1-10. General

1-11. The HP 5334A/B and related documentation must be reviewed for familiarization with safety markings and instructions before operation. **Before applying power,** verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to Section II, Installation.

Table 1-1. HP Model 5334A/B 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 MΩ, 30 Hz to 100 MHz
50Ω, 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: ±5V dc (X ATTN)

Trigger Level:
Range:
Manual (Auto Trigger OFF): Continuously adjustable over ±5.1V, displayed by Read Levels in 20 mV steps. In X10, ±51V displayed in 200 mV steps.
Preset: 0V NOMINAL in Sensitivity Mode
Auto Trigger: See Automatic Measurements Section.

Accuracy (Read Levels):
X1: ±30 mV ±1% of trigger level reading
X10: ±300 mV ±1% of trigger level reading (NOMINAL).

Coupling: ac or dc, switch selectable

Trigger Slope: Independent selection of + or - slope

Impedance †: 1 MΩ NOMINAL shunted by <60 pF or 50Ω 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:
50Ω: 5V rms
1 MΩ, X1:
0 to 3.5 kHz: 200V (dc + peak ac)
3.5 kHz to 100 kHz: 5 x 10^5V rms Hz/FREQ.
>100 kHz: 5V rms
1 MΩ, X10:
0 to 35 kHz: 200V (dc + peak ac)
35 kHz to 100 kHz: 5 x 10^6V 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 †: 500 kΩ NOMINAL shunted by <85 pF or 50Ω 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 μs

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 †: dc Coupled, 1 kΩ NOMINAL shunted by <30 pF.

Damage Level: ±15 V (dc + peak ac)

FREQUENCY A and FREQUENCY B

Range: 001 Hz to 100 MHz

LSD①: $\frac{4\text{ ns}}{\text{Gate Time}} \times \text{FREQ}$

Resolution: (see Graph 1)

$$\pm \text{LSD} \pm \frac{(1.4 \times \text{Trigger Error ③} + 1\text{ ns rms})}{\text{Gate Time}} \times \text{FREQ}$$

Accuracy: ± Resolution ± Timebase Error②

PERIOD A

Range: 10 ns to 10^3 s

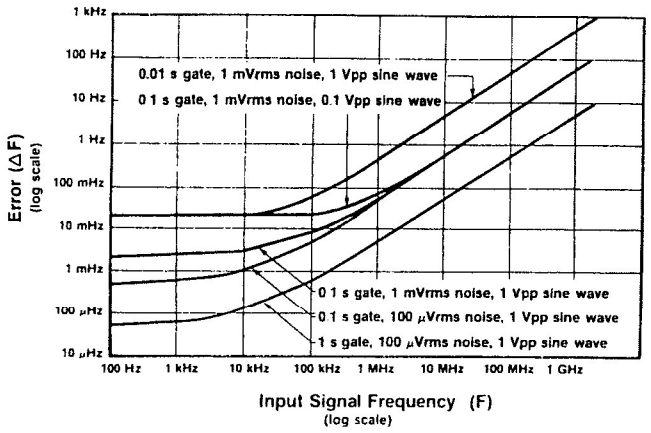
LSD①: $\frac{4\text{ ns}}{\text{Gate Time}} \times \text{PER}$

Resolution: (see Graph 1)

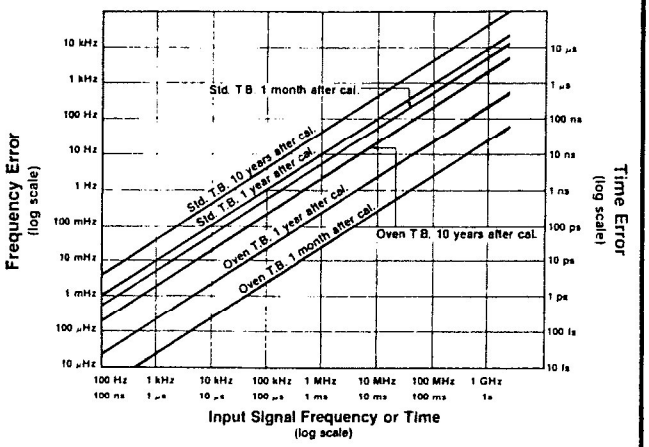
$$\pm \text{LSD} \pm \frac{(1.4 \times \text{Trigger Error ③} + 1\text{ ns rms})}{\text{Gate Time}} \times \text{PER}$$

Accuracy: ± Resolution ± Timebase Error②

Table 1-1. HP Model 5334A/B Specifications (Continued)



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.

† Resistance values are measured at dc and capacitance values at 10 MHz

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

** 100 ps rms using 100 GATE AVERAGE

TIME INTERVAL A to B

Range: -1 ns to 10^3s (single-shot), 10s (100 GATE AVERAGE).

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

Resolution: ± LSD ± Start Trigger Error ③ ± Stop Trigger Error ③ ± 1 ns rms **

Accuracy: ± Resolution ± Timebase Error ② ± Trigger Level Timing Error ④ ± Trigger Level Setting Error ⑤ ± 2 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: ±100 μs ± 0.05% X DELAY TIME

RATIO A/B

Range: 001 Hz to 100 MHz both channels

LSD ①: 4 X RATIO/(FREQ A X Gate Time)

Resolution:

$$\pm \text{LSD} \pm \frac{\text{B Trigger Error ③}}{\text{Gate Time}} \times \text{RATIO}$$

Accuracy: Same as Resolution

Specified for higher frequency input connected to Channel A.

TOTALIZE A

Range: 0 to $10^{12}-1$

LSD Displayed: 1 count of input signal

Resolution: ±LSD

Accuracy: ±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 ± 5.1V OR difference between maximum and minimum peaks exceeds 5.1V

X1 attenuator enabled when: maximum and minimum peak amplitudes are less than ± 4.6V AND difference between maximum and minimum peaks is less than 4.4V

AUTO TRIGGER

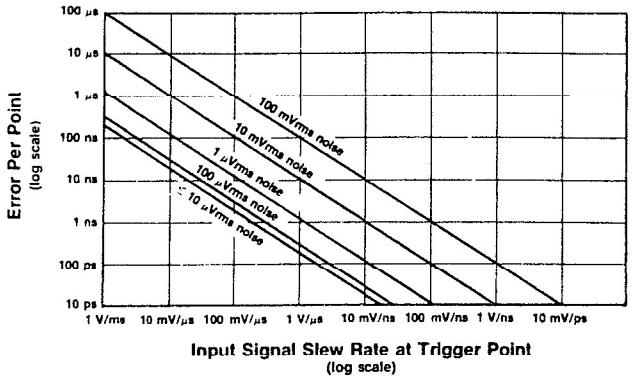
DC Coupled: 100 Hz to 100 MHz.

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

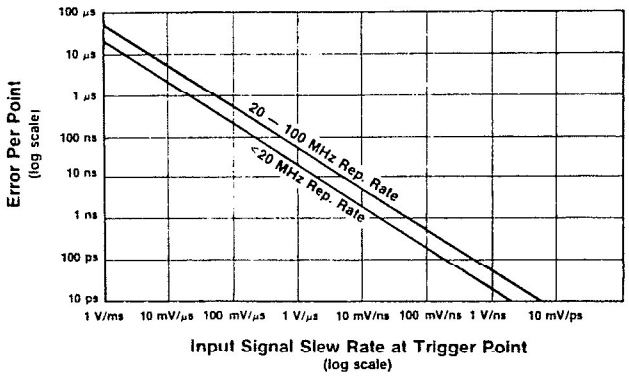
Minimum Amplitude: 100 mV rms sine wave, 280 mV peak-to-peak.

Trigger Level Accuracy: ±30 mV (X ATTN).
For Rise/Fall Time, ±40 mV (X ATTN).
Auto Trigger is disabled for Totalize, Frequency C, DVM (HP 5334A), and Read Trigger Levels.

Table 1-1. HP Model 5334A/B Specifications (Continued)



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



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.

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

LSD①: 1 ns (100 ps using 100 GATE AVERAGE)

Resolution: ± LSD ± Start Trigger Error③ ± Stop Trigger Error③ ± 1 ns rms.

Accuracy:
± Resolution ± Trigger Level Timing Error④
± Trigger Level Setting Error at 10% point⑤
± Trigger Level Setting Error at 90% point⑤
± Timebase Error② ± 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.

LSD①: 1 ns (100 ps using 100 GATE AVERAGE)

Resolution: ± LSD ± Start Trigger Error③ ± Stop Trigger Error③ ± 1 ns rms.**

Accuracy:
± Resolution ± Trigger Level Timing Error④
± Trigger Level Setting Error⑤
± Timebase Error②.

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: ±51 volts

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

AC Accuracy: ± Resolution ± 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: ± 35 mV ± 0.5% of reading
X10: ± 300 mV ± 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. ± 1 X 10^{-10} to ± 9.99999999999 X 10^{9}.

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

GENERAL

TIMEBASE

Standard Crystal:

Frequency: 10 MHz

Aging Rate: <3 × 10^{-7} per month.

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

Line Voltage: <1 × 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 kΩ NOMINAL shunted by <20 pF

Timebase Output: 10 MHz, >500 mV rms sine wave into 50Ω 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: ± LSD

Accuracy: ±100 µs ±(0.05% × 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.

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

Table 1-1. HP Model 5334A/B Specifications (Continued)

MEMORY (HP 5334A only): Ten measurement set-ups, including trigger levels, may be stored in memory and subsequently re-called. When a measurement setup 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 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 kΩ. 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 $\pm10^{-17}$ to $\pm9.99999999 \times 10^{19}$.
OPERATING TEMPERATURE: 0 to 50° C.
POWER REQUIREMENTS: 47.5 – 440 Hz, 90 – 126.5V; 47.5 – 66 Hz, 198 – 225V; 50 VA maximum.
WEIGHT: Net, 5.3 kg (11 lb 12 oz); Shipping 8.1 kg (17 lb 12 oz).
DIMENSIONS: 89mm H x 422 mm W x 346 mm D (3 ½ in. H x 16 5/8 in. D), excluding bottom feet, front handles, and rear feet.

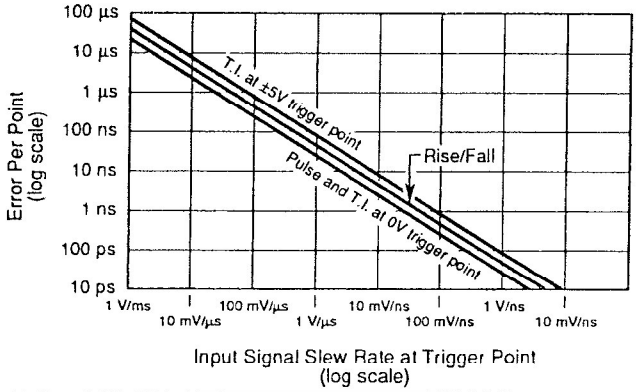
HEWLETT-PACKARD INTERFACE BUS

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 ± 1% of trigger level reading.
X10: ±300 mV ±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
Long Term (Aging Rate):
A. $<5 \times 10^{-10}$ per day after 24-hour warm-up when:
1. oscillator off-time was less than 24 hours.
2. oscillator aging rate was $<5 \times 10^{-10}$ per day prior to turn off.
B. $<5\times 10^{-10}$ per day in less than 30 days of continuous operation for off-time greater than 24 hours.
C. $<1 \times 10^{7}$ per year for continuous operation.
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).
Warmup: Within $<5 \times 10^{-9}$ of final value (see below) 10 min. after turn-on when:
1. oscillator is operated in a 25°C environment with 20 Vdc Oven Supply voltage applied.
2. oscillator off time was less than 24 hours.
3. oscillator aging rate was $<5 \times 10^{-10}$ per day prior to turn-off.
4. Final value is defined as oscillator frequency 24 hours after turn-on.

OPTION 020 (HP 5334A only) DC Digital Voltmeter.
Range: 4 digits autoranging, and autopolarity in ±10V, ±100V, ±1000V ranges.
Sensitivity: 100µV for ±1V reading. 1 mV for ±10V reading. 100 mV for ±1000V reading.
LSD: Same as Sensitivity.
Accuracy: 60 days, 24° ±5°C.
10V Range: ±0.045% of reading ±8 mV
100V Range: ±0.045% of reading ±80 mV.
1000V Range: ±0.060% of reading ±200 mV
Temperature Coefficient:
10V Range: ±(0.0055% of reading ±0.5mV)/°C
100V Range: ±(0.0055% of reading ±5mV)/°C
1000V Range: ±(0.008% of reading ±5mV)/°C
Input Type: Floating Pair.
Input Resistance: 10 MΩ ±1%
Maximum Input: High to Low ±1000V in all ranges.
Low to chassis ground: ±500 in all ranges.
Response Time: 800ms to within 1% of final value, within one range.
Normal Mode Rejection: 30 dB at 50/60 Hz.
Effective Common Mode Rejection (1kΩ 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.



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

Table 1-1. HP Model 5334A/B Specifications (Continued)

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

LSD①, 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 CIIL 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.

CIIL 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)

$$\frac{\text{1/2 hysteresis band}}{\text{Input slew rate at start trigger point ⑥}} \text{ or}$$

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

⑤ **Trigger Level Setting Error:** (see Graph 5)
Rise/Fall Time measurements:

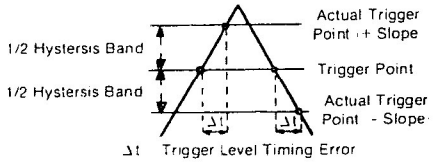
$$\frac{\pm 40 \text{ mV}}{\text{Input slew rate at trigger point ⑥}}$$

Pulse Width and Time Interval measurements:

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

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

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 =

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

For Rise/Fall Time, 10% trigger point =
(.1 (maximum peak) + 9 (minimum peak)) (X ATTN)
90% trigger point =
(.9 (maximum peak) + 1 (minimum peak)) (X ATTN)
(AC/DC Voltage function is used to measure peaks.)