqrt{2} \times \textit{Trigger Error}}{\textit{Gate Time} \times \sqrt{\textit{Number of Samples}}}\right) \times \begin{matrix}\textit{Frequency}\\ \textit{or}\\ \textit{Period}\end{matrix}$$

Measurement Specifications (Continued)

Frequency Measurement Example:

Given an HP 53181A with a High Stability Oven that was calibrated 3 days ago, measure a 15 MHz square wave signal (which has negligible trigger error) with a 1 second gate time. Compute the measurement error to within 2-sigma confidence.

$$\begin{aligned}
\text{Measurement Error} &= \text{Systematic Uncertainty} \pm 2\times \text{RMS Resolution} \\
&= \left(\left(\pm \text{Time Base Error} \pm \frac{t_{acc}}{\text{Gate Time}}\right) \pm 2\times\left(\frac{4\times\sqrt{t_{res}^2 + (2\times \text{Trigger Error}^2)}}{\text{Gate Time}\times\sqrt{\text{Number of Samples}}} + \frac{t_{jitter}}{\text{Gate Time}}\right)\right)\times \text{Frequency} \\
\text{Number of Samples} &= 200{,}000 \text{ since Frequency is greater than 200kHz and gate time equals 1 second} \\
\text{Time Base Error} &= \text{Temperature Stability} + 3 \text{ Days}\times \text{Daily Aging Rate} \\
&= 2.5\times 10^{-9} + 3\times(5\times 10^{-10}) \\
&= 4.0\times 10^{-9} \\
\text{Measurement Error} &= \left(\left(\pm 4.0\times 10^{-9} \pm \frac{1\times 10^{-10}s}{1s}\right) \pm 2\times\left(\frac{4\times\sqrt{(500\times 10^{-12}s)^2 + (2\times 0)}}{1s\times\sqrt{200,000}} + \frac{50\times 10^{-12}s}{1s}\right)\right)\times 15MHz \\
&= (\pm 4.1\times 10^{-9} \pm 2\times(4.47\times 10^{-12} + 50\times 10^{-12}))\times 15MHz \\
&= (\pm 4.1\times 10^{-9} \pm 1.09\times 10^{-10})\times 15MHz \\
&= \pm 63.1\ mHz
\end{aligned}$$

Which is to say that the HP 53181A would display results in the range 15 MHz ±63.1 mHz. Note however that the dominant error is the Time Base Error. If an even higher stability time base is available to the instrument or if the instrument can be source locked to the 15 MHz signal, then this error term can be substantially reduced. The measurement resolution under these conditions is ±0.8 MHz (1 sigma) which determines the number of digits displayed.

3

Measurement Specifications (Continued)

Frequency Ratio: $\frac{Ch1}{Ch2}$ $\frac{Ch2}{Ch1}$

Measurement is specified over the full signal range of each input.

Results Range: 10^{-10} to 10^{11}
'Auto' Gate Time: 100 ms (or sufficient cycles on Channel 1 to make a valid measurement, whichever is longer)
LSD:

$$Ratio\ \tfrac{1}{2}: \frac{1}{Ch2\ Freq \times Gate\ Time}$$

$$Ratio\ \tfrac{2}{1}: \frac{Ch2\ Freq}{(Ch1\ Freq)^2 \times Gate\ Time}$$

RMS Resolution:

$$Ratio\ \tfrac{1}{2}: \frac{2 \times \sqrt{1 + (Ch1\ Freq \times Ch2\ Trigger\ Error)^2}}{Ch2\ Freq \times Gate\ Time}$$

$$Ratio\ \tfrac{2}{1}: \frac{2 \times Ch2\ Freq \times \sqrt{1 + (Ch1\ Freq \times Ch2\ Trigger\ Error)^2}}{(Ch1\ Freq)^2 \times Gate\ Time}$$

To minimize relative phase measurement error, connect the higher frequency signal to Channel 1 when possible.

Peak Volts

Measurement is specified on Channels 1 for DC signals, or for AC signals of frequencies between 100 Hz and 30 MHz with peak-to-peak amplitude greater than 100 mV. (The measurement will continue to operate up to 225 MHz, though results are for indication only.)

Results Range: −5.1 V to +5.1 V
Resolution: 10 mV
Systematic Uncertainty for AC signals: 25 mV + 10% of V
for DC signals: 25 mV + 2% of V

Use of the input attenuator multiplies all voltage specifications (input range, results range, resolution and systematic uncertainty) by a nominal factor of 10. For example with AC signals, the Systematic Uncertainty becomes: 250 mV + 10% of V.

Measurement Definitions

Definitions of Systematic Uncertainty Terms

- **Trigger Error**

  External source and input amplifier noise may advance or delay the trigger points that define the beginning and end of a measurement. The resulting timing uncertainty is a function of the slew rate of the signal and the amplitude of spurious noise spikes (relative to the input hysteresis band).

  The (rms) trigger error associated with a single trigger point is:

  $$\text{Trigger Error} = \frac{\sqrt{(E_{input})^2 + (E_{signal})^2}}{\text{Input Signal Slew Rate at Trigger Point}} \text{(in seconds)}$$

  where

  E_{input} = RMS noise of the input amplifier: 1 mVrms (350 µVrms typical). Note that the internal measurement algorithms significantly reduce the contribution of this term.

  E_{signal} = RMS noise of the input signal over a 225 MHz bandwidth (100 kHz bandwidth when the low-pass filter is enabled). Note that the filter may substantially degrade the signal's slew rate at the input of the trigger comparator.

- **Fractional Time Base Error**

  Time base error is the maximum fractional frequency variation of the time base due to aging or fluctuations in ambient temperature or line voltage:

  $$\text{Time Base Error} = \left(\frac{\Delta f}{f}\Big|_{aging\ rate} + \frac{\Delta f}{f}\Big|_{temperature} + \frac{\Delta f}{f}\Big|_{line\ voltage}\right)$$

  Multiply this quantity by the measurement result to yield the absolute error for that measurement. Averaging measurements will not reduce (fractional) time base error. The HP 53181A counters exhibits negligible sensitivity to line voltage; consequently this term may be ignored.

Typical Versus Worst Case Specifications

Specifications identified as "Typical" represent performance of the instrument that the majority of users will perceive under a wide variety of conditions and signals. The specifications identified as "Worst Case" should be used when the instrument is under extreme environmental conditions or when the accuracy of the measurement results are critically important.

3

3

Measurement Arming and Processing

Gate Time

Auto Mode, or 1 ms to 1000 s

Measurement Throughput

HP-IB ASCII: 200 Measurements/s (maximum)
(See examples in the Programming Guide for ways to optimize measurement throughput)

Measurement Arming

Start Measurement: Free Run, Manual, or External
Stop Measurement: Continuous, Single, External, or Timed
Arming Modes:
(Note: auto arming is the only mode available for the Peak Volts function.)

Auto Arming:	Measurements are initiated immediately and acquired as fast as possible, using a minimum number of signal edges. Auto arming offers the highest measurement throughput, though measurement resolution may be reduced.
Timed Arming:	The duration of the measurement is internally timed to a user-specified value (also known as the "gate time"). This mode should be used when the length of the measurement time must be controlled.
Digits Arming:	Measurements are performed to the requested resolution (number of digits) through automatic selection of the acquisition time. This is the most convenient mode when a specific measurement resolution is desired.
External Arming:	An edge on the External Arm Input enables the start of each measurement. Auto Arming, Timed arming modes or another edge on the External Arm Input may be used to complete the measurement.

Measurement Statistics

Available Statistics:	Mean, Minimum, Maximum, Standard Deviation
Number of Measurements:	2 to 1.000.000. Statistics may be collected on all measurements or on only those which are between the limit bands. When the Limits function is used in conjunction with Statistics, N (number of measurements) refers to the number of in-limit measurements. In general, measurement resolution will improve in proportion to $\sqrt{N}$, up to the numerical processing limits of the instrument.
Measurements:	Statistics may be collected for all measurements except Peak Volts.

Measurement Limits

Limit Checking:	The measurement value is checked against user-specified limits at the end of each measurement.
Display Modes:	The measurement result may be displayed as either the traditional numeric value or graphically as an asterisk moving between two vertical bars. These bars define the upper and lower limits, and the asterisk represents the current measurement result relative to these limits.
Out-of-Limits Indication:	The out-of-limits condition can be indicated by any of the following methods:

- The limits annunciator will light on the front panel display.
- The instrument will generate an SRQ if enabled via HP-IB.
- The limits hardware signal provided via the RS-232 connector will go low for the duration of the out-of-limit condition (see the description of this connector under the General Information section of this specifications table).
- If the Analog Display mode is enabled, the asterisk appears outside the vertical bars, which define the upper and lower limits.

General Information

Save and Recall: Up to 20 complete instrument setups may be saved and recalled later. These setups are retained when power is removed from the counter.

Rack Dimensions (HxWxD): 88.5 mm x 212.6 mm x 348.3 mm

Weight: 3.5 kg maximum

	AC Line Supply	DC Supply (Option 002 Only)
Power Supply Voltage:	100 to 120 VAC ±10% - 50, 60 or 400 Hz ±10% 220 to 240 VAC ±10% - 50 or 60 Hz ±10% AC Line Voltage Selection: Automatic	10 to 32 VDC, 3-pin male XLR connector Option 002 may not be ordered with Option 060
Power Requirements:	170 VA maximum (30 W typical)	4A initial inrush at 10 VDC 3A max, once stabilized

Operating Environment: 0° C to 55° C

Storage Environment: –40° C to 71° C

Remote Interface: HP-IB (IEEE 488.1-1987, IEEE 488.2-1987)

HP-IB Interface Capabilities: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2

Remote Programming Language: SCPI-1992.0 (Standard Commands for Programmable Instruments)

Safety: Designed in compliance with IEC 1010-1, UL 3111-1 (draft), CAN/CSA 1010.1

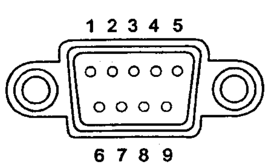
EMC: CISPR-11, EN50082-1, IEC 801-2, -3, -4

Electrostatic Discharge and Fast Transient/Burst Immunity Testing: When the product is operated at maximum sensitivity (20 mVrms) and tested with 8kV AD according to IEC801-2 or with 1kV power line transients according to IEC 801-4, frequency miscounts may occur that will affect measurement data made during these disturbances.

Radiated Immunity Testing: When the product is operated at maximum sensitivity (20 mVrms) and tested at 3 V/m according to IEC 801-3, external 100 to 200 MHz electric fields may cause frequency miscounts.

RS-232C: The rear-panel RS-232 connector is a 9-pin connector (DB-9, male). You can connect the universal counter to any terminal or printer with a properly configured DTE connector (DB-25). You can use a standard interface cable (HP part number 24542G or 24542H). Data is "output only"; the instrument can not be programmed via the RS-232 interface.

Note on Pin 4: May be used as either a DTR signal or an indication of measurement in-limit as configured by the Utility menu. When used as an in-limit indicator, the signal will be high for every measurement within the user set limits.



Pin Number	Type	Description
2	Input	Receive Data (RxD) (for Xon/Xoff only)
3	Output	Transmit Data (TxD)
4	Output	Data Terminal Ready (DTR) Measurement In-Limit Signal
5	—	Signal Ground
6	Input	Data Set Ready (DSR)
•	All other pins: no connection	