Errata

Title & Document Type: 5372A Frequency and Time Interval Analyzer Condensed Reference and Specification Guide

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HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

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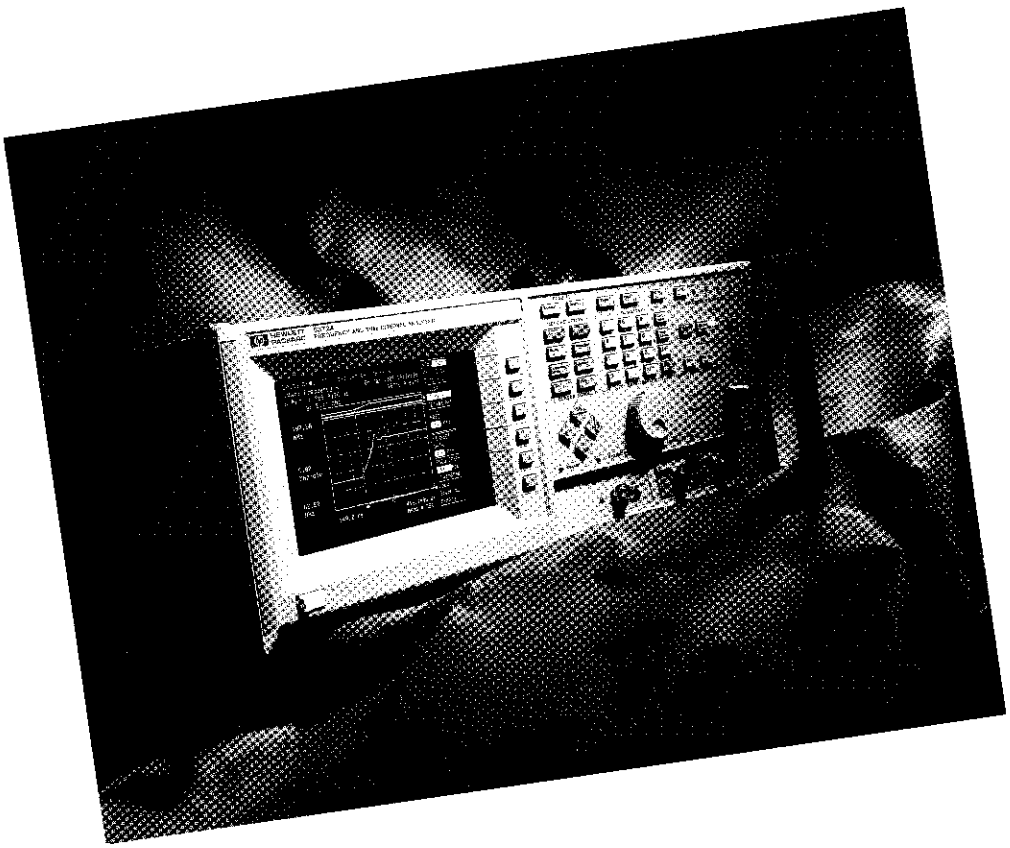
Condensed Reference and Specification Guide

HP 5372A
Frequency and Time Interval Analyzer



Purpose of this Reference Guide

This guide is designed to give you a detailed understanding of the HP 5372A Frequency and Time Interval Analyzer. As a complete reference source, it contains:

- general product information
- operating characteristics
- comprehensive specifications.

The information in this reference guide is essential for product understanding and will help you determine the applicability of the HP 5372A to your particular measurement problem. After you have purchased an HP 5372A, this guide will prove to be a valuable resource.

For even more detailed information, consult the HP 5372A Getting Started Guide (P/N 5952-8009), HP 5372A Operating Manual (P/N 05372-90001) and the HP 5372A Programming Manual (P/N 05372-90003). Or, contact your local HP sales representative.

Important Notes

Measurement Modes

The HP 5372A operates in two measurement modes - Normal and Fast. Specifications and operating characteristics may differ depending on the measurement mode selected. If there are differences, parameters pertaining to the Fast measurement mode will be contained in brackets [ ].

Warranted Specifications vs. Operating Characteristics

Both warranted specifications and operating characteristics are discussed in context throughout this guide. A comprehensive listing of warranted specifications can be found in Appendix C. To distinguish warranted specifications from operating characteristics, specifications are highlighted throughout in a bold typeface. Following is an example:

$$\pm \frac{\textbf{150ps rms + (1.4 x Trigger Error)}}{\textbf{Sample Interval}} \textbf{ x Frequency}$$

Uncertainty Definitions

Many terms such as Least Significant Digit, Resolution, Accuracy, Trigger Error and Trigger Level Timing Error are used throughout this guide. Definitions of these terms can be found in Appendix A.

Organization of this Reference Guide

This reference guide is divided into nine sections and Appendices. Following is a brief description of each section.

Measurement Functions

The eighteen measurement functions of the HP 5372A are fully described. Their associated characteristics and specifications are noted and the setup for each is explained.

Measurement Control

The HP 5372A's extensive arming capability provides precise control of measurement acquisition. The twenty five arming modes are each discussed in two groups. Their description and individual characteristics are given. Additionally, Pre-trigger and Inhibit are explained.

Analyzer Memory

The HP 5372A provides a large measurement memory capable of storing up to 8191 measurements depending on measurement function. The relationship between measurement function and measurement storage capacity is explained.

Input

The input signal conditioning provided by the HP 5372A is discussed.

Data Analysis

HP 5372A Data Analysis features provide new insights into signals previously difficult to measure. Each capability is specifically discussed.

HP-IB (IEEE 488)

HP-IB is standard and the HP 5372A is capable of transferring data in one of three output formats - ASCII, Floating Point, and Binary. Performance information on each is provided.

Rear Panel Connectors

Rear panel connectors of the HP 5372A are individually described.

Time Base

The HP 5372A provides an ovenized crystal oscillator as standard equipment for optimal performance.

General

This section contains an overall description of the HP 5372A. Its physical attributes and required environmental conditions are discussed. The Display Characteristics and Ease-of-use Features are fully explained.

Appendices

A - Measurement Uncertainty Definitions
 Every measurement contains uncertainties. The uncertainties associated with the HP 5372A are defined in this Appendix.

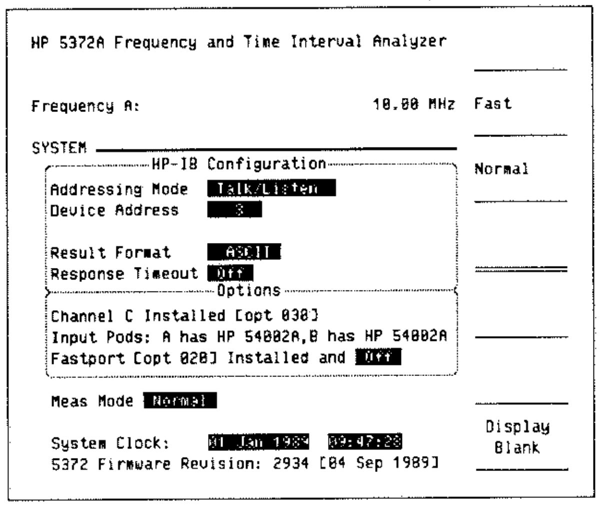
B - Example Measurement and Uncertainty Calculations
 Three measurement examples are presented along with their associated uncertainty calculations.

C - Warranted Specifications
 A comprehensive list of specifications is provided.

Table of Contents

Measurement Functions

The HP 5372A has two measurement modes - Normal and Fast.



The HP 5372A is easily configured for optimum performance.

Fast measurement mode allows for higher measurement rates by limiting the range of the measurements. Further, significant increases in transfer rates over HP-IB can be achieved using the Binary output format for data. Normal measurement mode allows for measurement functions to measure lower minimum frequencies and longer time intervals. In this section, the specifications and operating characteristics for both modes will be indicated. If there are differences in the two modes, **parameters pertaining to the Fast measurement mode will be contained in brackets [ ].**

The minimum continuous sample interval is 100 ns [75 ns] for single-channel measurements, and 200 ns [135 ns] for dual-channel measurements. This corresponds to a sample rate of 10 MHz [13.3 MHz] for single-channel measurements and 5 MHz [7.4 MHz] for dual-channel measurement. Measurements may be made over intervals as short as 2 ns; however, they will not be contiguous.

Frequency

The HP 5372A offers single-channel and dual-channel measurement features for frequency. The following single-result and dual-result arithmetic combinations of frequency measurements are available for display and analysis:

Frequency A (single-result).
Frequency B (single-result).
Frequency C*(single-result).
Frequency A&B (dual-result).
Frequency A&C*(dual-result).
Frequency B&C*(dual-result).
Frequency A+B (single-result).
Frequency A+C*(single-result).
Frequency B+C*(single-result).
Frequency A-B (single-result).
Frequency A-C*(single-result).
Frequency B-A (single-result).
Frequency B-C*(single-result).
Frequency C-A*(single-result).
Frequency C-B*(single-result).
Frequency A/B (single-result).
Frequency A/C*(single-result).
Frequency B/A (single-result).
Frequency B/C*(single-result).
Frequency C/A*(single-result).
Frequency C/B*(single-result).

* This measurement is only available with Option 030 or Option 090.

Accuracy and resolution equations apply to all input channels.

Frequency measurements are acquired simultaneously for all two-channel measurements. Measurement throughput is dictated by the lower frequency input signal.

RANGE

Single Channel Measurements:

Channels A and B: **125 mHz [8 kHz] to 500 MHz.**
Channel C: **100 MHz to 2 GHz.**

Dual Channel Measurements:

Channels A and B: **250 mHz [16 kHz] to 500 MHz.**
Channel C: **100 MHz to 2 GHz.**

FOR A SINGLE MEASUREMENT

Least Significant Digit Displayed:

$$\pm \frac{\text{200ps}}{\text{Sample Interval}} \times \text{Frequency}$$

Resolution†:

$$\pm \frac{\text{150ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Frequency}$$

Accuracy‡:

$$\pm \text{Resolution} \pm (\text{Time Base Aging} \times \text{Frequency})$$

† Refer to Graph 1
‡ Refer to Graph 2

MEAN ESTIMATION FOR AVERAGED MEASUREMENTS

rms Resolution:

Continuous Measurements (Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times (150\text{ps rms} + 1.4 \times \text{Trigger Error})}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

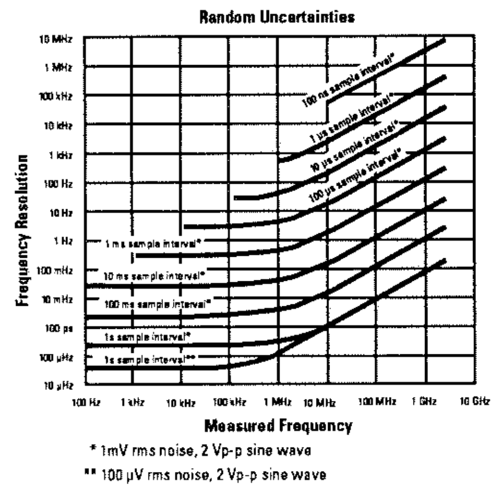
All other Measurements:

N = number of measurements averaged.

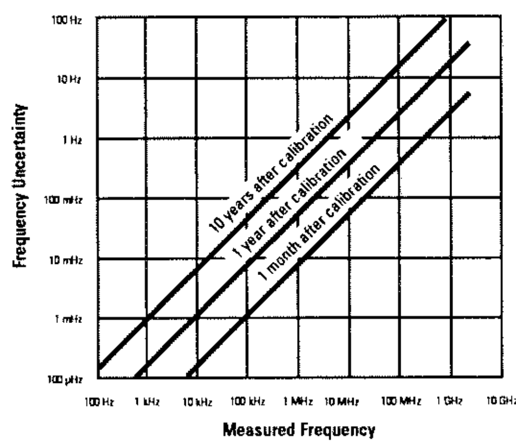
$$\pm \frac{150\text{ ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval} \times \sqrt{N}} \times \text{Frequency}$$

Accuracy‡:

± Resolution ± (Time Base Aging x Frequency)



Graph 1. Noise on the input signal will add uncertainty to Frequency or Period measurements. Longer sample intervals and averaging will reduce the effects of random noise.



Graph 2. Time Base crystal aging affects Frequency and Period measurement accuracy. You can further reduce aging uncertainty by using an atomic standard, such as the HP 5061B.

‡ Refer to Graph 2

Period

The HP 5372A offers single-channel and dual-channel period measurement features. The following single-result and dual-result arithmetic combinations of period measurements are available for display and analysis:

Period A (single-result).
Period B (single-result).
Period C*(single-result).
Period A&B (dual-result).
Period A&C*(dual-result).
Period B&C*(dual-result).
Period A+B (single-result).
Period A+C*(single-result).
Period B+C*(single-result).
Period A-B (single-result).
Period A-C*(single-result).
Period B-A (single-result).
Period B-C*(single-result).
Period C-A*(single-result).
Period C-B*(single-result).
Period A/B (single-result).
Period A/C*(single-result).
Period B/A (single-result).
Period B/C*(single-result).
Period C/A*(single-result).
Period C/B*(single-result).

* This measurement is only available with Option 030 or 090.

Accuracy and resolution equations apply to all input channels.

Period measurements are acquired simultaneously for all two-channel measurements. Throughput is dictated by the lower frequency (larger period) input signal.

RANGE

Single Channel Measurements:

Channels A and B: **2 ns to 8.0 s [131 μs].**
Channel C: **0.5 ns to 10 ns.**

Dual Channel Measurements:

Channels A and B: **2 ns to 4.0 s [65 μs].**
Channel C: **0.5 ns to 10 ns.**

FOR A SINGLE MEASUREMENT

Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Sample Interval}} \times \text{Period}$$

Resolution:

$$\pm \frac{150\text{ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Period}$$

Accuracy:

± Resolution ± (Time Base Aging x Period)

MEAN ESTIMATION FOR AVERAGED MEASUREMENTS

rms Resolution:

Continuous Measurements (Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times \left(150\text{ps rms} + (1.4 \times \text{Trigger Error})\right)}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Period}$$

All other Measurements:

N = number of measurements averaged.

$$\pm \frac{150\text{ ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval} \times \sqrt{N}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Time Base Aging x Period)

Frequency or Period Ratio

The following equations apply for frequency or period ratio measurements:

Range:

Channel A and B: **250 mHz [16 kHz] to 500 MHz (2 ns to 4.0 s [65 μs]).**
Channel C: **100 MHz to 2 GHz (0.5 ns to 10 ns).**

Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Sample Interval}} \times \text{Ratio}$$

Resolution:

$$\pm \frac{150\text{ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Ratio}$$

Accuracy (for Frequency A/B):

$$\pm \text{Resolution} \pm \frac{\text{Timebase Aging} \times \text{Frequency A}}{\text{Timebase Aging} \times \text{Frequency B}}$$

Totalize

The HP 5372A offers single-channel and dual-channel measurement features for totalize. The following single-result and dual-result arithmetic combinations of totalize measurements are available for display and analysis:

Totalize A (single-result).	Totalize A-B (single-result).
Totalize B (single-result).	Totalize B-A (single-result).
Totalize A&B (dual-result).	Totalize A/B (single-result).
Totalize A+B (single-result).	Totalize B/A (single-result).

Accuracy and resolution equations apply to input channels A and B.

Totalize measurements are acquired simultaneously for all dual-channel measurements. Note that all totalize measurements are made in the Normal measurement mode regardless of the measurement mode setting.

Range:

0 to 4 x 10^9 events per measurement sample, for each channel.

Least Significant Digit Displayed:

1 count of input per measurement sample, for each channel.

Resolution:

±1 count of input per measurement sample, for each channel.

For A/B:

$$\pm \frac{\textbf{Totalize Result A} \pm 1}{\textbf{Totalize Result B} \mp 1}$$

For B/A:

$$\pm \frac{\textbf{Totalize Result B} \pm 1}{\textbf{Totalize Result A} \mp 1}$$

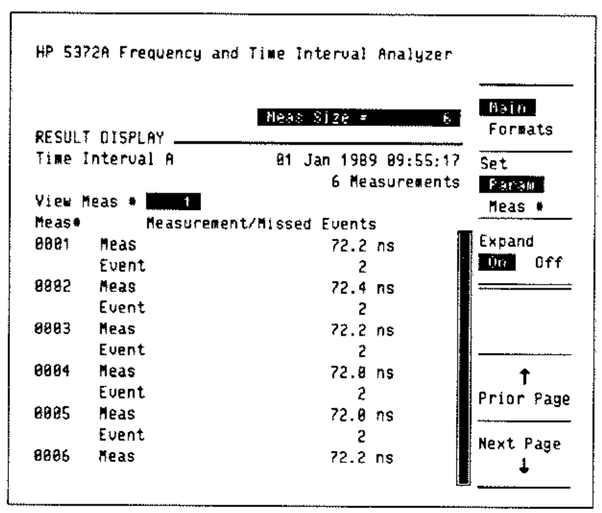
Accuracy:

± Resolution

Time Interval

The HP 5372A is capable of measuring consecutive time intervals up to a 10 MHz [13.3 MHz] rate for period type interval measurements (Continuous Time Interval A or B), and 5 MHz [7.4 MHz] for dual-channel measurements such as Time Interval A→B.

If data rates exceed these values, the number of events which do not have timing information are noted on the **Numeric** screen in the Expanded Data results display.



The HP 5372A Numeric display shows the number of intermediate events between time samples, if any occur.

The following single-result time interval measurement configurations are available:

Time Interval, ± Time Interval, Continuous Time Interval A.

Time Interval, ± Time Interval, Continuous Time Interval B.

Time Interval and ± Time Interval A→B.

Time Interval and ± Time Interval B→A.

Range

Time Interval: **10 ns to 8.0 s [131 μs].**

Continuous Time Interval: **100 ns [75 ns] to 8.0 s [131 μs].**

± Time Interval: **- 4.0 s [- 65 μs] to + 4.0 s [+ 65 μs], including 0 seconds.**

Least Significant Digit Display:

N = number of measurements averaged.

$$\pm \frac{200\ \text{ps}}{\sqrt{N}}$$

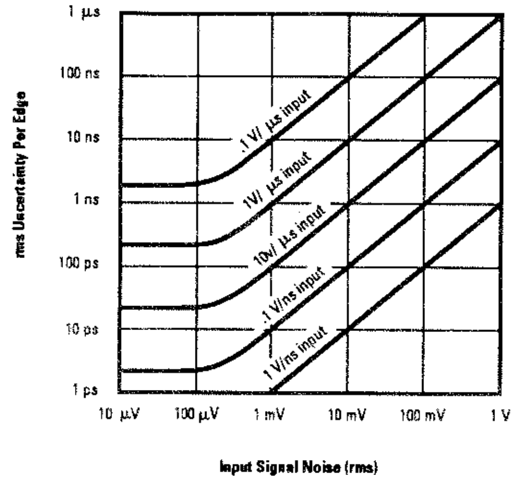
Resolution:

$$\pm \frac{150\ \text{ps rms} \pm \text{Start Trigger Error}^{\dagger} \pm \text{Stop Trigger Error}^{\dagger}}{\sqrt{N}}$$

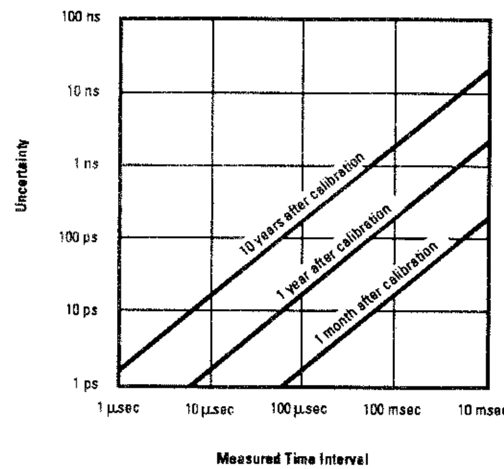
Accuracy:

± Resolution ± (Time Base Aging x Time Interval††) ± Trigger Level Timing Error‡ ± 1 ns Systematic Error*

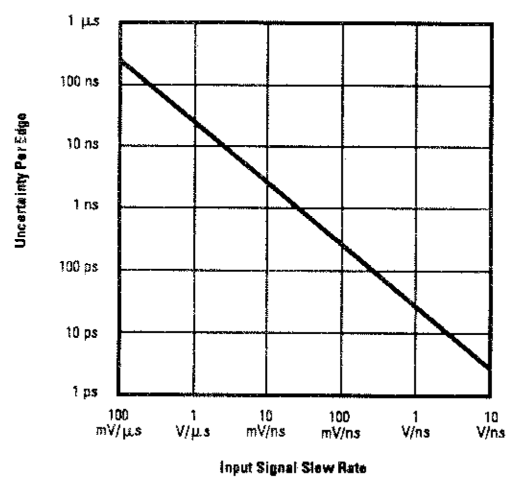
† Refer to Graph #3.
†† Refer to Graph #4.
‡ Refer to Graph #5.
* Systematic error can be reduced to less than 10 ps with the HP J06-59992A Time Interval Calibrator.



Graph 3. Noise on the input signal will add uncertainty to time interval measurements. Averaging will reduce the effects of random noise.



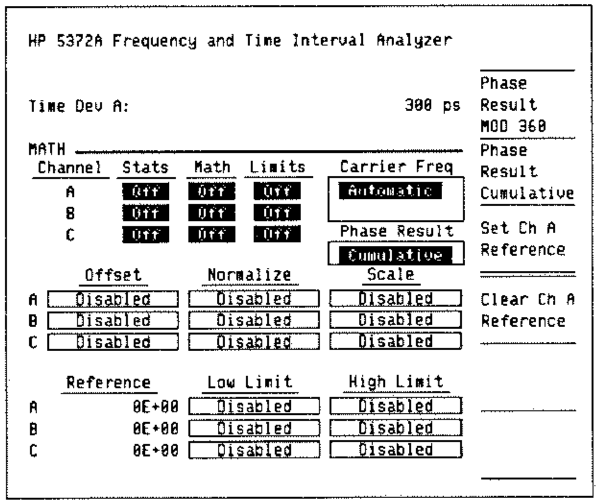
Graph 4. Time Base crystal aging affects time interval measurement accuracy. You can reduce aging uncertainty by using an atomic standard, such as the HP 5061B.



Graph 5. Trigger Level Timing Error varies with input slew rate. Uncertainty is associated with both start and stop edges. Trigger Level Timing Error is zero for Continuous Time Interval, Histogram Continuous Time Interval, Time Interval A or B, and Histogram Time Interval A or B.

Time Deviation

The HP 5372A is capable of measuring the timing relationships of a signal supplied to input channel A or B with respect to a computed carrier. The input channel to be analyzed is specified on the **Function** menu while the source of the carrier is specified on the **Math** menu.



The carrier can be determined automatically from the measurement data or entered manually. If the carrier determination is specified to be automatic, the average frequency for the block is used for the carrier frequency. It should be noted that the carrier is determined separately for each block for a multi-block acquisition.

Time deviations in excess of one period of the carrier can be analyzed. The measurement technique allows for phase shifts of many periods between the carrier and the signal being characterized; therefore, time shifts greater than one period will be measured and displayed.

Time Deviation measurements are made continuously (back-to-back), up to a rate of 10 MHz [13.3 MHz]. Time Deviation is a single-channel, single-result measurement.

Input Signal Range:

2 ns to 8.0 s [131 µs].

Least Significant Digit Displayed:

± 200 ps

Resolution:

±150 ps rms ± (1.4 x Trigger Error)

Accuracy:

±Resolution± (Time Base Aging x Time Interval) ± 1 ns Systematic Error

Automatic Carrier Determination

rms Resolution (for Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times (150\text{ps rms} + 1.4 \times \text{Trigger Error})}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Time Base Aging x Frequency).

Rise Time A and Fall Time A

Common input channels and Repetitive Auto Trigger are automatically enabled for these measurements. Trigger points default to the 20% and 80% points of the peak-to-peak amplitude for Rise Time (or 80% and 20% for Fall Time). Other trigger values may be selected from the **Input** menu.

Rise Time and Fall Time measurements are dual-channel, single-result measurements.

Range:

1 ns to 100 µs transitions (auto trigger).

Repetition Rate:

≥ 0.5 Hz.

Time between pulses:

≥ 8 ns.

Minimum Pulse Height (X1 Attenuation, Minimum Hysteresis):

200 $mV_{pk\text{-}pk}$ (auto trigger).

Least Significant Digit Displayed:

N = number of measurements averaged.

$$\pm \frac{200\text{ ps}}{\sqrt{N}}$$

Resolution:

$$\pm \frac{150\text{ ps rms} \pm \text{Start Trigger Error} \pm \text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy:

± Resolution ± (Time Base Aging x Rise Time) ± Trigger Level Timing Error ± 1 ns Systematic Error

Positive and Negative Pulse Width A

Common input channels and Repetitive Auto Trigger are automatically enabled for these measurements. Trigger points default to the 50% point of the peak-to-peak amplitude. Other trigger values may be selected from the **Input** menu.

Positive and Negative Pulse Width measurements are dual-channel, single-result measurements.

Range:
1 ns to 1 ms pulse width (auto trigger).

Repetition Rate:
≥ 0.5 Hz.

Time between pulses:
≥ 8 ns.

Minimum pulse height (X1 Attenuation, Minimum Hysteresis):
200 mV_{pk-pk} (auto trigger).

Least Significant Digit Displayed:
N = number of measurements averaged.

$$\pm \frac{200\ \text{ps}}{\sqrt{N}}$$

Resolution:

$$\pm \frac{150\ \text{ps rms} \pm \text{Start Trigger Error} \pm \text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy:

± Resolution ± (Time Base Aging x Pulse Width) ± Trigger Level Timing Error ± 1 ns Systematic Error*

*Systematic error can be significantly reduced with the HP J06-59992A Time Interval Calibrator.

Duty Cycle A

Common input channels and Repetitive Auto Trigger are automatically enabled for these measurements. Trigger points default to the 50% point of the peak-to-peak amplitude. Trigger levels can then be varied on the **Input** menu if desired.

Duty Cycle A consists of simultaneous positive pulse width and period measurements on input channel A. Duty Cycle A measurements are made continuously, or consecutively to a maximum rate of 5 MHz [7.4 MHz].

Duty Cycle A is a dual-channel, single-result measurement.

Range:

0% to 100% (provided pulse width is > 1 ns, and signal period is:
< 1 ms (auto trigger)
< 2 s [32.5 μs] (manual trigger)

Repetition rate:

≥ 0.5 Hz.

Time between pulses:

≥ 8 ns.

Minimum pulse height (X1 Attenuation, Minimum Hysteresis):

200 $mV_{pk\text{-}pk}$ (auto trigger).

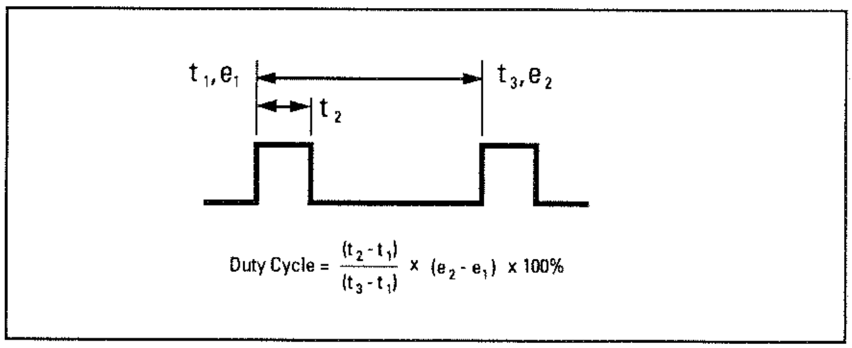
Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Period}} \times 100\%$$

Resolution:

$$\pm \text{Duty Cycle} \times \left(150 \text{ ps rms} \pm (1.4 \times \text{Trigger Error})\right) \times \sqrt{\frac{1}{(t_2 - t_1)^2} + \frac{1}{(t_3 - t_1)^2}}$$

where t_1, t_2, and t_3 are time samples,
and e_1 and e_2 are event samples.



Duty Cycle

Accuracy:

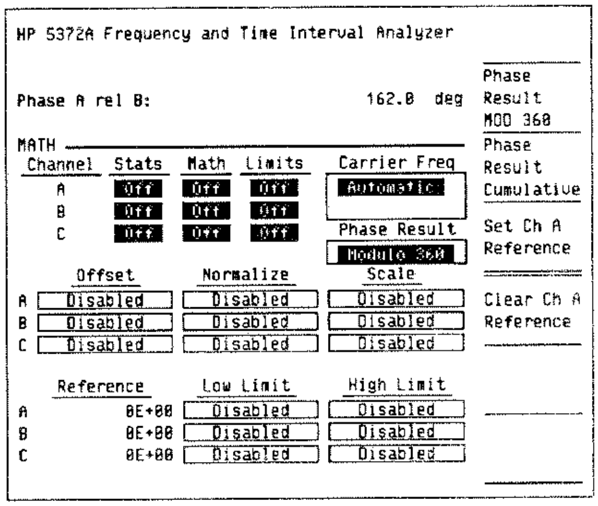
$$\pm \text{Resolution} \pm \left(\frac{\text{Trigger Level Timing Error} \pm 1 \text{ ns}}{\text{Period}}\right) \times 100\%$$

Phase

Phase A-relative-to-B, Phase B-relative-to-A

Repetitive Auto Trigger is automatically enabled for this measurement. Trigger points are defaulted to the 50% point of the peak-to-peak amplitude for both input channels A and B. Trigger levels can then be varied on the **Input** menu if desired.

Phase deviations in excess of ± 360° can be analyzed. If cumulative results are selected, results are not adjusted modulo 360°; therefore, phase shifts greater than 360° will be displayed. If modulo 360° results are specified, the deviations will be displayed in the range of +180° to -180°. The choice of cumulative or modulo 360° results is made on the **Math** menu.



Phase measurements are made continuously up to a rate of 5 MHz [7.4 MHz]. Phase measurements are dual-channel, single-result measurements.

Input Signal Range:

250 mHz [16 kHz] to 500 MHz.

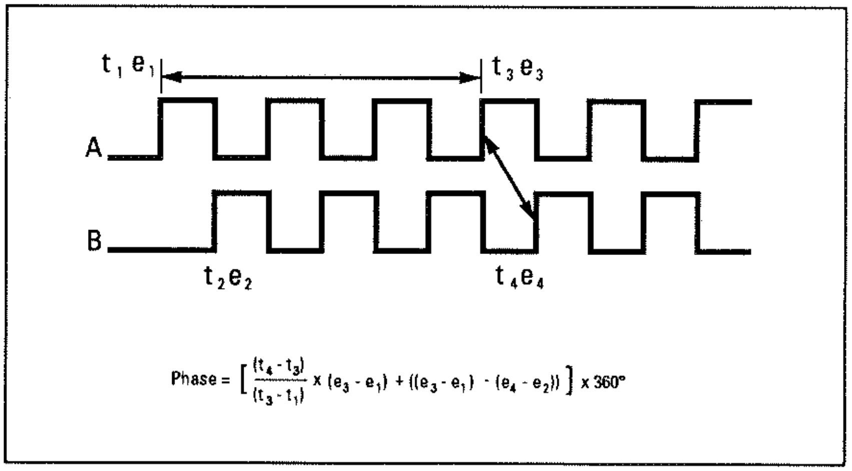
Least Significant Digit Displayed:

$$\pm \frac{200\ \text{ps}}{\text{Period}} \times 360°$$

Resolution: A relative to B (B relative to A)

$$\pm\text{Phase} \times \left(150\ \text{ps rms} \pm (1.4 \times \text{Trigger Error})\right) \times \sqrt{\frac{1}{(t_4 - t_3)^2} + \frac{1}{(t_3 - t_1)^2}}$$

where t_1, t_2, t_3 and t_4 are time samples and e_1, e_2, e_3 and e_4 are event samples.



Phase B relative to A

Accuracy: A relative to B (B relative to A)

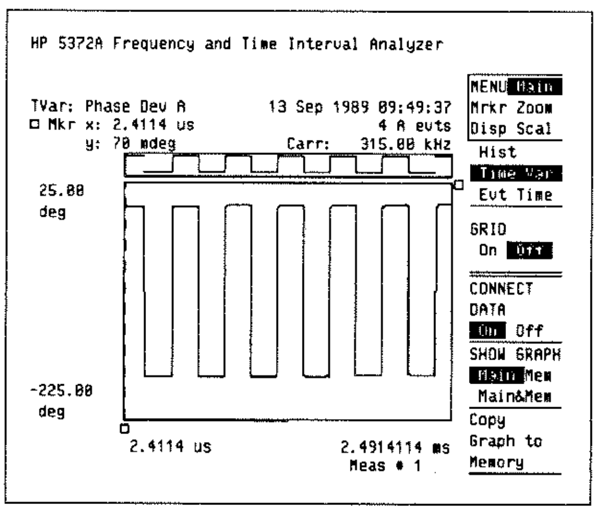
$$\pm \text{Resolution} \pm \left(\frac{\text{Trigger Level Timing Error} \pm 1\text{ ns}}{\text{Period}} \right) \times 360°$$

Phase Deviation

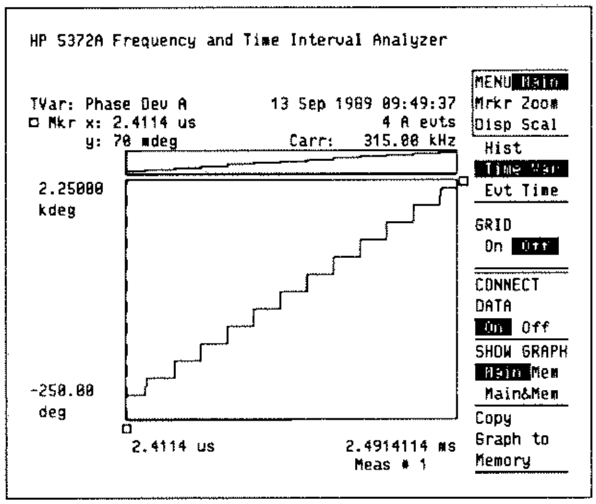
The HP 5372A is capable of measuring the phase relationship of a signal supplied to input channel A or B with respect to a computed carrier. The input channel to be analyzed is specified on the **Function** menu while the source of the carrier is specified on the **Math** menu.

The carrier can be determined automatically from the measurement data or entered manually as desired. If the carrier determination is specified to be automatic, the average frequency for the block is used for the carrier frequency. It should be noted that the carrier is determined separately for each block for a multi-block acquisition.

Phase deviations in excess of ± 360° can be analyzed if cumulative results are requested. If modulo 360° results are specified, the deviations will be displayed in the range of +180° to -180°. The choice of cumulative or modulo 360° results is made on the **Math** menu.



Phase Deviation measurement on BPSK signal with Modulo 360° selected.



Phase Deviation Measurement on BPSK signal with Cumulative selected.

Phase Deviation measurements are made continuously (back-to-back), up to a rate of 10 MHz [13.3 MHz]. Phase Deviation is a single-channel, single-result measurement.

Input Signal Range:

125 mHz [8 kHz] to 500 MHz.

Least Significant Digit Displayed:

$$\pm \frac{200\text{ ps}}{\text{Reference Period}} \times 360^\circ$$

Resolution:

$$\pm \left(\frac{150\text{ ps rms} \pm (1.4 \times \text{Trigger Error})}{\text{Reference Period}} \right) \times 360^\circ$$

Accuracy:

$$\pm \text{Resolution} \pm \left(\frac{(\text{Time Base Aging} \times \text{Time Interval}) \pm \text{Trigger Level Timing Error} \pm 1\text{ ns Systematic Error}}{\text{Reference Period}} \right) \times 360^\circ$$

Automatic Carrier Determination

rms Resolution (for Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times (150\text{ps rms} + 1.4 \times \text{Trigger Error})}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

Accuracy:

$$\pm \text{Resolution} \pm (\text{Time Base Aging} \times \text{Frequency})$$

Peak Amplitudes A, B

Frequency range:

1 kHz to 200 MHz.

Amplitude range (X1 Attenuation):

200 mV$_{pk-pk}$ to 2 V$_{pk-pk}$

Resolution:

X1: 2 mV

X2.5: 5 mV

Accuracy:

±20% of peak-to-peak amplitude, 1 kHz to 200 MHz.

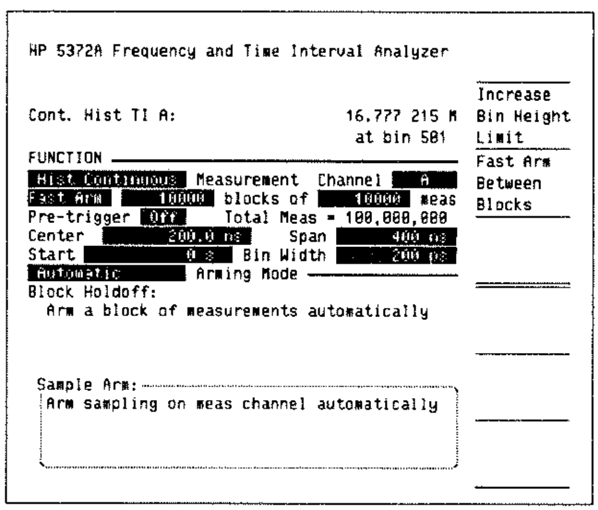
Note: The peak amplitude measurement mode is operational for frequencies between 200 MHz and 500 MHz, but accuracy is not warranted. When the frequency range is exceeded, a message is displayed.

Hardware Histogram

In addition to the powerful graphical analysis which offers a software histogram, the HP 5372A offers measurement features that allow for hardware histogramming of time interval measurements at the maximum measurement rate of the analyzer (i.e. up to 13.3 MHz). These features sort time interval measurements on-the-fly and do not maintain the order of the individual measurements. The following measurement configurations are available:

Histogram Time Interval A, B, A→B, or B→A
Histogram ± Time Interval A, B, A→B, or B→A
Histogram Continuous Time Interval A or B

In these configurations, measurements can only be analyzed graphically using a histogram. Other graphical analysis modes are not available. Unlike the histogram offered in the graphical analysis, hardware Histogram measurements require the Histogram limits to be defined prior to measurements being taken.



Hardware Histogram Set-up Menu

For multi-block measurements, the hardware Histogram will accumulate each block of measurements. Between blocks, the bin counts can be accumulated in software and the histogram cleared to allow for very large total bin counts. Or, the measurements can be accumulated in hardware across blocks to minimize the time between blocks. This selection is made on the **Function** Menu by selecting "Increase Bin Height Limit" or "Fast Arm Between Blocks".

For "Fast Arm Between Blocks", there is a delay of < 2μs from the last measurement in the block. Following this delay, the next block may be armed as soon as its Holdoff arming condition is satisfied.

Measurement parameters for Time Interval, ± Time Interval and Continuous Time Interval apply to Histogram Time Interval, Histogram ± Time Interval and Histogram Continuous Time Interval, respectively.

Number of bins:

2000.

Maximum hardware bin size:

2^{24}-1 (16,777,215).

Maximum number of measurements*:

2 x 10^9, 1 x 10^{12}, or 2 x 10^{15}, depending on measurement configuration.

Maximum number of blocks*:

1 to 99,999,999.

Maximum number of measurements per block*:

1, 32,750, 65,500, or 2 x 10^9 depending on measurement configuration.

Bin widths:

200 ps to 1.6777216 ms [51.2 ns], in binary steps (i.e. 200 ps, 400 ps, 800 ps...) or 2 ns to 1.048576 ms [64 ns], in binary steps (i.e. 2 ns, 4 ns, 8ns . . .).

Span:

Span = 2000 x Bin Width, or 400 ns to 3.3554432 s [128 μs].

Maximum Histogram limits:

Histogram ± Time Interval:

- 4.0 s [-65 μs] to + 4.0 s [+65 μs].

Histogram Continuous Time Interval or Time Interval:

0 to + 8.0 s [+ 131 μs].

Note that the hardware Histogram's lower and upper limits are determined by setting a combination of parameters - Start and Bin Width, or Center and Span. These parameters are interrelated.

* For further details refer to HP 5372A Operating Manual (HP P/N 05372-90001).

Measurement Control

The HP 5372A features extensive arming and triggering capabilities. They fall into two main categories - Holdoff and Sample. One or both can be specified for a given measurement. If only one is specified, the unspecified parameter will default to Automatic (arm as soon as possible or sample as fast as possible).

For continuous measurements, Holdoff allows you to control the start of each block of measurements and Sampling allows you to control how often the measurements are taken within each block. For non-continuous measurements, Holdoff allows you to control the start of each measurement (Start Arm) and Sample allows you to control the stop of each measurement (Stop Arm). Consequently, we will discuss the HP 5372A arming modes in two groups - continuous measurement and non-continuous measurement. The available Holdoff and Sample arming options are measurement dependent and summarized in Table 1 (on the inside rear cover).

Although the specified Holdoff and Sample arming is not affected, there are two specific cases when the analyzer stores measurement data on a selected basis: 1) when block Pre-trigger is enabled, or 2) when Inhibit is enabled. Pre-trigger and Inhibit will be discussed separately as exceptions at the end of this section.

As discussed in the Measurement Modes section, the HP 5372A offers two measurement modes - Normal and Fast. The selection of measurement mode does not affect the availability of arming options; however, some parameters related to a specific arming selection may be affected. In this section, the changes are indicated. If there are differences in the two modes, **parameters pertaining to the Fast mode will be contained in brackets [ ].**

Continuous Measurement Arming Modes

Holdoff Arming

The start of a block can be armed automatically on a signal edge on the measurement channel, or armed one of three different ways relative to a reference edge. Channel A, Channel B or External Arm may be selected as the source of the reference edge. Although the External Arm channel (100 MHz bandwidth) is generally used, Channel A and Channel B offer higher performance (500 MHz bandwidth & shorter setup times). If a reference edge is used to arm the block, the time from the reference edge to the first measurement in the block is recorded for some measurement functions. They are Frequency or Period on a single channel, Continuous Time Interval, Phase Deviation, and Time Deviation.

Automatic (no Holdoff specified)

Using Automatic arming, the HP 5372A arms the block as soon as it is ready to take a measurement. This arming mode configures the HP 5372A to arm as fast as possible for a given measurement function.

Edge

Using Edge Holdoff, the start of the block can be armed from a reference edge on Channel A, Channel B, or External Arm. The slope and source of this edge is specified on the **Function** menu, while the trigger voltage is specified on the **Input** menu.

Setup Time:

External Arm arms Channel A or B: <15 ns
Channel B arms Channel A: <8 ns
Channel A arms Channel B: <8 ns
Channel A arms Channel A: <5 ns
Channel B arms Channel B: <5 ns

Time (after an edge)

Time Holdoff is similar to Edge Holdoff, but the block can be armed to start a specified time after the reference edge on Channel A, Channel B, or External Arm. The slope and source of the reference edge is specified on the **Function** menu, while the trigger voltage is specified on the **Input** menu.

Range:
2 ns to 8.0 s [131 µs].

Resolution:
2 ns.

Setup time:
< 25 ns after the specified time has elapsed.

Event (after an edge)

Event Holdoff is similar to Edge Holdoff, but the block can be armed to start after a specified number of events on Channel A or Channel B after a reference edge on Channel A, Channel B, or External Arm. The source and slope of the events and reference edge are specified on the **Function** menu, while the trigger voltages are specified on the **Input** menu.

Range:

0 to 4 x 10^9 [65,000]. If 0 is specified, the block Holdoff defaults to Edge Holdoff.

Resolution:

± 1 count of input signal.

Setup time:

< 25 ns after completion of event countdown.

Sample Arming

The rate at which measurements are taken within a block can be controlled in numerous ways. In all cases, the Sample arming only controls the measurement after the Holdoff arming condition is satisfied.

Automatic

Using Automatic for Sample arming, the HP 5372A takes a measurement as soon as it is ready. This arming mode configures the HP 5372A to take measurements as fast as possible for a given measurement function.

Range:

Continuous measurements - single-channel Frequency or Period (except when using Externally Gated arming), Phase Deviation, Time Deviation, Histogram Continuous Time Interval and Continuous Time Interval:

100 ns [75 ns] to 8.0 s [131 μs].

Non-continuous measurements and those continuous measurements not mentioned above:

200 ns [135 ns] to 8.0 s [131 μs].

Interval

Using Interval sampling, the start of each measurement (and often the stop of the previous measurement) within the block is armed to begin at a specified interval. This allows you to control the rate at which measurements are taken within a block, based on intervals of time. The sample interval is specified on the **Function** Menu.

Range:

± Time Interval and Histogram ± Time Interval:
100 ns to 4.0 s [65 μs].

Otherwise:

100 ns to 8.0 s [131 μs].

Resolution:

100 ns.

Note that this refers to the "settability" of the sample interval. Since the HP 5372A uses a reciprocal counting technique which synchronizes measurements to the input signal, the actual rate will vary depending on this synchronization. Actual measurement intervals can be displayed with 200 ps LSD.

Setup Delay:

The first interval will begin < 200 ns after the block becomes armed.

Cycle

Using Cycle sampling, the start of each measurement (and the stop of the previous measurement) within the block is armed to begin after a specified number of events on Channel A, Channel B or the internal 500 MHz timebase. This allows you to control the rate at which measurements are taken within a block, based on number of input events.

Cycle sampling on an input channel essentially offers a continuous Event sampling mode (similar to those described in the non-continuous arming modes). Cycle sampling using the HP 5372A's internal 500 MHz timebase offers a high precision continuous time sampling mode (similar to those described in the non-continuous arming modes). The number of events is specified on the **Function** menu.

Range:

2^4, 2^8, 2^{12}, 2^{16}, 2^{20}, 2^{24} or 2^{28} [2^4, 2^8 or 2^{12}]

The 2^4 value is not recommended for input frequencies above 160 MHz [213 MHz] since the prescaled result would exceed the maximum measurement rate of the HP 5372A.

Maximum Time Between Measurements:

8.0 s [131 μs].

Note that using large cycle factors, in combination with low frequencies, may violate this requirement.

Resolution:

2ns, or 1 edge of input.

Edge and Repet(itive) Edge

Using Edge sampling or Repet(itive) Edge sampling, the start of each measurement (and often the stop of the previous measurement) within the block is armed to begin by an edge on Channel A, Channel B or External Arm. This allows you to control the rate at which measurements are taken within a block based on an external signal transition. The source and slope of the edge are specified on the **Function** menu, while the trigger voltages are specified on the **Input** menu.

Maximum Time Between Measurements:

± Time Interval or Histogram ± Time Interval: 4.0 s [65 μs]

All other measurements: 8.0 s [131 μs].

Setup Time:

External Arm arms Channel A or B: <15 ns
Channel B arms Channel A: <8 ns
Channel A arms Channel B: <8 ns
Channel A arms Channel A: <5 ns
Channel B arms Channel B: <5 ns

Parity

Using Parity sampling, the start of each measurement is armed only after a signal edge has been detected on both Channel A and Channel B. This mode is useful when measuring time intervals between edges that lead and follow one another randomly.

Frequency Range:

± Time Interval or Histogram ± Time Interval:
250 MHz [16 kHz] to 100 MHz.

All other measurements: 125 MHz [8 kHz] to 100 MHz.

Repet(itive) Edge-Parity

Using Repet(itive) Edge-Parity sampling allows you to combine the benefits of both Edge sampling and Parity sampling. Both the Edge sampling condition and the Parity sampling condition must be satisfied.

Random

Using Random sampling, the start of each measurement is armed by a number of input events on channel A. The number of events is pseudo-randomly selected from six to seventeen. This sampling mode helps prevent sampling sychronously with the modulation effect to be studied. This is useful for signals exceeding the measurement rate of the HP 5372A. For signals below the analyzer's measurement rate, this sampling mode provides no benefit since every event can be captured.

Maximum Input Frequency:

100 MHz.

Minimum Pulse Width:

5 ns.

Random Sampling extends total measurement time due the pseudo-random sequence used to acquire data.

Holdoff/Sample Arming

Holdoff/Sample arming modes combine the benefits of Holdoff arming and Sample arming modes described previously. The naming convention is as follows: the first word describes the type of holdoff while the second word describes the type of sampling. The following combinations are available:

Edge/Interval

Edge/Edge

Edge/Cycle

Edge/Parity

Edge/Random

Time(after an edge)/Interval

Event(after an edge)/Interval

Additionally, the HP 5372A provides one more Holdoff/Sample arming mode:

Externally Gated

Using Externally Gated, the start of the block is automatically armed. The start and stop of each measurement within the block are armed by the leading and trailing edge of a positive or negative pulse on Channel A, Channel B or External Arm. The source of the pulse and the slope of the leading edge are specified on the **Function** menu, while the trigger voltage is specified on the **Input** menu.

Gate Width Range:

± Time Interval or Histogram ± Time Interval: 10 ns to 4.0 s [65 μs].

All other measurements: 10 ns to 8.0 s [131 μs].

Setup Delay:

30 ns.

Amplitude:

The gating signal must meet specifications for the input channel. When using the External Gate mode with the Totalize function, the maximum repetition rate of the external gating signal is 2.5 MHz. Otherwise, the maximum repetition rate is 5.0 MHz [7.4 MHz].

Non-continuous Measurement Arming Modes

The block size for non-continuous modes is set to one measurement. Consequently, Holdoff (Start Arm) and Sample (Stop Arm) arming control the start and stop of each measurement, respectively.

MEASUREMENT CONTROL

Sample Arming

When Sample arming is selected for non-continuous measurements the start of each measurement is automatically armed as soon as the HP 5372A is ready to take a measurement.

Time

Using Time Sampling, the stop of each measurement can be armed a specified time after the start of the measurement. This time can be specified on the **Function** menu.

Range:
2 ns to 8.0 s [131 μs].

Resolution:
2 ns.

Setup time:
< 25 ns after the specified time has elapsed.

Holdoff/Sample Arming

Edge/Time (after an edge)

Using Edge/Time arming, the start of each measurement is armed using a reference edge and the stop of the measurement is armed by a time following the reference edge. Channel A, Channel B or External Arm may be selected as the source of the reference edge. The slope and source of this edge are specified on the **Function** menu, while the trigger voltage for the reference edge is specified on the **Input** menu.

Holdoff Setup time:
<25 ns.

Sample Range:
2 ns to 8.0 s [131 μs].

Sample Resolution:
2 ns.

Sample Setup time:
< 25 ns after the specified time has elapsed.

Edge/Event (after an edge)

Using Edge/Event arming, the start of each measurement is armed using a reference edge and the stop of the measurement is armed by a number of events following the reference edge. Channel A, Channel B or External Arm may be selected as the source of the reference edge. The slope and source of this edge are specified on the **Function** menu, while the trigger voltage for the reference edge is specified on the **Input** menu. Channel A or Channel B can be selected as the source of the events. The source and number of events is specified on the **Function** menu, while the slope and trigger voltage for the events are specified on the **Input** menu.

Holdoff Setup time:

<25 ns.

Sample Range:

± Time Interval or Histogram ± Time Interval:

0 to 2 x 10^9 [32,500].

Otherwise:

0 to 4 x 10^9 [65,000].

Sample Resolution:

± 1 count of input signal.

Sample Setup time:

< 25 ns upon completion of event countdown.

Event (after an edge)/Event (after the same edge)

Using Event/Event arming, the start and stop of each measurement can be armed on a specified number of events following a reference edge. Channel A, Channel B, or External Arm may be selected as the source of the reference edge. The slope and source of the reference edge can be specified on the **Function** menu, while the trigger voltage of the reference edge is specified on the **Input** menu. Channel A and/or Channel B can be selected as the sources for the events. The source and number of events for start and stop arming is specified on the **Function** menu, while the slope and trigger voltage for the events is specified on the **Input** menu.

Holdoff and Sample Range:

0 to 4 x 10^9 [65,000].

Note that the time difference between start and stop of the measurement can be no larger than 4.0 s [65μs].

Holdoff and Sample Resolution:

± 1 count of input signal.

Holdoff and Sample Setup time:

< 25 ns upon completion of event countdown.

Time (after an edge)/Time (after an edge)

Using Time/Time arming, the start and stop of each measurement can be armed a specified time after a reference edge on Channel A, Channel B, or External Arm. The slope and source of the reference edge can be specified on the **Function** menu, while the trigger voltage is specified on the **Input** menu. The delay times for arming the start and stop are specified on the **Function** menu.

Holdoff and Sample Range:

2 ns to 8.0 s [131 μs].

Note that the time difference between start and stop of the measurement can be no larger than 4 s [65 μs].

Holdoff and Sample Resolution:

2 ns.

Holdoff and Sample Setup time:

< 25 ns after the specified time has elapsed.

Manual

Using Manual arming, the start and stop of the measurement are armed alternately by pressing the Manual Arm key. In this arming mode, the number of blocks and number of measurements within a block are set to one.

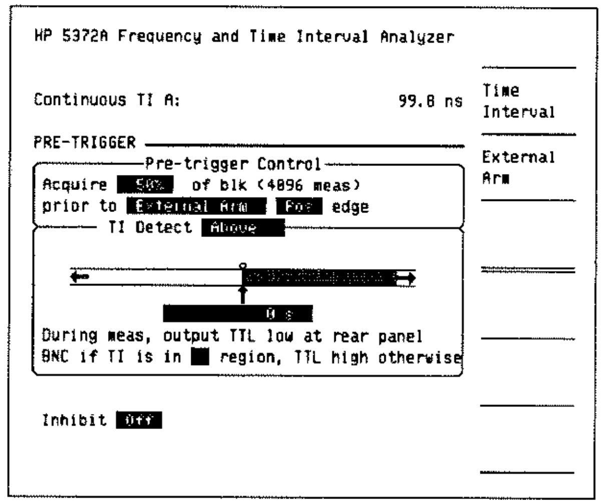
Pre-trigger

The HP 5372A offers the ability to pre-trigger blocks of measurements. Availability of Pre-trigger is measurement function related and arming related. Pre-trigger is available for the following measurement functions when making continuous measurements (refer to Table 1 on inside rear cover):

Frequency
Period
Totalize
Time Interval
± Time Interval
Continuous Time Interval

Histogram Time Interval, Histogram ± Time Interval, and Histogram Continuous Time Interval also have limited Pre-trigger capability. They will be addressed at the end of this Pre-trigger discussion.

By enabling Pre-trigger on the **Function** menu, the measurements leading up to, surrounding, or after the Pre-trigger condition can easily be examined. The Pre-trigger condition is specified on the **Pre-trigger** menu.

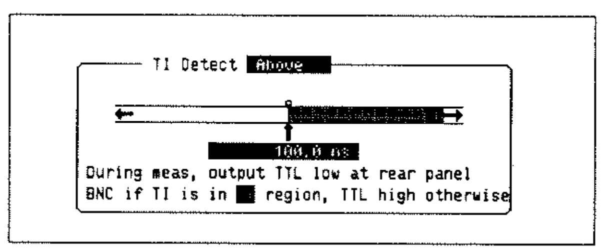


The Pre-trigger capability simplifies data capture.

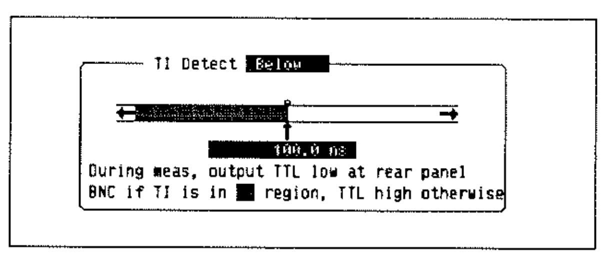
A block of measurements can be pre-triggered on a signal applied to the External Arm input, or by a measured time interval using the Time Interval Detect feature. The amount of Pre-trigger can be specified by a number of measurements, or a percentage of the measurements within a block. For example, a Pre-trigger amount of 10% would indicate that 90% of the measurements in the block will be taken after the Pre-trigger event. The amount of Pre-trigger is specified on the **Pre-trigger** menu.

As mentioned above, Time Interval Detect can be used to Pre-trigger a block of measurements. This capability is only available when making time interval measurements. These include Time Interval, ± Time Interval, Continuous Time Interval, Histogram Time Interval, Histogram ± Time Interval, and Histogram Continuous Time Interval. Time Interval Detect can provide a Pre-trigger event based on one of four conditions:

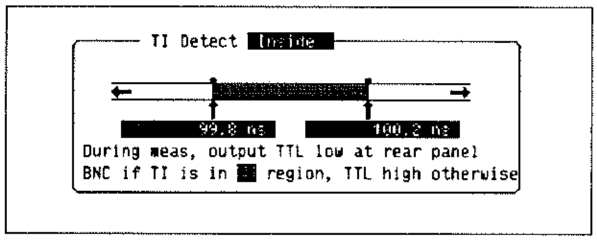
1) Measured time interval is above a specified threshold



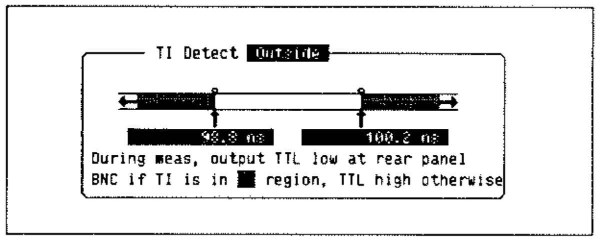
2) Measured time interval is below a specified threshold



3) Measured time interval is inside a region (inclusive of threshold values) specified by two thresholds



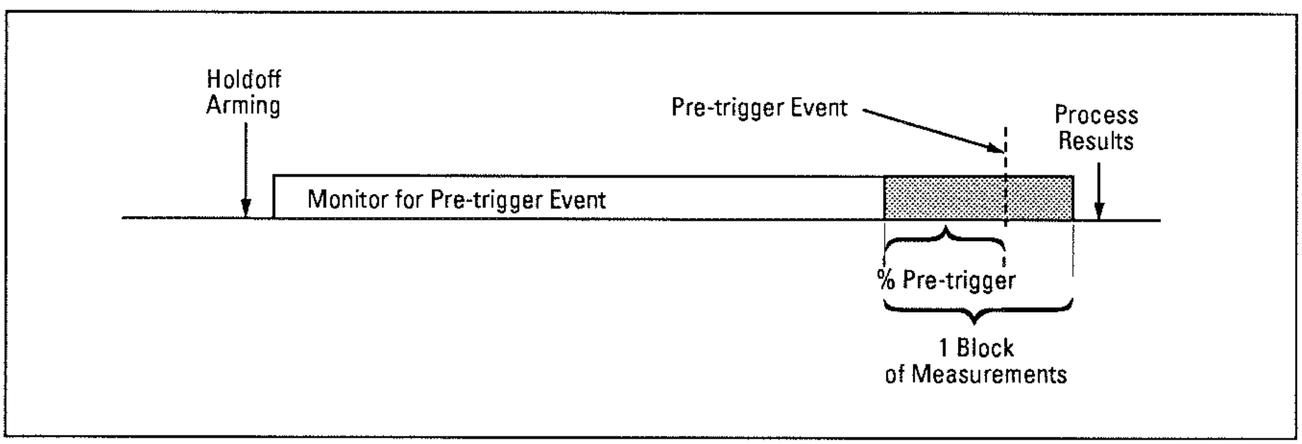
4) Measured time interval is outside of a region specified by two thresholds



In addition to supplying the Pre-trigger event to the internal hardware of the HP 5372A, a Time Interval Detect output is provided on the rear panel (refer to Rear Panel Connectors section). Using Time Interval Detect, limit testing on time interval measurements is easily done since Time Interval Detect is available even when Pre-trigger is not being used.

The slope of the external arm signal used for pre-trigger can be specified on the **Pre-trigger** menu, while the voltage threshold is specified on the **Input** menu. If Time Interval Detect is utilized, the time thresholds are specified on the **Pre-trigger** menu.

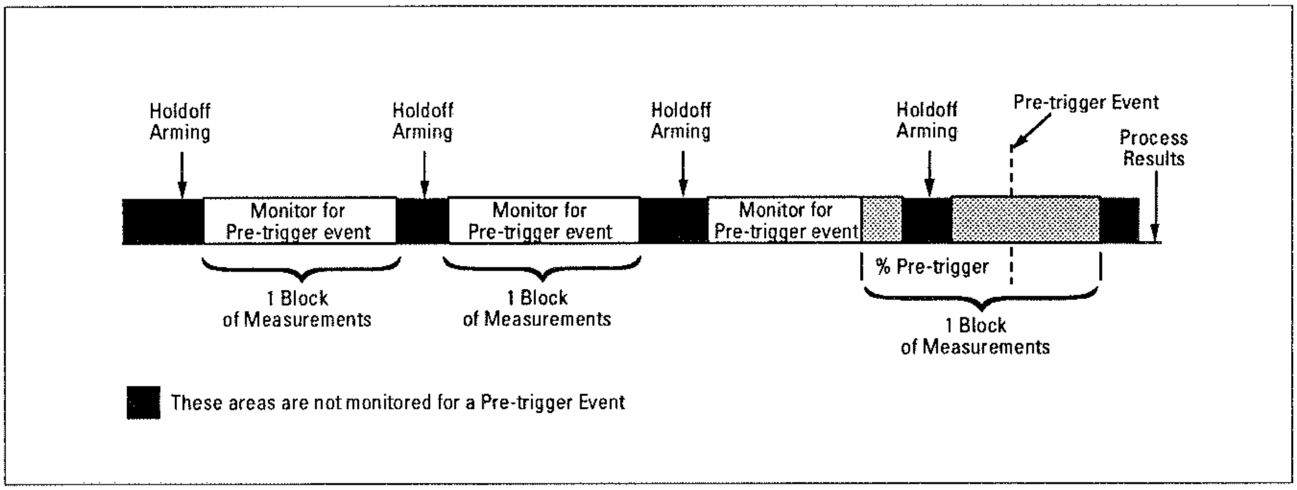
It should be noted that the use of Pre-trigger modifies which measurements are retrieved from analyzer memory. For a single block of measurements, the block arming determines when the HP 5372A begins monitoring measurements and sample arming determines how the measurements will be taken.



For a single block, continuous monitoring of measurement results occurs until the Pre-trigger condition is satisfied.

When the Pre-trigger condition is satisfied, the acquisition will be terminated with the proper number of measurements following the Pre-trigger event. Based on the block size and amount of Pre-trigger, only the measurements surrounding the Pre-trigger event are retrieved from analyzer memory.

For multiple blocks of measurements, the HP 5372A begins monitoring blocks of measurements and awaiting the Pre-trigger event.



Multiple blocks of measurements are monitored until Pre-trigger event occurs.

When this occurs, the acquisition will be completed with the proper number of measurements following the Pre-trigger event. Memory Segmentation is utilized when pre-triggering occurs such that the acquired data spans multiple blocks (refer to Memory Section). Based on the block size and amount of Pre-trigger, only the measurements surrounding the Pre-trigger event are retrieved from analyzer memory.

Range:

0 to 100%, selectable in 1% steps, or
0 to the number of measurements per block

Setup time

External Arm: < 50 ns
Time Interval Detect: < 600 ns

Pre-trigger Accuracy:

± 2 measurements

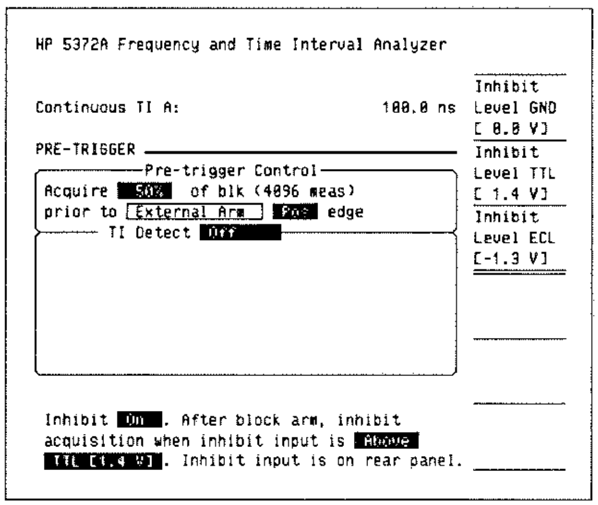
As mentioned above, Histogram Time Interval, Histogram ± Time Interval, and Histogram Continuous Time Interval also have Pre-trigger capability. The Pre-trigger condition can be either an external edge or a measured time interval. If Time Interval Detect is used for the Pre-trigger condition, the allowable time thresholds are the upper and lower bounds of the Histogram. For these measurement functions, the occurance of the Pre-trigger condition terminates acquistion (i.e. 100 % Pre-trigger).

Inhibit

The HP 5372A provides the ability to selectively suppress storage of measurement data. By enabling Inhibit on the **Pre-trigger** menu, the HP 5372A can be prevented from storing a measurement. This is controlled by an external signal applied to the Inhibit input on the rear panel of the analyzer (refer to Rear Panel Connectors section for electrical specifications).

Inhibit is available for the following measurements when making continuous measurements (Refer to Table 1 on inside rear cover):

Frequency
Period
Totalize
Time Interval
± Time Interval
Continuous Time Interval
Histogram Time Interval
Histogram ± Time Interval
Histogram Continuous Time Interval.



Measurement control on-the-fly is provided by the HP 5372A Inhibit capability.

The voltage threshold and the inhibit signal's polarity can be specified on the **Pre-trigger** menu. The voltage threshold can be set to GND (0 Volts), TTL (1.4 Volts), or ECL (-1.3 Volts).

When Inhibit is asserted, no new measurements will be taken until Inhibit is de-asserted. If a measurement is in progress and Inhibit is asserted when the measurement should end, the analyzer will respond in one of two ways depending on measurement function and arming mode. If a Time Interval, Histogram Time Interval, ± Time Interval, Histogram ± Time Interval, Histogram Continuous Time Interval or an Externally Gated measurement is being made, the analyzer will discard the measurement under progress and wait until Inhibit is de-asserted to begin a new measurement. If the measurement under progress is a Continuous Time Interval, Frequency, Period or Totalize measurement, the analyzer will extend the measurement - terminating it on the first input event following the de-assertion of Inhibit.

Inhibit does not affect the specified arming. Blocks and samples are armed normally with Inhibit asserted. Pre-trigger capabilities using the external arm input will be unaffected by the Inhibit signal but no further measurements will be taken until Inhibit is de-asserted. Time Interval Detect is disabled when Inhibit is asserted; consequently, Pre-triggering based on Time Interval Detect will only occur when Inhibit is de-asserted. Time Interval Detect will not be performed on measurements extended by Inhibit.

Analyzer Memory

The HP 5372A stores measurements in an internal memory. The number of measurements it can store is dependent on the measurement mode and arming mode used. Table 1 (located on the inside rear cover) summarizes the measurement modes and arming modes available on the analyzer. This may be a useful reference. Listed below are the maximum number of measurements that can be taken per block.

8191 Measurements (8190 if Edge, Time or Event Holdoff is used):

- Single-channel Frequency or Period (except when Externally Gated or non-continuous arming modes are used)
- Phase Deviation
- Time Deviation
- Continuous Time Interval

4096 Measurements:

- Single-channel Frequency (when using Externally Gated Arming)
- ± Time Interval (except when using non-continuous arming modes)
- Time Interval
- Rise/Fall Time
- Positive/Negative Pulse Width

4095 Measurements:

- Dual-channel Frequency or Period
- Dual-channel Phase
- Duty Cycle
- Totalize (except when using Externally Gated Arming or Manual Arming)

2048 Measurements:

- Totalize (when using Externally Gated Arming)

1 Measurement

- All measurements made with non-continuous arming modes

For applications requiring greater memory, Option 020 FastPort should be considered. Refer to the Rear Panel Connectors section for additional information.

Memory Segmentation

Generally, the HP 5372A will clear the internal memory before acquiring a new block of measurements. Consequently, only the last block of data can be reviewed and graphically analyzed. However, if the total number of measurements in a multi-block acquisition can be stored in memory, the HP 5372A will automatically store all the measurements. In this case, all the measurements are available for review and analysis. When memory segmentation is used, the Re-arm time between blocks is minimized.

Re-arm Time:

The time between blocks is minimized when memory segmentation is used. From the last measurement in the block, there is a delay of $< 2\ \mu s$. Following the delay, the next block may be armed as soon as its Holdoff arming condition is satisfied.

Input

Channel A and B

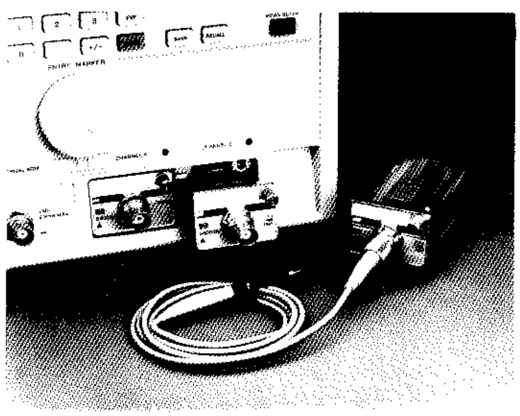
All input signals refer to sinusoidal signals, except where noted.

Input Pods

The following refers to pods installed in an HP 5372A system.

	HP 54002A	**HP 54001A**	**HP 54003A** with 10:1 probe	**HP 54003A** without 10:1 probe
Coupling	dc	dc	dc	dc
Input Capacitance	N/A	2 pf	8 pf	10 pf
Input Resistance	50 Ω	10 kΩ	1 MΩ	1 MΩ
Bandwidth (-3dB)	**dc to 500MHz**	**dc to 500MHz**	**dc to 300MHz**	**dc to 300MHz**
Maximum Input Voltage x1: x2.5:	 **±2V** **±5V**	 **±20V** N/A	 **±20V** N/A	 **±2V** N/A

INPUT



The HP 5372A provides flexibility through a choice of three input pods: HP 54001A 10 K Ω active pod/probe, HP 54002A 50 Ω pod (standard), and HP 54003A 1 M Ω pod.

The following specifications refer to an HP 5372A with HP 54002A pods installed. For all other input pods, refer to Appendix B.

Range:

dc coupled to 500 MHz.

Sensitivity (X1 Attenuation, Minimum Hysteresis):

15 mV rms sine wave (45 mV_{pk-pk}).
45 mV_{pk-pk} for a minimum pulse width.

Minimum Pulse Width:

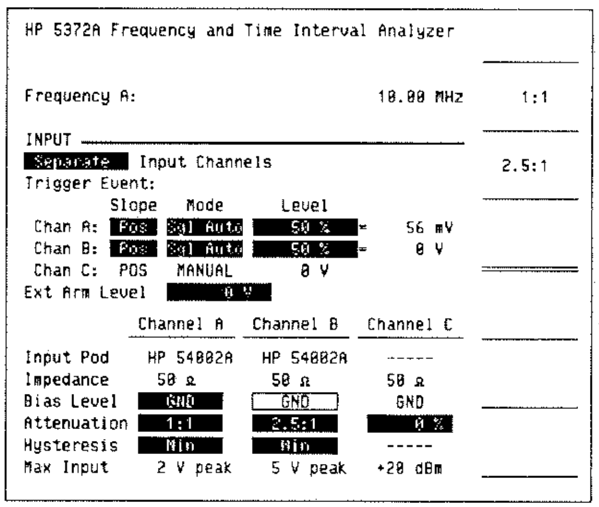
For all measurement modes except Holdoff Arming: **1 ns** (at a minimum amplitude).

Holdoff Arming modes: **1.5 ns** (at a minimum amplitude).

Attenuator:

X1 or X2.5, selectable, for termination (Bias Level) to ground.
X1 only for termination (Bias Level) to -2 Vdc.

Note that X2.5 attenuation and -2 Vdc termination are only available for the 50 Ω pods.



The HP 5372A features 1:1 and 2.5:1 attenuation choices for the HP 54002A 50 Ω pod.

Attenuator Accuracy:

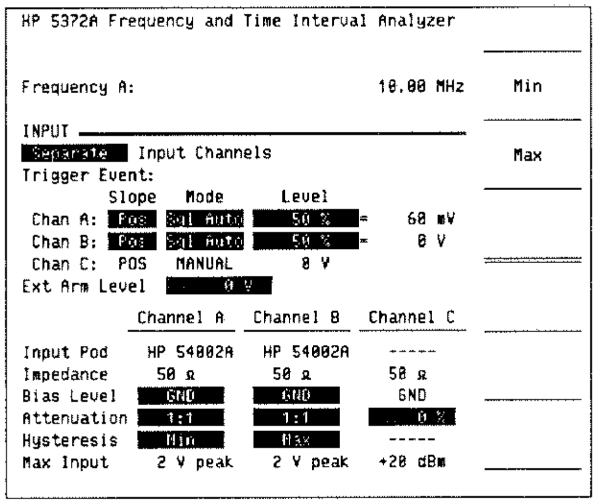
X1: Direct connection.

X2.5: ± 5 %.

Hysteresis:

Minimum or Maximum, selectable.

Minimum Hysteresis configures the HP 5372A input circuitry to be as sensitive as possible. Maximum Hysteresis increases the minimum signal amplitude to trigger the HP 5372A by a factor of two (nominal), providing additional noise immunity. Note the sensitivity of the HP 5372A, with Hysteresis set to Minimum, is commonly much better than the sensitivity specified.

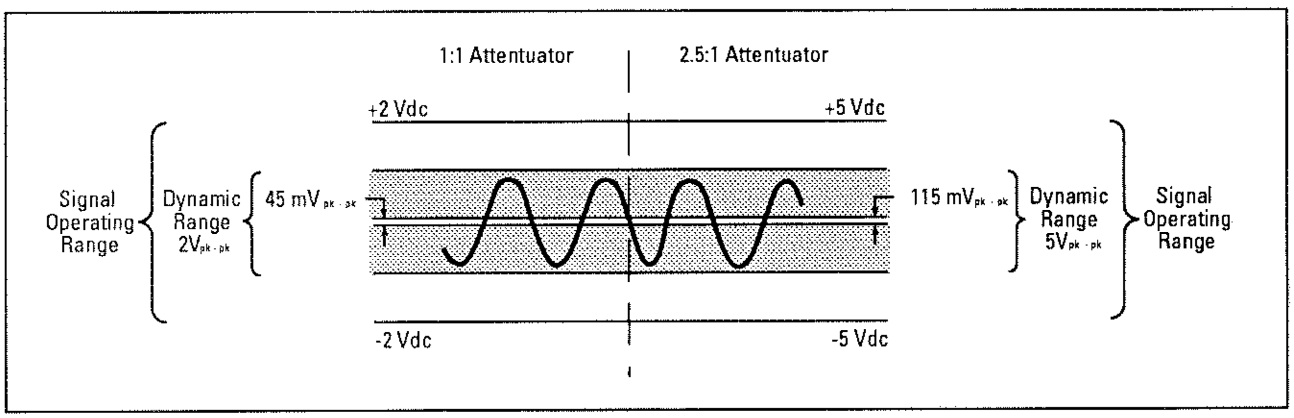


Hysteresis provides noise rejection at a touch of a button to prevent erroneous measurements.

Dynamic Range:

X1: **45 mV$_{pk\text{-}pk}$ to 2 V$_{pk\text{-}pk}$.**

X2.5: 115 mV$_{pk\text{-}pk}$ to 5 V$_{pk\text{-}pk}$.



The input signal amplitude peaks must be within the shaded region of the diagram to match the dynamic range of the HP 5372A. The dynamic range "window" can be positioned anywhere within the limits of the signal operating range.

Signal Operating Range:

X1: **-2 Vdc < dc ± ac pk < +2 Vdc.**

X2.5: -5 Vdc < dc ± ac pk < +5 Vdc.

Damage Level:

X1: **±2.5 V (dc ± ac pk).**

X2.5: **±5.5 V (dc ± ac pk).**

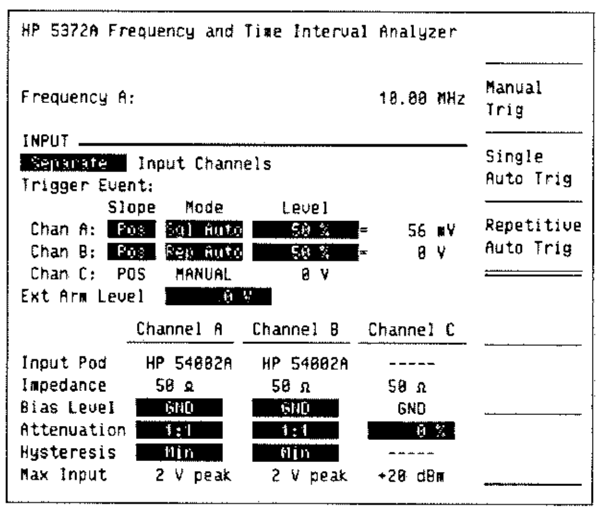
Input Triggering Characteristics

	Manual Triggering	Auto Triggering (Single or Repetitive)
Voltage Range:		
X1:	**-2 Vdc to +2 Vdc**	**-2 Vdc to +2 Vdc**
X2.5:	**-5 Vdc to +5 Vdc**	**-5 Vdc to +5 Vdc**
Frequency Range:	**dc to 500 MHz**	**1 kHz to 200 MHz***
Resolution:		
X1:	2 mV	1% steps (2 mV minimum)
X2.5:	5 mV	1% steps (5 mV minimum)
Accuracy:	**20 mV ± 1% of setting**	**±20% of $_{pk-pk}$ amplitude (200 mV$_{pk-pk}$ minimum)**

* For input frequencies greater than 200 MHz, auto trigger modes are functional, but accuracy specifications are not warranted.

Auto trigger modes require a repetitive input signal and are available for input channels A and B.

Auto Trigger Modes

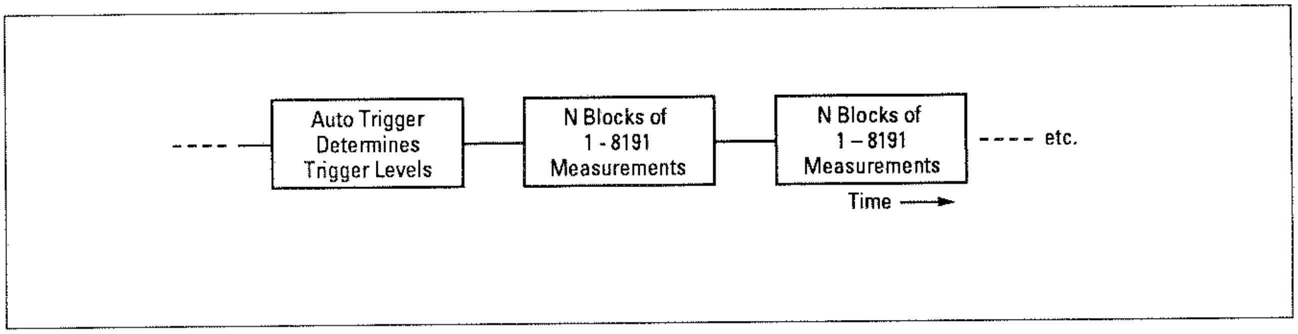


Auto Trigger provides triggering ease on most input signals

Single Auto Trigger Mode:

The HP 5372A determines voltage trigger levels automatically at the beginning of the first block of measurements. These trigger levels are maintained until a parameter is changed or restart is pressed to initiate a new aquisition.

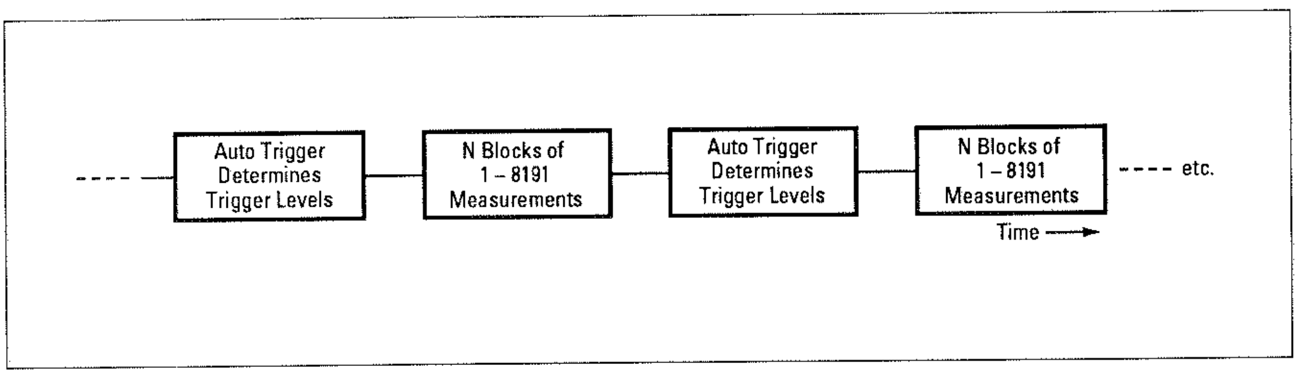
The following sequence occurs when acquiring blocks using Single Auto Trigger.



Repetitive Auto Trigger Mode:

The HP 5372A determines voltage trigger levels automatically at the beginning of the first block of each set of measurements. These trigger levels are maintained for subsequent blocks within that set of measurements. For example, in a multi-block acquisition the voltage trigger levels would be determined prior to the first block of every multi-block acquisition.

The following sequence occurs when acquiring blocks using Repetitive Auto Trigger.



Auto Trigger Aquisition Time:

100 ms per channel, 200 ms for two-channel measurements. Auto triggering will only be performed for channels which are currently selected as measurement and arming sources on the **Function** menu.

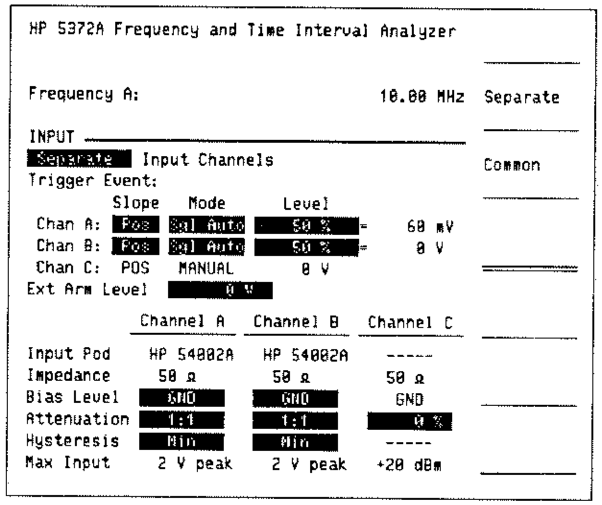
Triggering Indicator:

An LED for each respective input: A, B, and External Arm, will flash when a signal is triggering the input circuitry. The LED will not flash if the signal does not cross the trigger threshold except during power up or self test.

Trigger Level Drift:

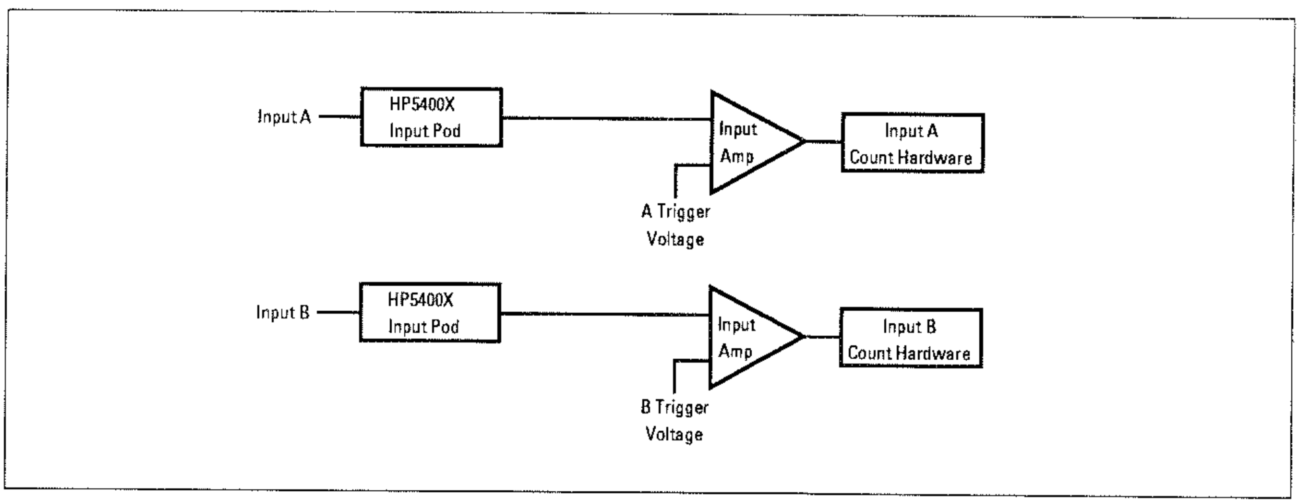
Full Range: < ± 10 mV.
Limited Range (25° C ± 2° C): < ± 2 mV.

Input Mode Selection:



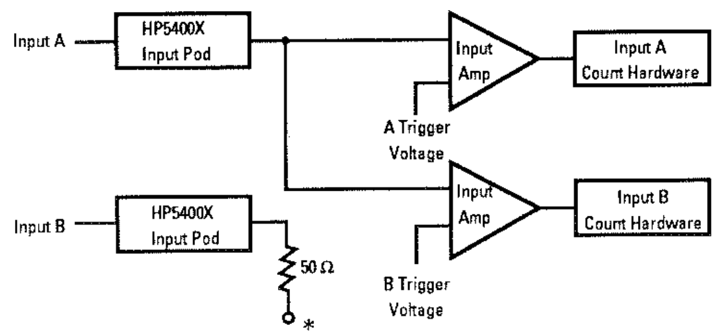
Measurement integrity is assured with a buffered common mode that maintains circuit-under-test impedance.

Separate: User-selectable. Each input channel A and B is connected directly to its respective input circuitry.



HP 5372A Separate mode input configuration.

Common A: User-selectable. Channel A signals are routed internally to both the channel A and B count circuitry. Channel B is terminated per the **Input** menu selection. Termination characteristics are maintained to the device under test, while signal amplitude is maintained to both input channels.



* Configuration is maintained from Separate mode. For example, if the HP 54002A pod is used with -2V termination and 1:1 attenuation, this configuration will be maintained for Common mode.

HP 5372A Common mode connects Channel A to Channel B internally.

External Arm

In addition to the External Arm input, both input channels A and B may also be used as high performance arming inputs.

Range:
dc coupled to 100 MHz.

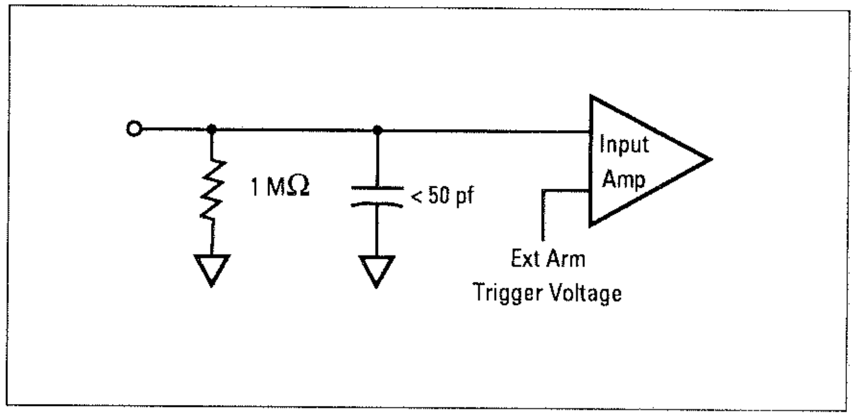
Sensitivity:
50 mV rms sine wave.

140 mV$_{pk\text{-}pk}$ at a minimum pulse width.

Minimum Pulse Width:
5 ns at a minimum amplitude.

Impedance:
1 M Ω, shunted by < 50 pf.

INPUT



The HP 5372A External Arm input is a fixed 1 M Ω impedance.

Dynamic Range:

140 $mV_{pk\text{-}pk}$ to 5 $V_{pk\text{-}pk}$.

Signal Operating Range:

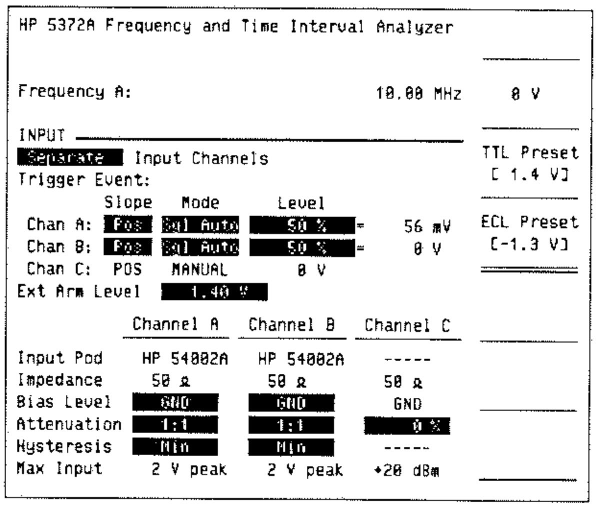
-5 Vdc < dc ± ac pk < + 5 Vdc.

Damage Level:

5 V rms (± 15 $V_{pk\text{-}pk}$, dc ± peak ac).

Trigger Level Range:

Adjustable from -5.00 Vdc to +5.00 Vdc in 20 mV steps.



The full capability of the External Arm can be realized through a complete range of trigger level adjustability.

Trigger Level Resolution:

20 mV.

Trigger Level Accuracy:

±20 mV or ± 10% of trigger level setting, whichever is greater.

Option 030 or Option 090 Channel C

The following applies to the optional high frequency measurement channel included with Option 030 and Option 090.

Range:

100 MHz to 2 GHz.

Sensitivity (0% attenuation):

100 MHz to 1.5 GHz: - 25 dBm.
>1.5 GHz to 2.0 GHz: - 20 dBm.

Dynamic Range (0% attenuation):

100 MHz to 1.5 GHz: - 25 dBm to + 7 dBm.
>1.5 GHz to 2.0 GHz: - 20 dBm to + 7 dBm.

Signal Operating Range:

- 5 Vdc to +5 Vdc.

Damage Level:

AC > +20 dBm.
DC ±5 V.

Trigger Level:

0 volts on a Positive Slope (AC coupled).

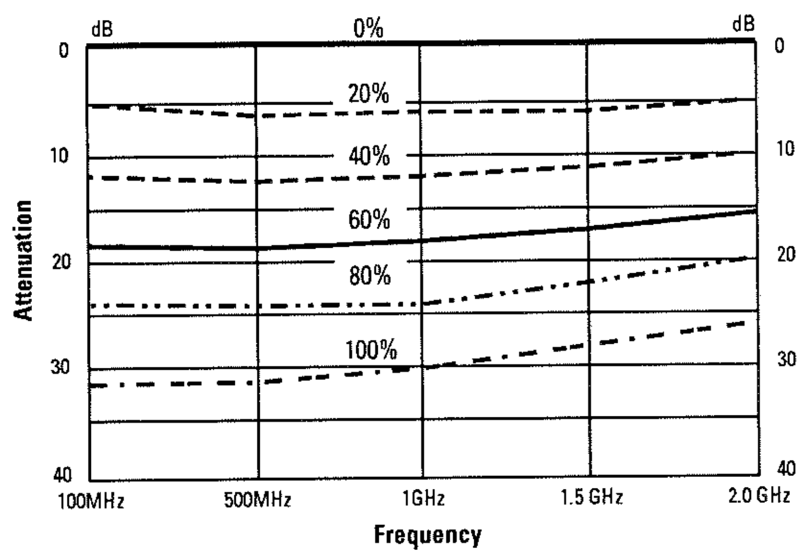
Input Impedance:

AC coupled, 50 Ω, VSWR ≤ 2.5.

Attenuation:

Adjustable from 0 to 100%, selectable in 5% steps, where 100 % is approximately 26 db attenuation.

Shown below is the typical performance of a Channel C at various attenuation selections.



The optional Channel C expands continuous measurements to 2 GHz.

INPUT

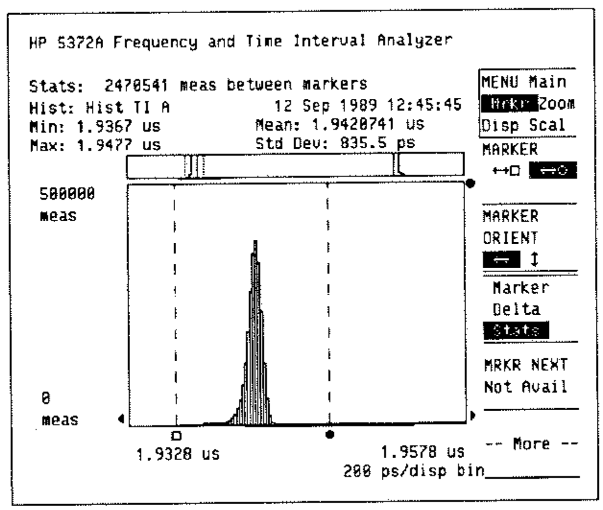
Data Analysis Features

The HP 5372A offers a variety of analysis capabilities. Measurement data can be mathematically manipulated to enhance representation. Powerful graphical displays allow quick analysis of measurement information. Statistical analysis is available for all, or portions of, the measurement data. Limit testing in the analyzer provides direct comparision of measurement data to specified test limits. The availability of these analysis features is measurement dependent.

Histogram

The histogram discussed here is a post-processed analysis of measurement data. This analysis is different than the Histogram measurement functions discussed in the measurement mode section.

Histograms, or probability density distributions, may be displayed for all measurement types. The user may define minimum histogram limit and data bin width, or an auto-scaling feature can be used to scale the data bin values to the measurement results. All histograms have 2000 data bins, which are compressed into 125 display bins when displayed.



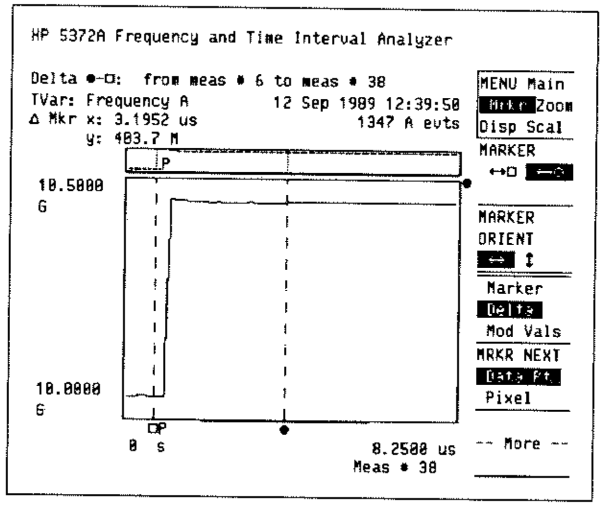
Histograms can be displayed by the HP 5372A. Marker and Zoom features enhance the analysis flexibility of this display.

Linear or logarithmic scaling may be selected for the vertical axis. Measurements are acquired in blocks of up to 8191 measurements. Larger sample sizes may be obtained by specifying multiple blocks of measurements. The histogram may be made to "grow" (accumulate) with each new block of data, or the histogram for each block of measurements may be displayed upon its completion. Individual measurements are retained for the most recent measurement block or all blocks if Memory Segmentation occurs (see Analyzer Memory section).

Individual measurements extended due to Inhibit will not be histogrammed.

Time Variation

The Time Variation Graph displays measurement values versus their time of occurrence. Measurement sizes up to 8191 measurements may be acquired and displayed.



This HP 5372A Time Variation Graph shows how the VCO output frequency varies with time as a voltage step input is applied.

On the Time Variation Graph, all measurements are depicted by a dot. Due to the available resolution of the CRT, the time axis of the display shows up to 125 discrete time bins (horizontal). Consequently, for some displays (especially those displaying more than 125 measurements), not all the measurements may be discretely displayed. In these cases, multiple measurements may appear at the same position in time (in the same time bin). When this occurs, all of the measurements displayed in each discrete time bin are joined with a vertical bar, spanning from the minimum measurement to the maximum measurement. To analyze individual measurements, the zooming features may be used until individual measurements can be displayed or markers may be used to access measurements individually.

Depending on measurement mode, several additional annotations may appear on the Time Variation Graph. They are:

I- Inhibit affected measurement acquisition. Extended measurements are not displayed on the Time Variation Graph. An 'I' will be displayed at the bottom of the graphical display whenever a measurement is extended. If measurements are discarded or not taken due to Inhibit, an 'I' will be displayed above the first measurement following the Inhibit.

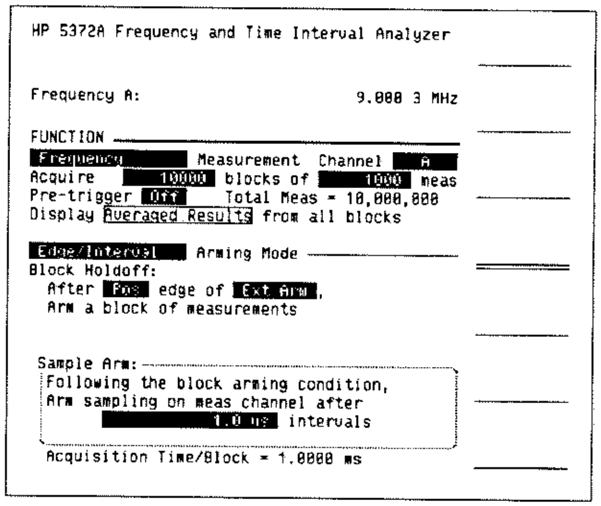
P- Pre-trigger event occurred. A 'P' will appear at the bottom of the graphical display to indicate the time of occurrence of the Pre-trigger event.

E- Indicates the last measurement of the block. This will be seen when Memory Segmentation occurs and the cursor is set on the last measurement of the block. In that case the measurement number will be displayed with an 'E' appended (i.e. Meas #125E).

T- Holdoff edge occurred. This will only be seen on the Time Variation Graph when the time for the Holdoff edge is recorded, Memory Segmentation occurs and all results are displayed. The Holdoff edge for the first block does not appear on the Time Variation graph; however, the time axis is referenced to that point.

Averaging

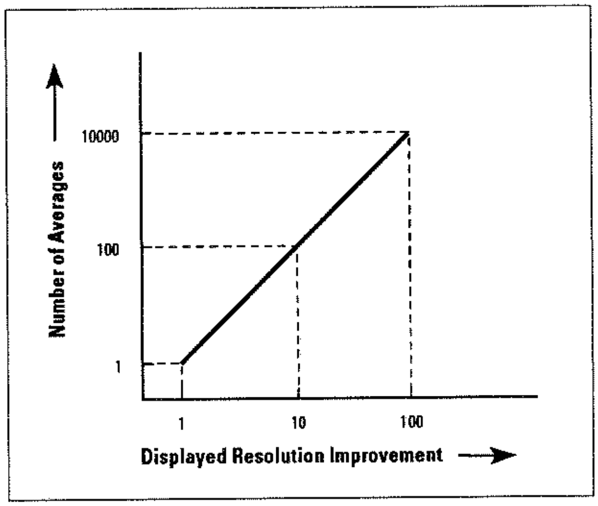
Averaging is provided for those multi-block measurements where the time of the Block Holdoff edge is recorded. When averaging is selected, the Numeric and Time Variation displays use averaged results for display and analysis while the histogram displays all measurements. Averaging is selected if the specified acquistion exceeds the size of the internal memory of the HP 5372A. If Memory Segmentation is used, then display "all results" or "averaged results" is selectable.



Averaging of measurements on the Time Variation Graph provides new insights into signals generally difficult to measure.

Displayed measurement resolution is improved by averaging. Based on the number of blocks averaged, the following shows the displayed resolution improvement. The displayed resolution for the individual measurement functions should be compensated accordingly.

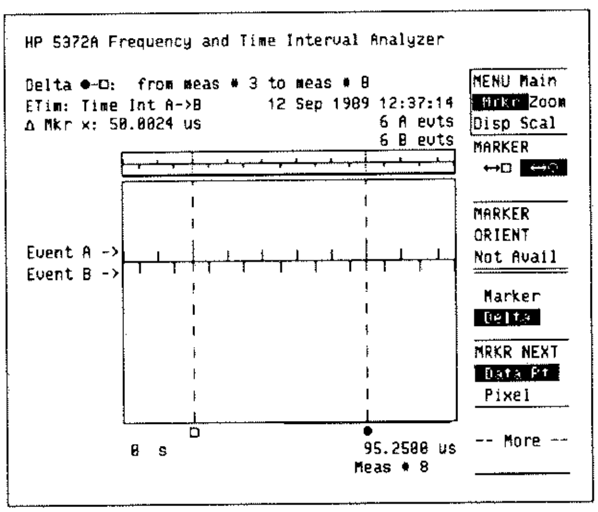
DATA ANALYSIS



Note that averaging is not available with Pre-trigger or Inhibit. When using Phase or Time Deviation, manual carrier must be selected; otherwise averaging is unavailable.

Event Timing

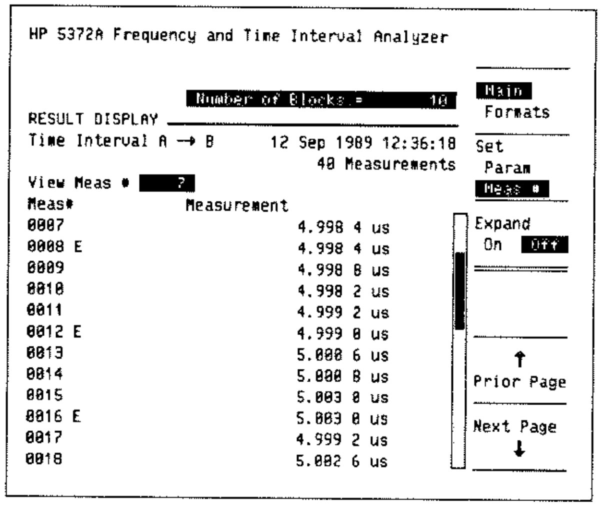
The Event Timing Graph depicts the starting and ending time of each time interval measurement. Start values are denoted with an upward tick mark while stop values are denoted with a downward tick mark. Measurement sizes up to 8191 measurements can be analyzed with this graph.



The Event Timing Graph depicts the power of continuous measurements by giving timing information between any two measurement points.

Numeric Analysis

The **Numeric** menu allows viewing of the actual measurements stored by the analyzer. By scrolling through the numeric results, all stored measurements can be accessed individually.



Viewing numerical results for all measurements is easy using the Numeric display.

In addition to the individual measurements, the following annotations may be seen in the numeric data:

I- Inhibit affected measurement acquisition. The Numeric display will indicate an 'I' whenever a measurement is suppressed or extended by an Inhibit signal.

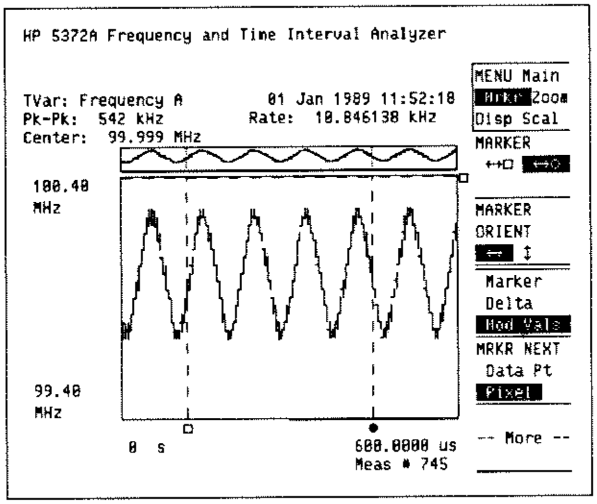
P- Pre-trigger event occurred. A 'P' will appear with the measurement associated with the Pre-trigger event occurs.

E- Indicates the last measurement of the block. This will seen when Memory Segmentation occurs and is shown as an 'E' appended to the measurement number (i.e. Meas #125E).

T- Holdoff edge occurred. This will only be seen when the time for the Holdoff edge is recorded. When it is displayed, a 'T' is shown with an associated time - the time from the Holdoff edge until the first measurement occurs.

Modulation Analysis

The Modulation Analysis feature provides modulation parameters at the touch of a button. Three parameters are provided: 1) Peak to Peak Deviation, 2) Modulation Rate, and 3) Center. They are determined from the measurement data bounded by the ↔□ and ↔● markers on the Time Variation Graph. Modulation Analysis is only available on the Time Variation Graph.



Modulation is easy to characterize using the HP 5372A Modulation Analysis features.

Modulation Analysis results improve with an increasing number of measurements per cycle of modulation.

Window Margin Analysis

For clocked, or synchronous, communication channels, timing jitter can be analyzed using the HP 5372A's histogram analysis features. Computer storage peripherals including magnetic and optical disk, as well as tape may also use timing information to determine margin at a specified error rate. Typically timing data is analyzed using Window Margin Analysis; a plot of log error rate versus half decoding window.

The HP 5372A features computation of window margin from the data acquired with the Histogram Continuous Time Interval or Histogram Time Interval measurement functions. Timing data can be acquired for data-to-data measurement configurations as well as data-to-clock configurations. Histogram distributions are acquired at the measurement rate of the HP 5372A in these modes resulting in potentially large measurement sizes in a relatively short time.

The histogram or probability density function (pdf) is integrated in a single-sided fashion to derive a cumulative probability function, or a plot of log error rate versus half decoding window. Early margin, late margin, and combined margin information are displayed for these plots. For low error rates, such as $1x\ 10^{-10}$, where quantification of error rate performance is impractical (due to time constraints), extrapolation techniques are availible in the HP 5372A to predict available margin from the measured data.

For further information, refer to the HP 5372A Operating Manual (HP P/N 05372-90001).

Statistical Analysis

The following statistical values are available on the Numeric display:

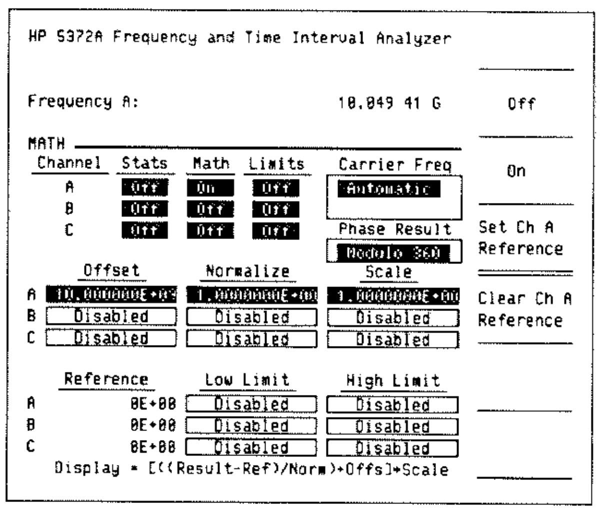
- Mean
- Minimum Value
- Maximum Value
- Variance
- Standard Deviation
- rms (Root Mean Square)
- Allan Variance
- Root Allan Variance (square root of the Allan Variance calculation).

Measurement sample sizes in excess of 800 billion measurements are available (99,999,999 blocks of 8191 measurements). Note that any measurements extended due to Inhibit will not be included for Statistical Analysis. Further, Allan Variance and Root Allan Variance are not available when Inhibit is active.

In addition, statistics on subsets of measurement data can be computed on the Histogram display by using the display markers. These statistics are: Mean, Minimum, Maximum, and Standard Deviation. They are determined by the measurement data bounded by the ←→□ and ←→● markers on the Histogram Graph.

Math:

Computations can be automatically performed on each measurement result in order to scale results to appropriate values. Separate math values are available for input channels A, B and C. Other instrument functions such as Statistics, Limit checking, and Graphics are performed on this processed data. Math values are set and enabled on the **Math** menu.



The HP 5372A Math features allow easy manipulation of measurement results into meaningful answers.

The math functions are applied in the following manner:

$$\text{Math Result} = \left[\frac{\text{Measurement Result - Reference}}{\text{Normalize}} + \text{Offset} \right] \times \text{Scale}$$

Normalize:

Raw measurement results, less the Reference value, are divided by the Normalize value. This value may not be 0.

Negative Range: $-1 \times 10^{12} \leq$ Normalize value $\leq -1 \times 10^{-12}$.

Positive Range: $1 \times 10^{-12} \leq$ Normalize value $\leq 1 \times 10^{12}$.

Resolution: 10 digits, with minimum LSD of 1×10^{-12}.

Default value: 1.

Offset:

The Offset value is added to the Normalized result.

Negative Range: $-1 \times 10^{12} \leq$ Offset value $\leq -1 \times 10^{-12}$.

Positive Range: $1 \times 10^{-12} \leq$ Offset value $\leq 1 \times 10^{12}$, and 0.

Resolution: 10 digits, with minimum LSD of 1×10^{-12}.

Default value: 0.

Scale:

After Normalize and Offset processing, the result is multiplied by the Scale value.

Negative Range: $-1 \times 10^{12} \leq$ Scale value $\leq -1 \times 10^{-12}$.

Positive Range: $1 \times 10^{-12} \leq$ Scale value $\leq 1 \times 10^{12}$, and 0.

Resolution: 10 digits, with minimum LSD of 1×10^{-12}.

Default value: 1.

Reference:

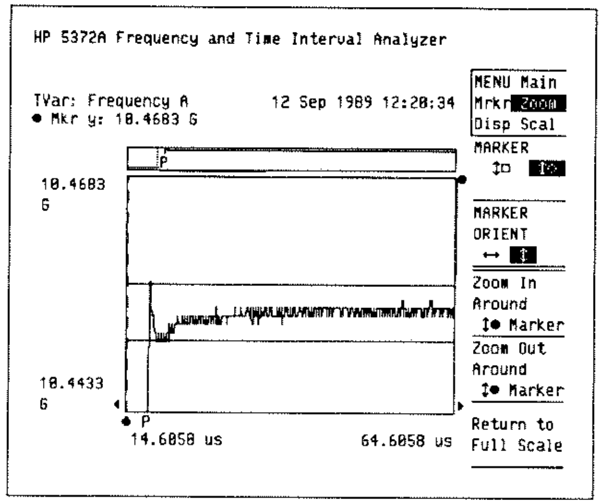
Reference is a constant value subtracted from each measurement result before other math operations are performed. Reference differs from Offset in that it cannot be entered directly from the Numeric keypad. Instead, it is entered using the Set Reference feature. This will enter the mean of the last sample set if Statistics are enabled, or the first measurement value if Statistics are disabled. By using a Reference value, measurement data may easily be manipulated to compensate for systematic measurement errors.

Separate Reference values are available for Channel A, Channel B and Channel C. Clear Reference sets the Reference value to 0.

Default value: 0.

Limit Test:

Upper and lower limit values may be specified for Channel A, Channel B, and Channel C. Limit comparison is performed after the measurement block has been acquired. Via the Numeric display, Limit Test results can be viewed by individual measurement or for all measurements graphically. For systems applications, a bit is set in an HP-IB status register, indicating an out-of-limit occurrence. Limit values are also denoted on the Time Variation and Histogram displays.



Limit test values can be applied to Channel A, B and C.

Default is off.

Negative Range: $-1 \times 10^{34} \leq$ Limit value $\leq -1 \times 10^{-34}$.

Positive Range: $1 \times 10^{-34} \leq$ Limit value $\leq 1 \times 10^{34}$, and 0.

Resolution: 1×10^{-34}.

Any measurements extended due to Inhibit will not be considered in Limit Testing.

HP-IB (IEEE 488)

Interface Capabilities

Subset Identifier	Interface Function
SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T5	Basic talker with serial poll and talk-only capabilities
TE0	No extended talker capability
L4	Basic listener
LE0	No extended listener capability
DT1	Device trigger capability
DC1	Complete device clear capability
RL1	Remote/local capability
SR1	Serial poll capability
PP0	No parallel poll capability
C0	No controller capability
E2	Three-state drivers

HP-IB Address

The HP-IB address may be changed via the **System** menu. This address is saved in non-volatile memory. The default HP-IB address is 03.

Data Output Formats

The HP 5372A automatically makes measurements available to an external HP-IB controller at the completion of each block of measurements. Characteristic output rates are listed below. For example, the Binary output rate for the Continuous Time Interval Mode is 25,000 measurements per second. This could be interpreted as "up to five blocks of 5000 measurements can be transferred to an instrument controller in 1 second."

The HP 5372A can transfer data in one of three formats:

- ASCII
- IEEE Double Precision Floating Point (matches HP 9000 Series 200/300 floating point format, no character conversion is required for these controllers)
- Binary (raw Binary results from the HP 5372A counting hardware). Data must be processed with a computer to produce measurement results.

Transfer Rate

The table below summarizes the HP-IB performance of the HP 5372A. For this testing, the HP 5372A was used with a HP 9000 Series 370 controller with DMA. Measurement programs were written in BASIC and sample programs are shown in Transfer Rate Benchmarks. All transfer rate values include measurement times as well as transfer times.

The HP 5372A was configured to the **Preset** condition prior to the appropriate instrument conditions being selected. To maximize measurement throughput, Statistical and Math operations were not enabled and the **Help** menu was selected for display. All trigger levels were set manually and Automatic arming used when possible.

Two input signals were used to characterize the analyzer's performance - 13 MHz and 400 MHz. The 13 MHz signal was used for all input channel A and B signals and the 400 MHz signal was used for all input channel C measurements. Both Normal and Fast measurement modes were characterized. **The throughput rates for Fast measurement mode are shown in brackets [ ] if there are significant performance differences.**

Note that performance is also affected by other instrumentation on HP-IB, the controller's performance, and the particular measurement software.

(All results shown are readings/second)

Measurement Function	ASCII	Floating Point	Binary
Time Interval	550	1200	12,000 [16,000]
Continuous Time Interval	650	2000	19,500 [25,000]
± Time Interval[1]	550	1200	12,000 [16,000]
Frequency (Single-channel)	600	1600	14,000 [20,000]
Frequency (Dual-channel,Single-result)	450	750	6,000 [9,500]
Frequency (Dual-channel,Dual-result)	300	750	6,000 [9,500]
Totalize (Single-channel)[2]	650	2100	8,000 [N/A]
Totalize (Dual-channel)[2]	550	1400	6,000 [N/A]
Rise/Fall Times, Pos/Neg Pulse Width, Duty Cycle	500	1000	12,000 [16,000]
Phase (Dual-channel)	450	850	12,000 [16,000]
Phase Deviation	600	1500	14,000 [20,000]
Time Deviation	650	1900	14,000 [20,000]
Histogram TI, Histogram ± TI, Histogram Continuous TI[3]	650	3000	N/A
Peak Amplitude[4]	8	8	N/A

1 Event/Event Arming for ± Time Interval A or B.
2 Interval Sampling of 100 ns.
3 Characterized using Full histogram format; consequently all 2000 histogram bin counts are transferred. Results are bin counts/second.
4 Characterized using ten measurements.

In addition to the HP 9000 Series 370 characterization shown above, similar results are available with an HP Vectra (IBM PC/AT compatible) with HP 82300 BASIC Language Processor System installed. The transfer rates for ASCII and Floating Point data were 85 - 90% of those shown above. Binary data transfer rates were 60% of the aforementioned values.

Transfer Rate Benchmarks

ASCII

For ASCII data, transfer rates are determined by using 10 blocks of 1000 single-result measurements or 500 dual-result measurements. The BASIC program below illustrates how to setup, transfer and time a single block of measurements.

```
10  OPTION BASE 1
20  CLEAR 703             ! Clear the HP 5372A
30  RESET 7               ! Clear the HP-IB interface
40  CLEAR SCREEN          ! Clear the CRT (BASIC 5.0 and above, only)
50  DIM Results$[23000] BUFFER,Func$[8],Result(1000),Ch$[5] !Set up arrays
60  INTEGER I,Meas_size
70  Func$="FREQ"          ! Measurement will be Frequency
80  Ch$="A"               ! Measure Channel A
90  Meas_size=1000        ! Take 1000 measurements
100 ASSIGN @Ctr TO 703  ! Set up path to HP 5372A
110 ASSIGN @Buff TO BUFFER Results$
120 OUTPUT @Ctr;"PRESET"                      ! Preset the HP 5372A
130 OUTPUT @Ctr;"SMOD SING"                   ! Put HP 5372A into single mode
140 OUTPUT @Ctr;"MEN,HELP"                    ! Display Help menu. This menu
150                                           ! does not get updated during
160                                           ! measurements, so transfer of
170                                           ! data does not get slowed.
180 OUTPUT @Ctr;"MEAS;FUNC,";Func$            ! Set up frequency measurement
190 OUTPUT @Ctr;"MEAS;SOUR,";Ch$              ! Set up Channel
200 OUTPUT @Ctr;"INP;SOUR A;TRIG MAN;LEV 0"   ! Set trigger levels to Manual,
210 OUTPUT @Ctr;"INP;SOUR B;TRIG MAN;LEV 0"   ! which is faster than Auto
220 OUTPUT @Ctr;"MEAS;SSIZ";Meas_size         ! Set up for 1000 measurements
230 OUTPUT @Ctr;"INT;OUTP ASCII"              ! Output in ASCII
240 T0=TIMEDATE                               ! Start timer
250 TRIGGER @Ctr                              ! Trigger HP 5372A
260 TRANSFER @Ctr TO @Buff;END,WAIT           ! Transfer Data to computer
270 T1=TIMEDATE                               ! Stop timer
280 ENTER Results$;Result(*)                  ! Convert string to numbers
290 !
300 !
310 ! Print the results
320 !
330 PRINT USING "28A,D.DD,8A";"Measurement transfer time = ";T1-T0;" seconds"
340 PRINT USING "28A,4D";"Number of measurements  = ";Meas_size
350 PRINT USING "28A,3D";"Measurements per second  =";Meas_size/(T1-T0)
360 PRINT USING "14A,4D,8X,2A,D.3DE,3A";"Measurement #";Meas_size;"=
        ";Result(Meas_size);" Hz"
370 END
```

This BASIC 5.0 program was used to characterize HP-IB performance using ASCII output format.

Floating Point

The transfer rates for Floating Point Data are determined using 10 blocks of 4000 single-result measurements or 2000 dual-result measurements. The Time Interval A→B measurement can be characterized with the following BASIC program using Floating Point Output format. Note that the program transfers and times one block of measurements.

```
10  OPTION BASE 1
20  CLEAR 703            ! Clear the HP 5372A
30  RESET 7              ! Reset the HP-IB interface
40  CLEAR SCREEN         ! Clear the CRT (BASIC 5.0 and later, only)
50  DIM Result(4000) BUFFER,Func$[8],Ch$[5],Header$[7] ! Dim the arrays
60  INTEGER I,Meas_size
70  Func$="TINT"         ! Measurement will be Time Interval
80  Ch$="(A>B)"          ! from Channel A to B
90  Meas_size=4000       ! 4000 measurements will be taken
100 REDIM Result(Meas_size)
110 ASSIGN @Ctr TO 703                      ! Path to HP 5372A
120 ASSIGN @Ctr1 TO 703;FORMAT OFF          ! Use internal format for data
130 ASSIGN @Buff TO BUFFER Result(*)        ! Set up buffer for transfer
140 OUTPUT @Ctr;"PRESET"                    ! Preset HP 5372A
150 OUTPUT @Ctr;"SMOD SING"                 ! Put in single mode
160 OUTPUT @Ctr;"MEN,HELP"                  ! Put in Help menu (See ASCII program)
170 OUTPUT @Ctr;"MEAS;FUNC,";Func$          ! Set to Time Interval
180 OUTPUT @Ctr;"MEAS;SOUR,";Ch$            ! Measure on Channel A
190 OUTPUT @Ctr;"INP;SOUR A;TRIG MAN;LEV 0"  ! Set to trigger level to Manual
200 OUTPUT @Ctr;"INP;SOUR B;TRIG MAN;LEV 0"
210 OUTPUT @Ctr;"INP;MODE, COMM"            ! Put input in COMMON. This connects
220                                         ! Channel B to Channel A inside the
230                                         ! HP 5372A
240 OUTPUT @Ctr;"MEAS;SSIZ";Meas_size       ! Set to 4000 measurements
250 OUTPUT @Ctr;"INT;OUTP FPO"              ! Use Floating Point Output format
260 T0=TIMEDATE                             ! Start Timer
270 TRIGGER @Ctr                            ! Trigger measurement
280 ENTER @Ctr USING "#,7A";Header$         ! Read Data Header to determine
290                                         ! number of bytes to transfer
300 TRANSFER @Ctr1 TO @Buff;END,WAIT        ! Transfer data to computer
310 T1=TIMEDATE                             ! Stop timer
320 !
330 !Print the results
340 !
350 PRINT USING "28A,D.DD,8A";"Measurement transfer time = ";T1-T0;" seconds"
360 PRINT USING "28A,4D";"Number of measurements  = ";Meas_size
370 PRINT USING "28A,4D";"Measurements per second  = ";Meas_size/(T1-T0)
380 PRINT USING "14A,4D,7X,3A,D.3DE,8A";"Measurement #";Meas_size;" =
    ";Result(Meas_size);" seconds"
390 END
```

This BASIC 5.0 program was used to characterize HP-IB performance using Floating Point output format.

Binary

Binary format allows for the fastest transfer rates since measurement information is not processed by the HP 5372A. Consequently, transferred data must be processed in the controller.

In order to characterize this format, 10 blocks of 4000 measurements are used for both single and dual-result measurements. The following BASIC program can be used to characterize the transfer rates of Continuous Time Interval measurements using Binary output format. Note that the program does not convert raw data to measurement results and only transfers one block of measurements.

```
10  CLEAR 703              ! Clear the HP 5372A
20  RESET 7                ! Reset the HP-IB interface
30  CLEAR SCREEN           ! Clear the CRT (BASIC 5.0 and later, only)
40  INTEGER Meas_size
50  DIM Data_buff(23001) BUFFER,Func$[4],Ch$[5],A$[24006] ! Set up arrays
60  ASSIGN @Ctr TO 703                      ! Set up path to HP 5372A
70  ASSIGN @Buff TO BUFFER Data_buff(*)     ! Assign data buffers
80  Func$="CTIN"                            ! Measurement Continuous Time Interval
90  Ch$="A"                                 ! on Channel A
100 Meas_size=4000                          ! Take 4000 measurements
110 OUTPUT @Ctr;"PRES"                      ! Preset the HP 5372A
120 OUTPUT @Ctr;"MEN,HELP"                  ! Put in Help menu (See ASCII program)
130 OUTPUT @Ctr;"SMODE,SING"                ! Put in single mode
140 OUTPUT @Ctr;"MEAS;FUNC,";Func$          ! Measure Continuous Time Interval
150 OUTPUT @Ctr;"MEAS;SOUR,";Ch$            ! on Channel A
160 OUTPUT @Ctr;"INP;SOUR,A;TRIG,MAN"       ! Use MANUAL trigger
170 OUTPUT @Ctr;"INP;SOUR,B;TRIG,MAN"       ! on both channels
180 OUTPUT @Ctr;"MEAS;SSIZE,";Meas_size     ! Program number of measurements
190 OUTPUT @Ctr;"INT;OUTP,BIN"              ! Use Binary output format
200 WAIT .65                                ! Make sure HP 5372A has processed
210                                         ! all the commands
220 T0=TIMEDATE                             ! Start timer
230 TRIGGER @Ctr                            ! Trigger HP 5372A
240 ENTER @Ctr USING "#,8A";Header$         ! Read Header to determine number
250 Tot_byte_count=VAL(Header$[3])          ! of bytes to tranfer
260 TRANSFER @Ctr TO @Buff;COUNT Tot_byte_count,WAIT !Transfer the data
270 T1=TIMEDATE                             ! Stop Timer
280 !
290 ! Print results
300 !
310 PRINT USING "28A,D.DD,8A";"Measurement transfer time =";T1-T0;" seconds"
320 PRINT USING "28A,5D";"Measurements per second  = ";Meas_size/(T1-T0)
330 LOCAL @Ctr
340 END
```

This BASIC 5.0 program was used to characterize HP-IB performance using Binary output format.

Binary Data Conversion

The conversion time required to convert Binary data to measurement results is highly dependent on the specific measurement, instrument controller, programming language and program. Using the HP 9000 Series 370 controller, HP 98618A BASIC 5.X Compiler and the program listed below, conversion rates of 5,000 measurements per second could be achieved. Without compilation, conversation rates of 2,400 measurements per second are achievable.

Conversion rates in excess of 30,000 readings per second is possible using compiled BASIC 5.0 program with PASCAL CSUBs.

```
10  ! This program converts raw binary data to real numbers. It will only
20  ! work for the measurement function shown here. For other measurements,
30  ! different formats and conversion routines are required. See the
40  ! programming manual for more details
50  !
60  ! For information about the HP 5372A setup used here, see the binary
70  ! transfer program shown earlier in this section.
80 CLEAR 703
90 RESET 7
100 CLEAR SCREEN
110 INTEGER Meas_size,Data_buff(1:8192,1:5) BUFFER
120 DIM Func$[4],Ch$[5]
130 ASSIGN @Ctr TO 703
140 ASSIGN @Buff TO BUFFER Data_buff(*)
150 Func$="CTIN"
160 Ch$="A"
170 Meas_size=8191
180 OUTPUT @Ctr;"PRES"
190 OUTPUT @Ctr;"MEN,HELP"
200 OUTPUT @Ctr;"SMODE,SING"
210 OUTPUT @Ctr;"MEAS;FUNC,";Func$
220 OUTPUT @Ctr;"MEAS;SOUR,";Ch$
230 OUTPUT @Ctr;"INP;SOUR,A;TRIG,MAN;LEVEL,0"
240 OUTPUT @Ctr;"INP;SOUR,B;TRIG,MAN"
250 OUTPUT @Ctr;"INT;OUTP,BIN"
260 OUTPUT @Ctr;"MEAS;SSIZE,";Meas_size
270 WAIT .65
280 T0=TIMEDATE
290 TRIGGER @Ctr
300 ENTER @Ctr USING "#,8A";Header$
310 Tot_byte_count=VAL(Header$[3])
320 TRANSFER @Ctr TO @Buff;COUNT Tot_byte_count,WAIT
330 T1=TIMEDATE
340 PRINT USING "28A,D.DD,8A";"Measurement transfer time =";T1-T0;" seconds"
350 PRINT USING "28A,5D";"Measurements per second  = ";Meas_size/(T1-T0)
360 LOCAL @Ctr
370 Convert_bin72(Meas_size,Data_buff(*))
380 END
390  !
400  !
410 SUB Convert_bin72(INTEGER Meas_size,Buff(*) BUFFER)
420 Convert_bin72:        ! Converts binary 5372A data to Frequency and Time arrays.
430                       ! This subprogram has been written to
440                       ! maximize the data conversion rate.
450 INTEGER I,Format_words
460 REAL Time0,Time1,Event0,Event1,Time_ovfl,Time0_offset
470 DIM Freq(1:8191),Gate(1:8191)
480 Two_exp32=2^32
490 Two_exp16=2^16
500 Format_bytes=6
510 Format_words=Format_bytes DIV 2
520 Time_ovfl=0
530 REDIM Buff(0:Meas_size,1:Format_words)
540 T0=TIMEDATE
550  Time0=(Buff(0,1)+(Buff(0,1)<0)*Two_exp16+(Buff(0,2)<0))*Two_exp16+Buff(0,2)
560 Time0_offset=(Time0)*2.E-9-Buff(0,2) MOD 32*1.E-10
570  Time1=(Buff(1,1)+(Buff(1,1)<0)*Two_exp16+(Buff(1,2)<0))*Two_exp16+Buff(1,2)
580 IF Time1<Time0 THEN Time_ovfl=Time_ovfl+Two_exp32
590 Gate(1)=(Time1+Time_ovfl)*2.E-9-Buff(1,2) MOD 32*1.E-10-Time0_offset
600 Time0=Time1
610 FOR I=2 TO Meas_size
620   Time1=(Buff(I,1)+(Buff(I,1)<0)*Two_exp16+(Buff(I,2)<0))*Two_exp16+Buff(I,2)
630  IF Time1<Time0 THEN Time_ovfl=Time_ovfl+Two_exp32
640  Gate(I)=(Time1+Time_ovfl)*2.E-9-Buff(I,2) MOD 32*1.E-10-Time0_offset
650  Time0=Time1
660 NEXT I
670 T1=TIMEDATE
680 PRINT USING "36A,X,4D";"Measurements converted per second = ";8191/(T1-T0)
690 REDIM Buff(1:Meas_size,1:Format_words)
700 SUBEND   ! Convert_bin72
```

This BASIC 5.0 program may be used to characterize conversion time of Binary output format to measurement results.

Continuous Measurements Indefinitely

The HP 5372A can also be configured to output Binary data indefinitely to an external controller. This is achieved by configuring the HP 5372A for one block of one measurement, in the Repetitive acquisition mode. A single binary result will be transferred approximately every 10 ms (100 measurements per second). This rate will vary depending on the specific measurement, instrument controller and other instruments connected to the HP-IB.

Using the HP 9000 Series 370 controller, a transfer rate of 160 measurements per second can be achieved. Using an HP Vectra with HP 82300 HP BASIC Language Processor System, a transfer rate of 90 measurements can be achieved.

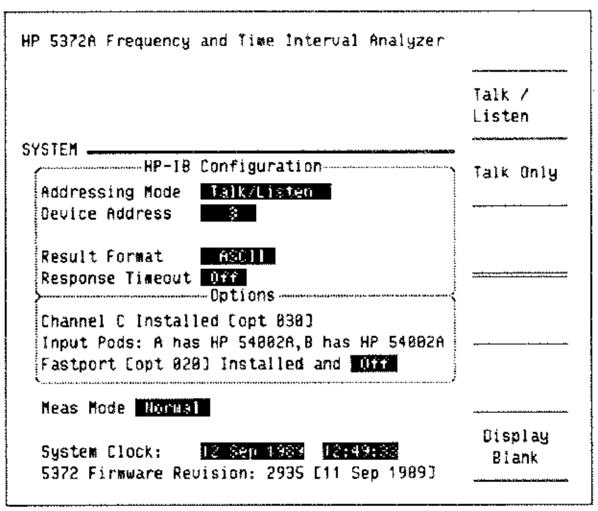
For even faster transfer rates, FastPort (Option 020) should be considered. Refer to the Rear Panel Connectors section for further details.

Direct Printer or Plotter Output

Any HP 5372A CRT display may be sent directly to an HP-IB graphics printer such as the HP 2225A ThinkJet Printer. In addition, a list of measurement results may be printed directly from the front panel (up to 8191 values).

Additionally, any graphics display may be sent directly to an HP-IB HP-GL plotter such as the HP 7440A ColorPro Plotter option 002.

To enable these capabilities, Talk Only mode must be specified on the **System** menu of the HP 5372A.



The HP 5372A Talk Only mode allows results to be printed or plotted without the need for an external controller.

The attached printer or plotter must be configured in the Listen Only mode.

Response Timeout

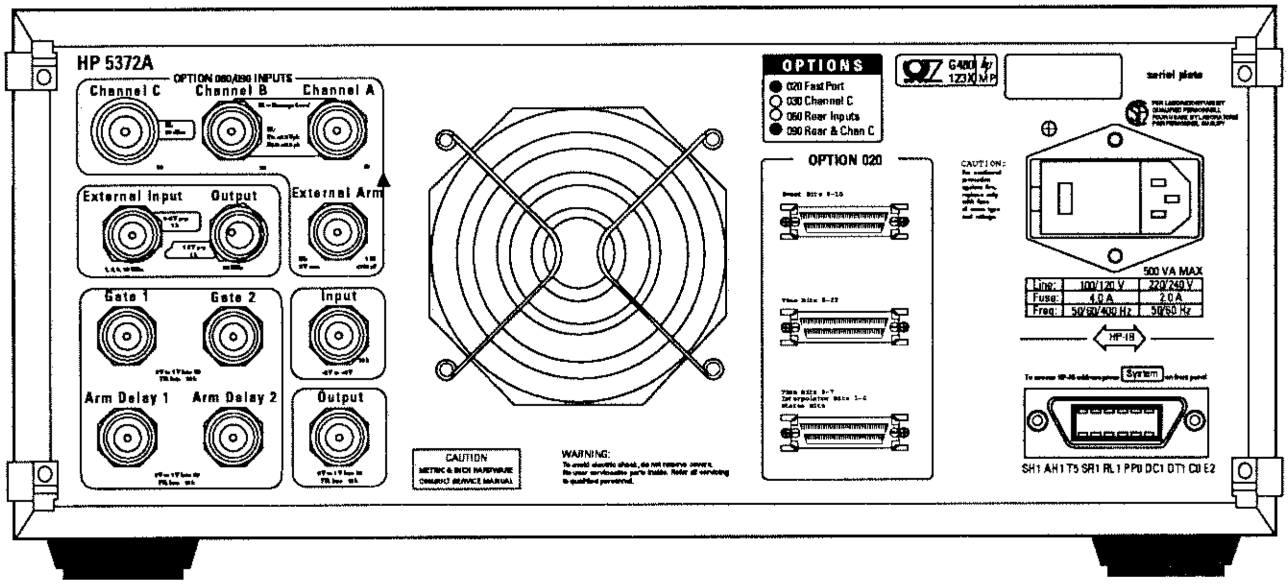
The Response Timeout feature enables the HP 5372A to generate a service request if the measurement is not completed within a specific time.

Timeout Range: 0 to 10 hours.

Resolution: 1 second.

Default Value: 5 seconds.

Rear Panel Connectors



HP5372A rear panel with Option 020 - FastPort and Option 090 - Rear Terminals Including Channel C installed.

Frequency Standard External Input

This BNC input will be automatically selected as the reference time base when a signal is present. The internal time base will be used when no signal is present at this BNC connector.

Impedance:

1 k Ω, ac coupled.

Input Level Range:

1.0 V_{pk-pk} to 5.0 V_{pk-pk}.

Acceptable Frequencies:

1 MHz, 2 MHz, 5 MHz, or 10 MHz, ± 1%.

Damage Level:

± 10 V (dc ± peak ac).

Note that a message will appear on the display of HP 5372A if the time base switches from one source to another.

Frequency Standard Output

When no external reference is present, the HP 5372A internal 10 MHz oscillator signal is provided at this output. When an external reference is applied, this output will always be 10 MHz; however, the long term stability characteristics will match the external reference.

Frequency:

10 MHz (see Time Base section).

Level:

> 2 V_{pk-pk}, ac coupled square wave into a high impedance.
> 1 V_{pk-pk}, ac coupled square wave into 50 Ω.

Gate Outputs 1 and 2

A falling edge indicates when measurement samples occur.

Delay:

30 ns.

Output Level:

Falling edge active, TTL levels into ≥ 10K Ω. > 1 V to 0 V into 50 Ω.

Pulse Width:

> 25 ns into 50 Ω.

Arm Delay Outputs 1 and 2

A falling edge occurs at these outputs with the completion of the arming condition. For example, if a Time Holdoff is specified, a falling edge will occur at the completion of the Time Holdoff.

Delay:

30 ns.

Output Level:

Falling edge active, TTL levels into ≥ 10 K Ω. >1 V to 0 V into 50 Ω.

Inhibit

For operating characteristics, refer to the Measurement Control section. Electrical specifications are:

Input Level Range:

-2 V to 5 V.

Minimum Pulse Height:

200 mV_{pk-pk}.

Impedance:

10 k Ω shunted by < 100 pF.

Damage Level:

±5.5 V.

Setup Time:

The Inhibit signal must be enabled > 25 ns prior to the input transition to be inhibited.

Hold Time:

The Inhibit signal must be enabled > 10 ns after the input transition to be inhibited.

Maximum Repetition Rate:

10 MHz.

Time Interval Detect

The TI Detect output will remain TTL low for the entire period of time the measurements are outside the specified range.

Refer to the Measurement Control section for operating characteristics of TI Detect. The electrical specifications for the TI Detect output are as follows:

Level:

Falling edge active, TTL levels into ≥ 10 K Ω. >1 V (minimum) to 0 V into 50 Ω.

Minimum Pulse Width:

50 ns.

Measurement to TI Detect Output Delay:

< 600 ns.

HP-IB Interface

Refer to the HP-IB section.

Power Connector

Refer to the General section.

Option 020 FastPort

FastPort provides real-time measurement information at the measurement rate of the HP 5372A. The measurements are unprocessed and are directly generated by the measurement hardware. Consequently, data is transferred at the measurement rate of the analyzer. With this interface, custom hardware can be designed and built to provide deeper memory than that available in the analyzer. FastPort can be enabled/disabled on the **System** Menu and has no effect on the operation of the HP 5372A.

With Option 020, three 48" interface cables and three 40 pin connectors (HP P/N 8120-3348 or AMP P/N 749089-2) are provided. Custom hardware should be designed to incorporate these connectors to provide a direct interface to the HP 5372A. Maximum data rates are 20 MHz at TTL levels.

Since there are some restrictions on data availability over FastPort, review of the FastPort User Manual (HP P/N 05372-90012) is recommended. For example, the following dual-channel measurements are not available over FastPort: Frequency, Period, Totalize or Phase. Other restrictions may apply.

Option 060 Rear Panel Inputs

With Option 060, the front panel inputs for Channel A, Channel B and External Arm are removed and BNC connectors are provided on the rear panel for these inputs. Channels A and B are 50 Ω while External Arm is 1 M Ω. Input pods are not used with Option 060; consequently, HP 54002A pods are not supplied.

Input channel A and B performance is equivalent to front panel performance. External Arm performance for the Option 060 configuration is as follows:

Range:

dc coupled to 100 MHz.

Sensitivity:

100 mV rms sine wave.
280 mV_{pk-pk} at a minimum pulse width.

Minimum Pulse Width:

5 ns at a minimum amplitude.

Impedance:

1 M Ω, shunted by < 100 pf.

Dynamic Range:

280 mV_{pk-pk} to 5 V_{pk-pk}, dc to 20 MHz.
280 mV_{pk-pk} to 2.5 V_{pk-pk}, 20 MHz to 100 MHz.

Signal Operating Range:

±5 Vdc.

Damage Level:

5 V rms (±15 V_{pk-pk}, dc ± peak ac).

All triggering specifications are the same as for the front panel configuration.

Option 060 is not available with Option 030. If rear terminals and Channel C are desired, Option 090 should be ordered.

Option 090 Rear Panel Inputs Including Channel C

Option 090 combines Options 030 and 060. The N type connector for the Channel C is mounted on the rear panel and its performance is unchanged. Characteristics described for Options 030 and 060 apply to Option 090.

Option 090 is not available with Options 030 and 060.

Time Base

Frequency

10 MHz.

Stability

Aging Rate:
< 5 x 10^{-10} per day after a 24 hour warm-up
when:
1. oscillator off-time* was less than 24 hours.
2. oscillator aging rate was < 5 x 10^{-10} per day prior to turn-off*

< 5 x 10^{-10} per day in less than 30 days of continuous operation for off-time* greater than 24 hours.

< 1 x 10^{-7} per year for continuous operation.

Short Term:
< 1 x 10^{-10} for a 1 second average.

Temperature:
< 7 x 10^{-9}, 0 to 40° C ambient temperature.

Line Voltage:
< 1 x 10^{-10} for 10% change from the Nominal line voltage.

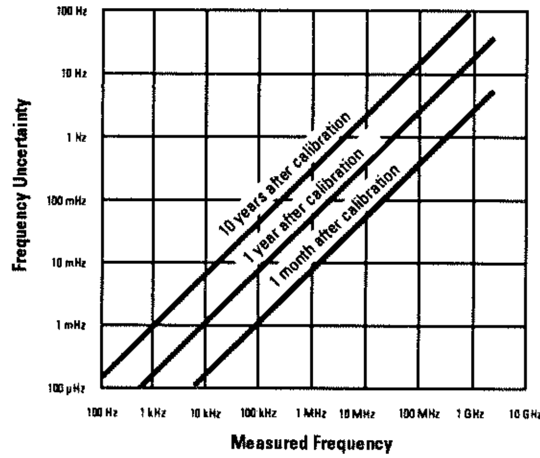
Warm-up:
Within 5 x 10^{-9} of final value, 10 minutes after turn-on**
when:
1. HP 5372A is operated in a 25° C environment.
2. Oscillator off-time* was less than 24 hours.
3. Oscillator aging rate was < 5 x 10^{-10} per day prior to turn-off*.

Refer to the Rear Panel Connectors section for information regarding signal levels.

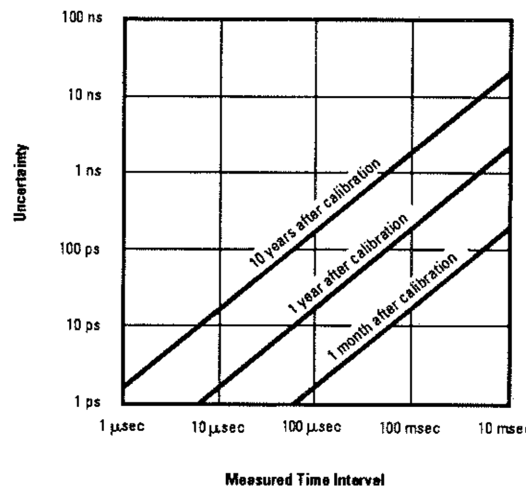
TIME BASE

* "Turn-off", "turn-on", and "off-time" apply to periods when power is disconnected from the HP 5372A rear panel. Stand-by operation provides power to the oscillator's oven.

** Final value is defined as oscillator frequency 24 hours after turn-on*.



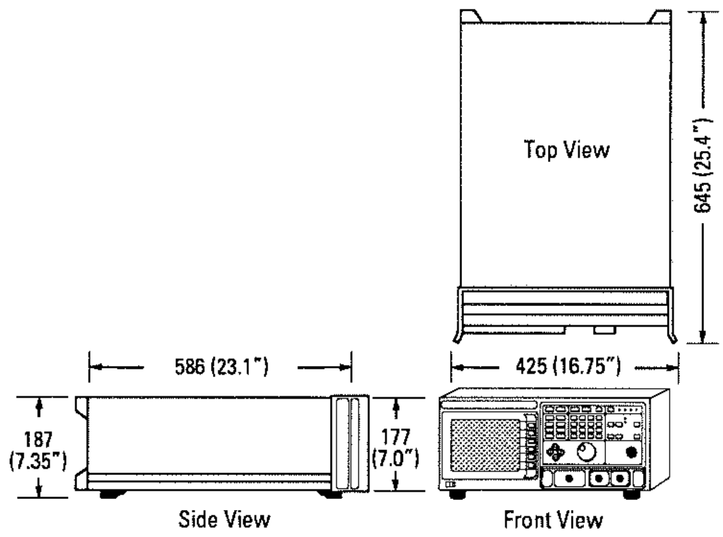
Time Base crystal aging affects Frequency and Period measurement accuracy. You can further reduce aging uncertainty by using an atomic standard, such as the HP 5061B.



Time Base crystal aging affects time interval measurement accuracy. You can reduce aging uncertainty by using an atomic standard, such as the HP 5061B.

General

Dimensions



Weight:

Net, 25.5 kg (56 lbs); Shipping, 36.4 kg (80 lbs).

Operating Temperature:

0 to 40° C.

Power Requirements:

Voltages:

100, 120, 220 or 240 Vac, ± 10%.

Frequencies:

45 - 66 Hz for all voltages.
360 - 440 Hz for 100 and 120 Vac.

Maximum Power:

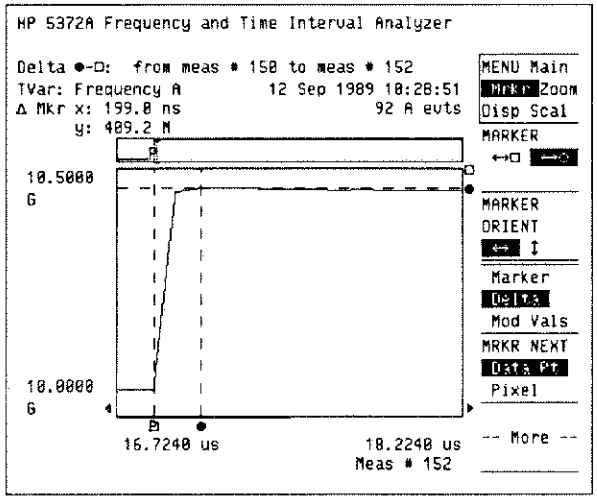
500 VA.

Display Characteristics

The HP 5372A features a raster-scan, green phosphor CRT. Screen display resolution is 408 pixels horizontally by 304 pixels vertically. Graph display resolution is 250 pixels horizontally by 180 pixels vertically.

For graphical displays, the screen is divided into three main sections.

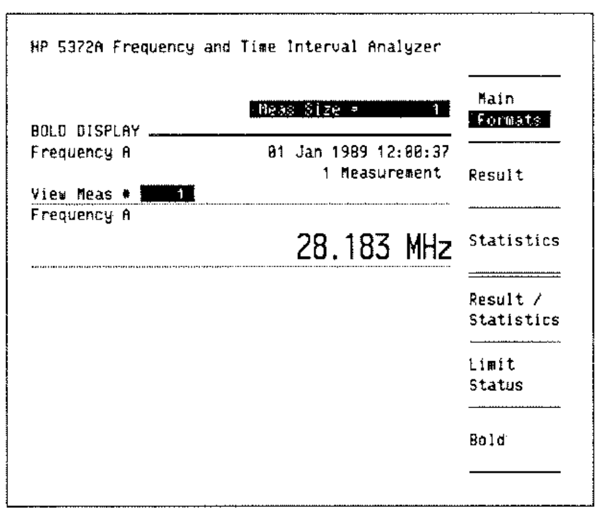
GENERAL



The HP 5372A graphical displays make analysis of this VCO step response easy.

The top section provides measurement information including measurement status, error messages and numerical results of analysis. The second area of of the display is the panorama. It provides a broad view of all the measurement data in memory. The third area of the display provides an in-depth look at the measurement data of interest. It can display all the measurement information or, using the zooming and cursor functions, display only a portion of it for close examination - while maintaining perspective with the panorama display. Graphical displays can be scaled automatically for optimum presentation of the measurement results or scaled manually for specialized requirements. Additional conveniences, such as display grids and connect data are available.

For numeric displays, a BOLD feature is available to display results in large characters for viewing from a distance.



For applications where results must be viewed from a distance, the HP 5372A features a Bold display mode.

Up to 12 measurements (6 measurements with associated expanded data) can be displayed in the standard numeric display. All results may be viewed using scrolling features.

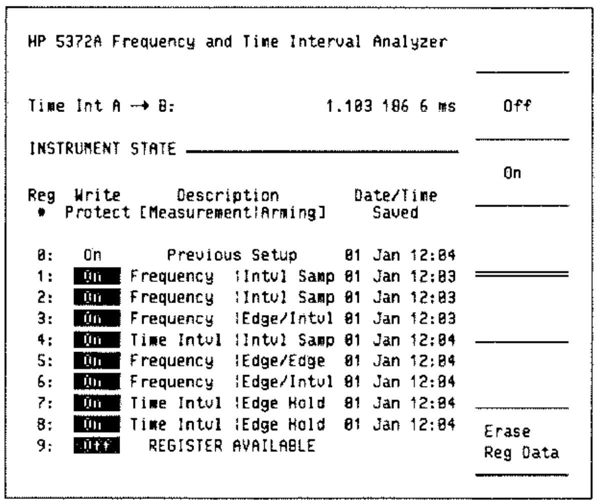
Results on the Numeric screen will be displayed with a up to 15 digits, depending on the measurement resolution.

Ease-of-use Features

Instrument States:

Up to nine instrument states can be saved from the front panel or via HP-IB. The **Instrument State** menu depicts the Function and Arming mode for each saved state, as well as the time and date saved. Each state also has a **Protect** feature to prevent accidental overwrite.

In addition to the nine saved states, there are additional states stored by the instrument. State 0 is reserved for use by the **Preset** or **Default Measurement Setup** functions. When either of these is pressed, the current instrument state is stored in State 0. These states are saved in non-volatile RAM.



Up to nine instrument states may be saved, and protected, from the front panel, or via HP-IB.

Preset and Default Measurement Setup:

A Preset function is available to return the HP 5372A to a known state. Saved instrument states and the HP-IB address are not affected; however, the measurement memory is cleared.

After selecting a measurement function, the Default Measurement Setup key is available to quickly begin making measurements for a given measurement function. When pressed, a sample size of 100 measurements is selected, with Statistics enabled. The analyzer automatically displays the Numeric screen.

GENERAL

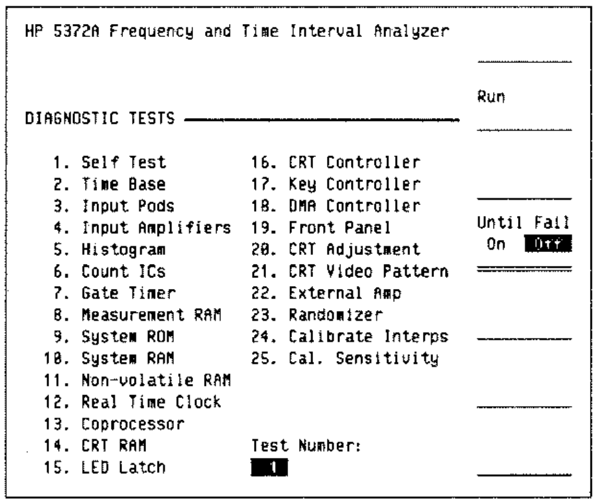
Teach/Learn String:

Programming can be simplified by configuring the HP 5372A to a particular measurement setup from the front panel and then reading the measurement setup into a "Learn String" via an HP-IB controller. The controller can then send this string back to the HP 5372A at any time as a "Teach String". This will restore the measurement setup to its original configuration.

Self Test:

The HP 5372A automatically runs a test of internal circuitry at power-on. In addition, a similar Self Test can be invoked at any time from the front panel or over HP-IB. Failures are noted on the CRT and over HP-IB for both types of tests, or can be logged on a printer directly using the Talk Only mode.

In addition to the Self Test, the HP 5372A allows diagnostic tests to be performed individually on portions of its internal circuitry.



The HP 5372A offers a complete set of diagnostics and Self Test for instrument troubleshooting.

Display Blanking:

For some applications, it may not be desireable to display measurement results on the CRT of the HP 5372A. Via the **System** menu, display blanking can be enabled. Status messages will still be displayed but measurement results will not appear. All measurement data can be retrieved over HP-IB. In addition, all front panel keyboard functions except the numeric keypad and **Restart** key are locked out. Using the Local Lockout command over HP-IB, all front panel keys can be locked out including the numeric keypad and **Restart** key.

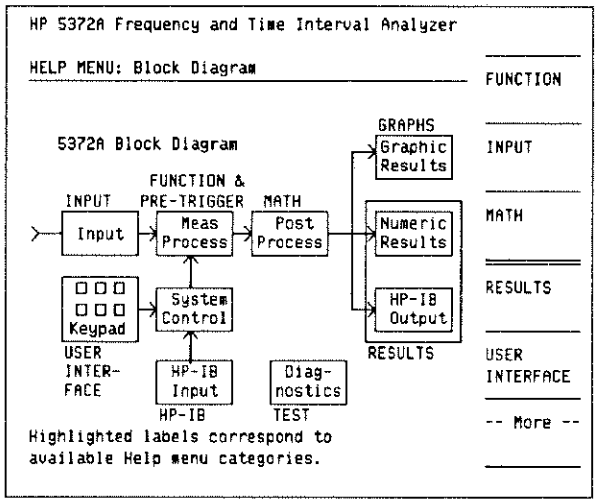
Display Blanking is retained during instrument power-down and can be exited by entering a number of 1000 or greater.

Measurement Abort:

A measurement process may be suspended before the end of the current block without loss of data by pressing the **Shift, Manual Arm** key on the front panel or by sending the HP-IB 'Abort' command. Measurements acquired up to that point can be accessed from the front panel or via HP-IB.

Help Screens:

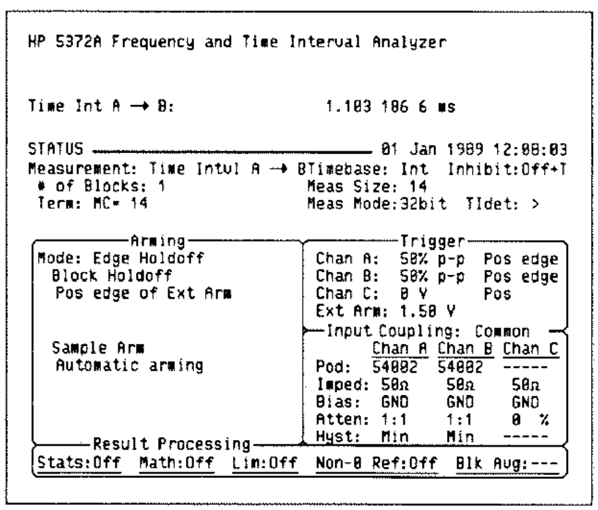
The HP 5372A offers an extensive series of Help screens providing key information on its operation. The screens can be accessed via the **Help** key.



HP 5372A Help screens replace bulky pull-out cards with quick and helpful operating information.

Status Menu:

The **Status** menu gives a complete summary of the current analyzer setup. This menu provides a convenient way to document a particular measurement setup, as well as view the entire instrument setup at a glance.



The Status menu give you a complete overview of the analyzer's configuration. This screen is also useful to document the HP 5372A configuration.

Appendix A

Measurement Uncertainty Definitions

All measured values have associated uncertainties. The following are definitions of terms used to describe these uncertainties. For frequency and time interval measurements and other specific implementations (i.e. rise time, pulse width, duty cycle, etc.) this measurement uncertainty is composed of three factors: Least Significant Digit (LSD), Resolution, and Accuracy.

Least Significant Digit, Resolution, and Accuracy

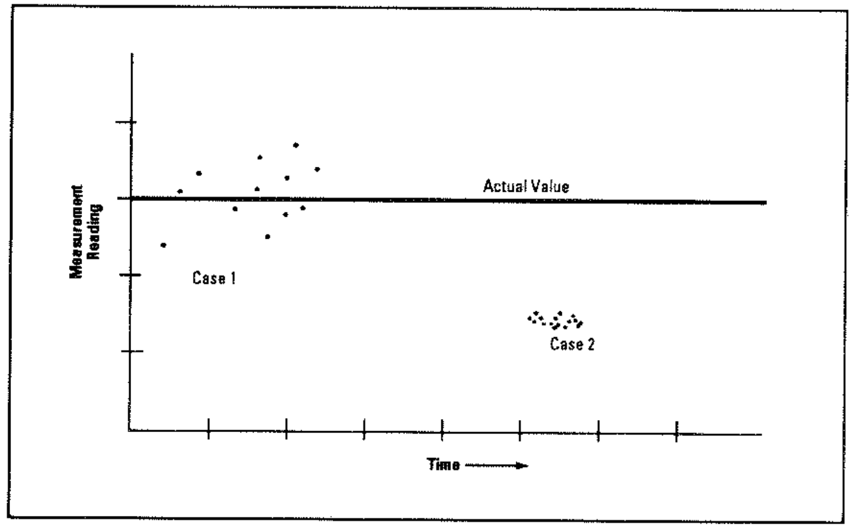
Least Significant Digit is the smallest incremental value displayed in a measurement. The LSD for the HP 5372A is 200 ps, therefore, the smallest displayed increment that two single-shot time interval measurements will differ by is 200 ps.

Resolution is the smallest difference in measurements that the instrument can discern. Measurement resolution is of primary concern when comparing data gathered by a single instrument; in other words, the meaning of results when compared against one another. Resolution describes uncertainty due to random effects, including short-term oscillator stability, trigger error, and the internal noise of the instrument itself. Since these effects are random, the resolution uncertainty is specified on an rms basis rather than a peak value. The time interval single-shot resolution of the HP 5372A is 150 ps rms. Resolution can also be improved by averaging single measurements, or in the case of frequency and period measurements, by increasing the measurement gate time as well as averaging measurements.

Accuracy is defined to be the combination of random uncertainties and systematic or bias uncertainties in a measurement. Accuracy is of primary concern when comparing data in an absolute sense, such as one production test station to the next. Systematic uncertainties include differential channel delay, long term drift or time base oscillator aging, and Trigger Level Timing Error. These uncertainties may be measured and removed from subsequent measurement data by subtracting the measured bias. Two methods are available to do this with the HP 5372A:

1) the Set Reference feature for each input channel, or
2) the HP J06-59992A Time Interval Calibrator.

Accuracy = Random Errors + Systematic Errors



Case 1 shows the results of random uncertainties (resolution) limiting measurement precision. Case 2 shows the results of systematic uncertainty limiting measurement precision. Accuracy specifications must include both systematic and random effects.

Trigger Error and Trigger Level Timing Error

Resolution and accuracy equations consist of two terms which describe uncertainties due specifically to triggering. These terms are separated from others since they are, in general, dependent upon the user's signal. The following describes these input trigger uncertainties.

Trigger Error is a random uncertainty caused by noise on the input signal. Trigger Error can be minimized by careful grounding and shielding techniques to minimize noise, and maintaining as high a signal slew rate as possible for the input to the HP 5372A. The following equation is used to quantify trigger error.

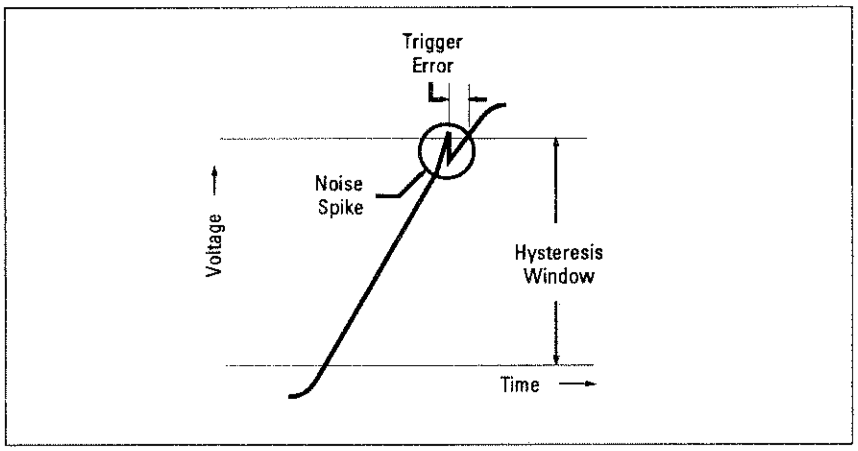
$$\text{Trigger Error} = \frac{\sqrt{(E_{amp})^2 + (E_n)^2}}{\text{Input Signal Slew Rate}}$$

Where:

E_{amp} is the typical rms input amplifier noise (200 µV rms typical).

E_n is the rms noise of the input signal over a 500 MHz bandwidth.

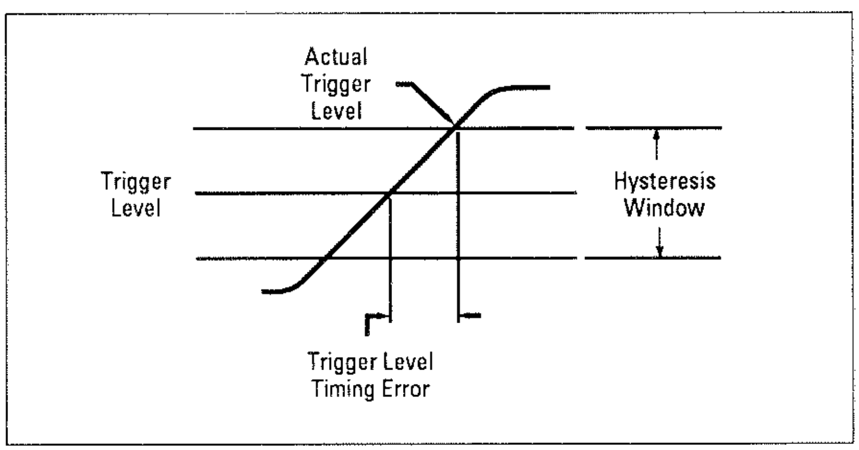
The input signal slew rate value is determined at the trigger point.



Trigger Error is due to noise on the input signal. Here a noise spike causes an 'early' trigger.

Trigger Level Timing Error is a systematic uncertainty due to the input hysteresis of the HP 5372A. Trigger Level Timing Error is a constant value for any particular signal and slew rate, but the effects will vary with amplitude and slew rate. Trigger Level Timing Error can be minimized by maintaining as high an input signal slew rate as possible, and can be removed by careful calibration with the HP J06-59992A Time Interval Calibrator.

$$\text{Trigger Level Timing Error} = \left(\frac{0.5 \times \text{Hysteresis Window}}{\text{Start Input Signal Slew Rate}} - \frac{0.5 \times \text{Hysteresis Window}}{\text{Stop Input Signal Slew Rate}} \right) \pm \frac{\text{Trigger Level Accuracy (start)}}{\text{Start Input Signal Slew Rate}} \pm \frac{\text{Trigger Level Accuracy (stop)}}{\text{Stop Input Signal Slew Rate}}$$



Trigger Level Timing Error is a systematic uncertainty. It is constant for any particular signal slew rate.

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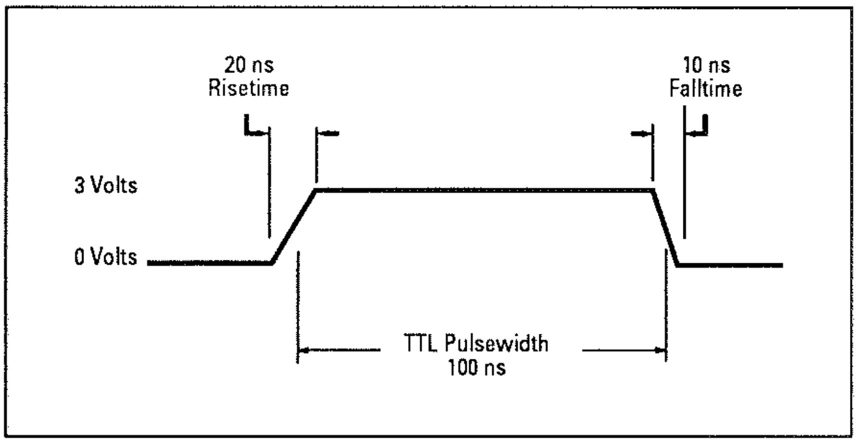
Appendix B

Example Measurements and Uncertainty Calculations

The following are measurement examples to illustrate the use of the measurement uncertainty equations for typical measurement applications. In these examples, the specific values have been entered into the complete equation. In practice, the associated graphs of these equations can be used to determine various uncertainties.

TTL Pulse Width Measurement

A single-shot Pulse Width measurement is made with a value of 100.0 ns. The signal has 10 mV rms (28 $mV_{pk\text{-}pk}$) noise, a rise time of 20 ns, and a fall time of 10 ns over a 3 volt swing. The measurement is made using the HP 54003A 1 MΩ input pod with a 10:1 divider probe. It has been 1 month since the HP 5372A time base has been calibrated.



TTL Pulse Width measurement uncertainty example.

Least Significant Digit Displayed:

$$= \pm 200 \text{ ps}$$

Resolution:

$$= \pm 150 \text{ ps rms} \pm \text{Start Trigger Error} \pm \text{Stop Trigger Error}$$

$$= \pm 150 \text{ ps rms} \pm \frac{\sqrt{(200\ \mu\text{V rms})^2 + (10\ \text{mV rms})^2}}{15\ \text{V}/\mu\text{s}} \pm \frac{\sqrt{(200\ \mu\text{V rms})^2 + (10\ \text{mV rms})^2}}{30\ \text{V}/\mu\text{s}}$$

$$= \pm 1.15 \text{ ns rms}$$

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Accuracy:

= ± Resolution ± (Time Base Aging x Pulse Width) ± Trigger Level Timing Error ± 1 ns Systematic Error

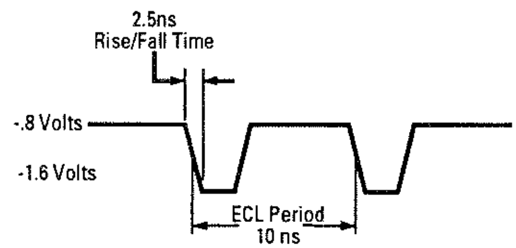
$$= \pm 1.15\ \text{ns rms} \pm (5 \times 10^{-10} \times 30\ \text{days} \times 100\ \text{ns}) \pm \left[\left(\frac{22.5\ \text{mV}}{15\ \text{V}/\mu\text{s}} - \frac{22.5\ \text{mV}}{30\ \text{V}/\mu\text{s}}\right) \pm \frac{21.5\ \text{mV}}{15\ \text{V}/\mu\text{s}} \pm \frac{21.5\ \text{mV}}{30\ \text{V}/\mu\text{s}}\right]$$

± 1 ns Systematic Error

= ± 3.62 ns

ECL Edge-to-Edge, or Single-Period Measurement

A single-shot period measurement is made from falling edge to falling edge of a ECL signal. The input signal has 1 mV rms of noise with a fall time of 2.5 ns over an 800 mV swing. The HP 54002A 50Ω input pod is used with a -2 volt termination. The measured value is 10.0 ns. It has been 1 month since the HP 5372A time base has been calibrated.



Measurement uncertainty example using Time Interval to measure from falling edge to falling edge of an ECL signal.

Least Significant Digit Displayed:

= ± 200 ps

Resolution:

= ± 150 ps rms ± Start Trigger Error ± Stop Trigger Error

$$= \pm 150\ \text{ps rms} \pm \frac{\sqrt{(200\ \mu\text{V rms})^2 + (1\ \text{mV rms})^2}}{0.32\ \text{V/ns}} \pm \frac{\sqrt{(200\ \mu\text{V rms})^2 + (1\ \text{mV rms})^2}}{0.32\ \text{V/ns}}$$

= ± 156 ps rms

Accuracy:

= ± Resolution ± (Time Base Aging x Pulse Width) ± Trigger Level Timing Error ± 1 ns Systematic Error

$$= \pm 156\ \text{ps rms} \pm (5 \times 10^{-10} \times 30\ \text{days} \times 10\ \text{ns}) \pm \left[\left(\frac{22.5\ \text{mV}}{0.32\ \text{V/ns}} - \frac{22.5\ \text{mV}}{0.32\ \text{V/ns}}\right) \pm \frac{24\ \text{mV}}{0.32\ \text{V/ns}} \pm \frac{24\ \text{mV}}{0.32\ \text{V/ns}}\right]$$

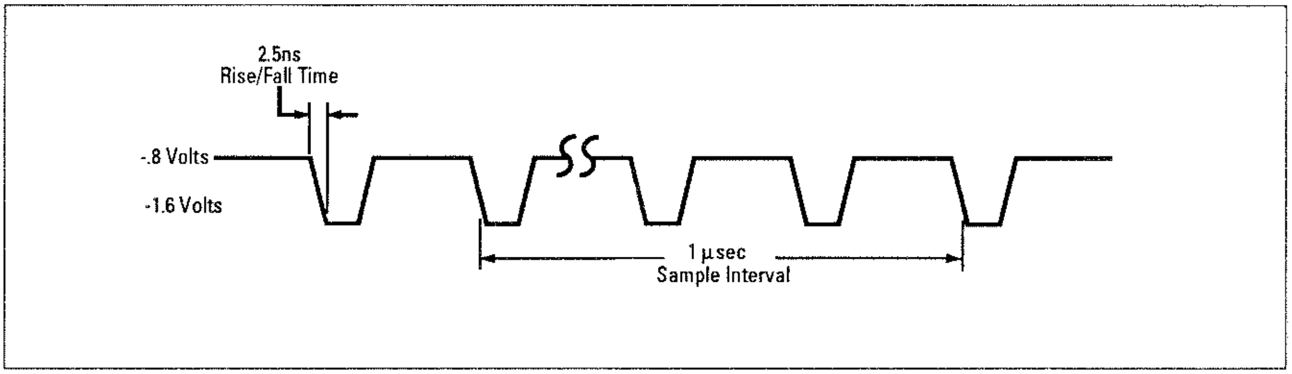
± 1 ns Systematic Error

= ± 1.31 ns

Note that a major portion of the measurement accuracy consists of the 1 ns systematic term. This can be reduced to less than 10 ps with careful calibration using the HP J06-59992A Time Interval Calibrator.

ECL Frequency Measurement

A Frequency measurement is made on a 100 MHz ECL signal with a 1 μs sample interval. The signal has 1 mV of noise with a transition time of 2.5 ns over an 800 mV swing. The HP 54002A 50Ω input pod is used with a -2 volt termination. It has been 1 month since the HP 5372A time base has been calibrated.



Measurement uncertainty example for a Frequency measurement on an ECL signal.

Least Significant Digit Displayed:

$$= \pm \frac{\textbf{200 ps}}{\textbf{Sample Interval}} \textbf{ x Frequency}$$

$$= \pm \frac{200 \text{ ps}}{1 \text{ μs}} \times 100 \text{ MHz}$$

$$= \pm 20 \text{ kHz}$$

Resolution:

$$= \pm \frac{\textbf{150 ps rms + (1.4 x Trigger Error)}}{\textbf{Sample Interval}}$$

$$= \pm \frac{150 \text{ ps rms} + \left(1.4 \times \frac{\sqrt{(200 \text{ μV rms})^2 + (1 \text{ mV rms})^2}}{0.32 \text{ V/ns}}\right)}{1 \text{ μs}} \times 100 \text{ MHz}$$

$$= \pm 15.4 \text{ kHz}$$

Accuracy:

= ± Resolution ± (Time Base Aging x Frequency)

$$= \pm 15.4 \text{ kHz} \pm (5 \times 10^{-10} \times 30 \text{ days} \times 100 \text{ MHz})$$

$$= \pm 15.4 \text{ kHz}$$

Appendix C

Warranted Specifications

The HP 5372A has two measurement modes - Normal and Fast. If there are differences in the two modes, **parameters pertaining to the Fast mode will be contained in brackets [ ].**

Measurement Functions

Frequency

RANGE

Single Channel Measurements:

Channels A and B: **125 mHz [8 kHz] to 500 MHz.**
Channel C: **100 MHz to 2 GHz.**

Dual Channel Measurements:

Channels A and B: **250 mHz [16 kHz] to 500 MHz.**
Channel C: **100 MHz to 2 GHz.**

FOR A SINGLE MEASUREMENT

Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Sample Interval}} \times \text{Frequency}$$

Resolution:

$$\pm \frac{150\text{ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Time Base Aging x Frequency).

MEAN ESTIMATION FOR AVERAGE MEASUREMENTS

rms Resolution:

Continuous Measurements (Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times (150\text{ps rms} + 1.4 \times \text{Trigger Error})}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

All other Measurements:

N = number of measurements averaged.

$$\pm \frac{150\text{ ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval} \times \sqrt{N}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Time Base Aging x Frequency).

Period

RANGE

Single Channel Measurements:

Channels A and B: **2 ns to 8.0 s [131 μs].**
Channel C: **0.5 ns to 10 ns.**

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Dual Channel Measurements:

Channels A and B: **2 ns to 4.0 s [65 μs].**
Channel C: **0.5 ns to 10 ns.**

FOR A SINGLE MEASUREMENT

Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Sample Interval}} \times \text{Period}$$

Resolution:

$$\pm \frac{150\text{ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Period}$$

Accuracy:

± Resolution ± (Time Base Aging x Period).

MEAN ESTIMATION FOR AVERAGED MEASUREMENTS

rms Resolution:

Continuous Measurements (Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times \left(150\text{ps rms} + (1.4 \times \text{Trigger Error})\right)}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Period}$$

All other Measurements:

N = number of measurements averaged.

$$\pm \frac{150\text{ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval} \times \sqrt{N}} \times \text{Period}$$

Accuracy:

± Resolution ± (Time Base Aging x Period).

Frequency or Period Ratio

Range:

Channel A and B: **250 mHz [16 kHz] to 500 MHz (2 ns to 4.0 s [65 μs]).**

Channel C: **100 MHz to 2 GHz (0.5 ns to 10 ns).**

Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Sample Interval}} \times \text{Ratio}$$

Resolution:

$$\pm \frac{150\text{ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Ratio}$$

Accuracy (for Frequency A/B):

$$\pm \text{Resolution} \pm \frac{\text{Time Base Aging} \times \text{Frequency A}}{\text{Time Base Aging} \times \text{Frequency B}}$$

Totalize

Resolution:

± 1 count of input per measurement sample, for each channel.

For A/B:

$$\pm \frac{\text{Totalize Result A} \pm 1}{\text{Totalize Result B} \mp 1}$$

For B/A:

$$\pm \frac{\text{Totalize Result B} \pm 1}{\text{Totalize Result A} \mp 1}$$

Accuracy:

± Resolution

Time Interval

Range:

Time Interval: **10 ns to 8.0 s [131 μs].**

Continuous Time Interval: **100 ns [75 ns] to 8.0 s [131 μs].**

± Time Interval: **- 4.0 s [- 65 μs] to +4.0 [+ 65 μs], including 0 seconds.**

Least Significant Digit Displayed:

N = number of measurements averaged.

$$\pm \frac{200\text{ ps}}{\sqrt{N}}$$

Resolution:

$$\pm \frac{150\text{ ps rms} \pm \text{Start Trigger Error} \pm \text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy:

± Resolution ± (Time Base Aging x Time Interval) ± Trigger Level Timing Error ± 1 ns Systematic Error.

Time Deviation

Signal Input Range:

2 ns to 8.0 s [131 μs].

Least Significant Digit Displayed:

± 200 ps.

Resolution:

±150 ps rms ± (1.4 x Trigger Error).

Accuracy:

±Resolution± (Time Base Aging x Time Interval) ± 1 ns Systematic Error.

Automatic Carrier Determination

rms Resolution (for Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times (150\text{ps rms} + 1.4 \times \text{Trigger Error})}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Time Base Aging x Frequency).

Rise Time A and Fall Time A

Range:

1 ns to 100 us transitions (auto trigger).

Repetition Rate:

≥ 0.5 Hz.

Time between pulses:

≥ 8 ns.

Minimum Pulse Height (X1 Attenuation, Minimum Hysteresis):

200 $mV_{pk\text{-}pk}$ (auto trigger).

Least Significant Digit Displayed:

N = number of measurements averaged.

$$\pm \frac{200\text{ ps}}{\sqrt{N}}$$

Resolution:

$$\pm \frac{150\text{ ps rms} \pm \text{Start Trigger Error} \pm \text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy:

± Resolution ± (Time Base Aging x Rise Time) ± Trigger Level Timing Error ± 1 ns Systematic Error

Positive and Negative Pulse Width A

Range:

1 ns to 1 ms pulse width (auto trigger).

Repetition Rate:

≥ 0.5 Hz.

Time between pulses:

≥ 8 ns.

Minimum Pulse Height (X1 Attenuation, Minimum Hysteresis):

200 $mV_{pk\text{-}pk}$ (auto trigger).

Least Significant Digit Displayed:

N = number of measurements averaged.

$$\pm \frac{200\ \text{ps}}{\sqrt{N}}$$

Resolution:

$$\pm \frac{150\ \text{ps rms} \pm \text{Start Trigger Error} \pm \text{Stop Trigger Error}}{\sqrt{N}}$$

Accuracy:

± Resolution ± (Time Base Aging x Pulse Width) ± Trigger Level Timing Error ± 1 ns Systematic Error*

*Systematic error can be significantly reduced with the HP J06-59992A Time Interval Calibrator.

Duty Cycle A

Range:

0% to 100% (provided pulse width is > 1 ns, and signal period is:

< 1 ms (auto trigger).
< 2 s [32.5 µs] (manual trigger).

Repetition Rate:

≤ 0.5 Hz.

Time between pulses:

≥ 8 ns.

Minimum Pulse Height (X1 Attenuation, Minimum Hysteresis):

200 $mV_{pk\text{-}pk}$ (auto trigger).

Least Significant Digit Displayed:

$$\pm \frac{200\text{ps}}{\text{Period}} \times 100\%$$

Resolution:

$$\pm \text{Duty Cycle} \times \left(150\ \text{ps rms} \pm (1.4 \times \text{Trigger Error})\right) \times \sqrt{\frac{1}{(t_2 - t_1)^2} + \frac{1}{(t_3 - t_1)^2}}$$

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Accuracy:

$$\pm \text{Resolution} \pm \left(\frac{\text{Trigger Level Timing Error} \pm 1\text{ ns}}{\text{Period}} \right) \times 100\%$$

Phase

Signal Input Range:

250 mHz [16 kHz] to 500 MHz.

Least Significant Digit Displayed:

$$\pm \frac{200\text{ ps}}{\text{Period}} \times 360°$$

Resolution: A relative to B (B relative to A)

$$\pm\text{Phase} \times \left(150\text{ ps rms} \pm (1.4 \times \text{Trigger Error})\right) \times \sqrt{\frac{1}{(t_4 - t_3)^2} + \frac{1}{(t_3 - t_1)^2}}$$

Accuracy: A relative to B (B relative to A)

$$\pm \text{Resolution} \pm \left(\frac{\text{Trigger Level Timing Error} \pm 1\text{ ns}}{\text{Period}} \right) \times 360°$$

Phase Deviation

Signal Input Range:

125 mHz [8 kHz] to 500 MHz.

Least Significant Digit Displayed:

$$\pm \frac{200\text{ ps}}{\text{Reference Period}} \times 360°$$

Resolution:

$$\pm \left(\frac{150\text{ ps rms} \pm (1.4 \times \text{Trigger Error})}{\text{Reference Period}} \right) \times 360°$$

Accuracy:

$$\pm \text{Resolution} \pm \left(\frac{(\text{Time Base Aging} \times \text{Time Interval}) \pm \text{Trigger Level Timing Error} \pm 1\text{ ns Systematic Error}}{\text{Reference Period}} \right) \times 360°$$

Automatic Carrier Determination

rms Resolution (for Number of Measurements per Block ≥3):

$$\frac{\sqrt{13.5} \times (150\text{ps rms} + 1.4 \times \text{Trigger Error})}{(\text{Number of Blocks})^{1/2} \times (\text{Number of Measurements per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Time Base Aging x Frequency).

Peak Amplitudes A, B

Frequency Range:
1 kHz to 200 MHz.

Amplitude Range (X1 Attenuation):
200 mV_{pk-pk} to 2 V_{pk-pk}.

Accuracy:
±20% of peak-to-peak amplitude, 1 kHz to 200 MHz.

Input

Channel A and B

All input signals refer to sinusoidal signals, except where noted.

Input Pods

The following specifications refer to pods installed in an HP 5372A system.

HP 54002A

Bandwidth:
dc to 500 MHz.

Maximum input voltage:
X1: **±2V.**
X2.5: **±5V.**

HP 54001A

Bandwidth:
dc to 500 MHz.

Maximum input voltage:
±20V.

HP 54003A with 10:1 probe

Bandwidth:
dc to 300 MHz.

Maximum input voltage:
±20V.

HP 54003A without 10:1 probe

Bandwidth:
dc to 300 MHz.

Maximum input voltage:
±2V.

The following specifications refer to an HP 5372A with HP 54002A pods installed.

Range:

dc coupled to 500 MHz.

Sensitivity (X1 Attenuation, Minimum Hysteresis):

15 mV rms sine wave (45 mV_{pk-pk}).
45 mV_{pk-pk} for a minimum pulse width.

Minimum pulse width:

For all measurement modes except Holdoff Arming: **1 ns** (at a minimum amplitude).

Holdoff Arming modes: **1.5 ns** (at a minimum amplitude).

Dynamic Range:

X1: **45 mV_{pk-pk} to 2 V_{pk-pk}.**

Signal Operating Range:

X1: **-2 Vdc < dc ± ac pk < +2 Vdc.**

Damage Level:

X1: **±2.5 V (dc ± ac pk).**

X2.5: **±5.5 V (dc ± ac pk).**

Input Triggering Characteristics

	Manual Triggering	Auto Triggering (Single or Repetitive)
Voltage Range:		
X1:	**-2 Vdc to +2 Vdc**	**-2 Vdc to +2 Vdc**
X2.5:	**-5 Vdc to +5 Vdc**	**-5 Vdc to +5 Vdc**
Frequency Range:	**dc to 500 MHz**	**1 kHz to 200 MHz**
Accuracy:	**20 mV ± 1% of setting**	**±20% of $_{pk-pk}$ amplitude (200 mV_{pk-pk} minimum)**

External Arm

In addition to the External Arm input, both input channels A and B may also be used as high performance arming inputs.

Range:

dc coupled to 100 MHz.

Sensitivity:

50 mV rms sine wave.
140 mV_{pk-pk} at a minimum pulse width.

Minimum Pulse Width:

5 ns at a minimum amplitude.

Dynamic Range:

140 mV_{pk-pk} to 5 V_{pk-pk}.

Signal Operating Range:

-5 Vdc < dc ± ac pk < + 5 Vdc.

Damage Level:

5 V rms (±15 V_{pk-pk}, dc ± peak ac).

Channel C
(Option 030 or Option 090)

The following applies to the optional high frequency measurement channel included with Option 030 and Option 090.

Range:

100 MHz to 2 GHz.

Sensitivity (0% attenuation):

100 MHz to 1.5 GHz: - 25 dBm.
>1.5 GHz to 2.0 GHz: - 20 dBm.

Dynamic Range (0% attenuation):

100 MHz to 1.5 GHz: - 25 dBm to + 7 dBm.
>1.5 GHz to 2.0 GHz: - 20 dBm to + 7 dBm.

Signal Operating Range:

- 5 Vdc to +5 Vdc.

Damage Level:

AC > +20 dBm.
DC ± 5 V.

Rear Panel Connectors

Frequency Standard External Input

Input Level Range:

1.0 V_{pk-pk} to 5.0 V_{pk-pk}.

Acceptable Frequencies:

1 MHz, 2 MHz, 5 MHz, or 10 MHz, ±1%.

Damage Level:

10 V (dc ± peak ac).

Inhibit

Damage Level:

±5.5 V.

Option 060 Rear Panel Inputs

Input channel A and B performance is equivalent to front panel performance. External Arm performance for the Option 060 configuration is as follows:

Range:

dc coupled to 100 MHz.

Sensitivity:

100 mV rms sine wave.
280 mV_{pk-pk} at a minimum pulse width.

Minimum Pulse Width:

5 ns at a minimum amplitude.

Dynamic Range:

280 mV_{pk-pk} to 5 V_{pk-pk}, dc to 20 MHz.
280 mV_{pk-pk} to 2.5 V_{pk-pk}, 20 MHz to 100 MHz.

Signal Operating Range:

±5 Vdc.

Damage Level:

5 V rms (±15 V_{pk-pk}, dc ± peak ac).

All triggering specifications are the same as for the front panel configuration.

Time Base

Frequency

10 MHz.

Stability

Aging Rate:

< 5 X 10^{-10} per day after a 24 hour warm-up
when:
1. oscillator off-time* was less than 24 hours.
2. oscillator aging rate was < 5 x 10^{-10} per day prior to turn-off.*

< 5 x 10^{-10} per day in less than 30 days of continuous operation for off-time* greater than 24 hours.

< 1 x 10^{-7} per year for continuous operation.

Short Term:

< 1 x 10^{-10} for a 1 second average.

Temperature:

< 7 x 10^{-9}, 0 to 40° C ambient temperature.

Line Voltage:

< 1 x 10^{-10} for 10% change from the Nominal line voltage.

Warm-up:

Within 5 x 10^{-9} of final value, 10 minutes after turn-on**
when:
1. HP 5372A is operated in a 25° C environment.
2. Oscillator off-time* was less than 24 hours.
3. Oscillator aging rate was < 5 x 10^{-10} per day prior to turn-off*.

General

Operating Temperature:
0 to 40° C.

Power Requirements:

Voltages:
100, 120, 220 or 240 Vac, ± 10%.

Frequencies:
45 - 66 Hz for all voltages.
360 - 440 Hz for 100 and 120 Vac.

Maximum Power:
500 VA.

* "Turn-off", "turn-on", and "off-time" apply to periods when power is disconnected from the HP 5372A rear panel. Stand-by operation provides power to the oscillator's oven.

** Final value is defined as oscillator frequency 24 hours after turn-on*.

Notes

Table 1. HP 5372A Arming Modes

ARMING MODE	MEASUREMENT FUNCTION													
	TIME INTERVAL OR HISTOGRAM TI		CONTINUOUS TIME INTERVAL OR HISTOGRAM CTI	±TIME INTERVAL OR HISTOGRAM ±TI		FREQUENCY, PERIOD		TOTALIZE		POS WIDTH NEG WIDTH RISE TIME FALL TIME DUTY CYCLE	PHASE	PEAK AMPLITUDE	PHASE DEVIATION	TIME DEVIATION
	A B	A → B B → A	A B	A	A → B B → A	A B C	DUAL[1] RATIO[2] SUM[3] DIFF[4]	A B	DUAL[1] RATIO[2] SUM[3] DIFF[4]	A	A rel B B rel A	A B	A B	A B
AUTOMATIC														
AUTOMATIC	C*	C*	C*		C*	C*	C*			C*	C*	N*	C*	C*
HOLDOFF														
EDGE HOLDOFF	C	C	C		C	C					C		C	C
TIME HOLDOFF	C	C	C			C								
EVENT HOLDOFF	C	C	C			C								
SAMPLING														
INTERVAL SAMPLING	C	C	C		C	C	C	C*	C*		C		C	C
TIME SAMPLING						N								
CYCLE SAMPLING						C								
EDGE SAMPLING						C	C	C	C					
PARITY SAMPLING					C									
REPET EDGE SAMPLING	C	C	C		C									
REPET EDGE-PARITY SAMPLING					C									
RANDOM SAMPLING	C	C			C									
HOLDOFF/SAMPLING														
EDGE/INTERVAL	C	C	C		C	C	C	C	C		C		C	C
EDGE/TIME						N								
DGE/EDGE						C		C	C					
EDGE/CYCLE						C								
EDGE/EVENT				N	N	N								
EDGE/PARITY					C									
EDGE/RANDOM	C	C			C									
TIME/INTERVAL						C		C						
TIME/TIME				N	N	N								
EVENT/INTERVAL						C								
EVENT/EVENT				N*	N	N								
EXTERNALLY GATED						C		C	C					
MANUAL								N	N					

Symbol C or N indicates that a measurement can be made using the corresponding combination of Function, Channel, and Arming selections.

C = Continuous Arming (Holdoff/Sample Arming)

N = Non-Continuous arming (Start/Stop Arming)

* = Default Arming

1. DUAL. Simultaneous Dual-Channel, (2 results). Frequency and Period options are: A&B, A&C, B&C. Totalize option is: A&B.
2. RATIO. Frequency and Period ratio options are: A/B, A/C, B/A, B/C, C/A, C/B. Totalize ratio options are: A/B, B/A.
3. SUM. Frequency and Period sum options are A+B, A+C, B+C. Totalize sum option is: A+B
4. DIFFERENCE. Frequency and Period difference options are: A-B, A-C, B-A, B-C, C-A, C-B. Totalize difference options are: A-B, B-A.

ARMING CATEGORIES

Category	Continuous Arming Modes	Non-continuous Arming Modes
Automatic	Block Holdoff is Automatic Sample Arm is Automatic	none
Holdoff Modes	Block Holdoff is Selectable Sample Arm is Automatic	none
Sampling Modes	Block Holdoff is Automatic Sample Arm is Selectable	Start Arm is Automatic Stop Arm is Selectable
Holdoff/Sampling Modes	Block Holdoff is Selectable Sample Arm is Selectable	Start Arm is Selectable Stop Arm is Selectable

For more information, call you local HP sales office listed in your telephone directory or an HP regional office listed below for the location of your nearest sales office.

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U.K.:
(0734) 777 828

Middle East and Africa:
Geneva-Switzerland
41/22 780 7111

European Headquarters
Hewlett-Packard S.A.
150, Route du Nant d'Avril
1217 Meyrin 2
Geneva--Switzerland
41/22 780 8111

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