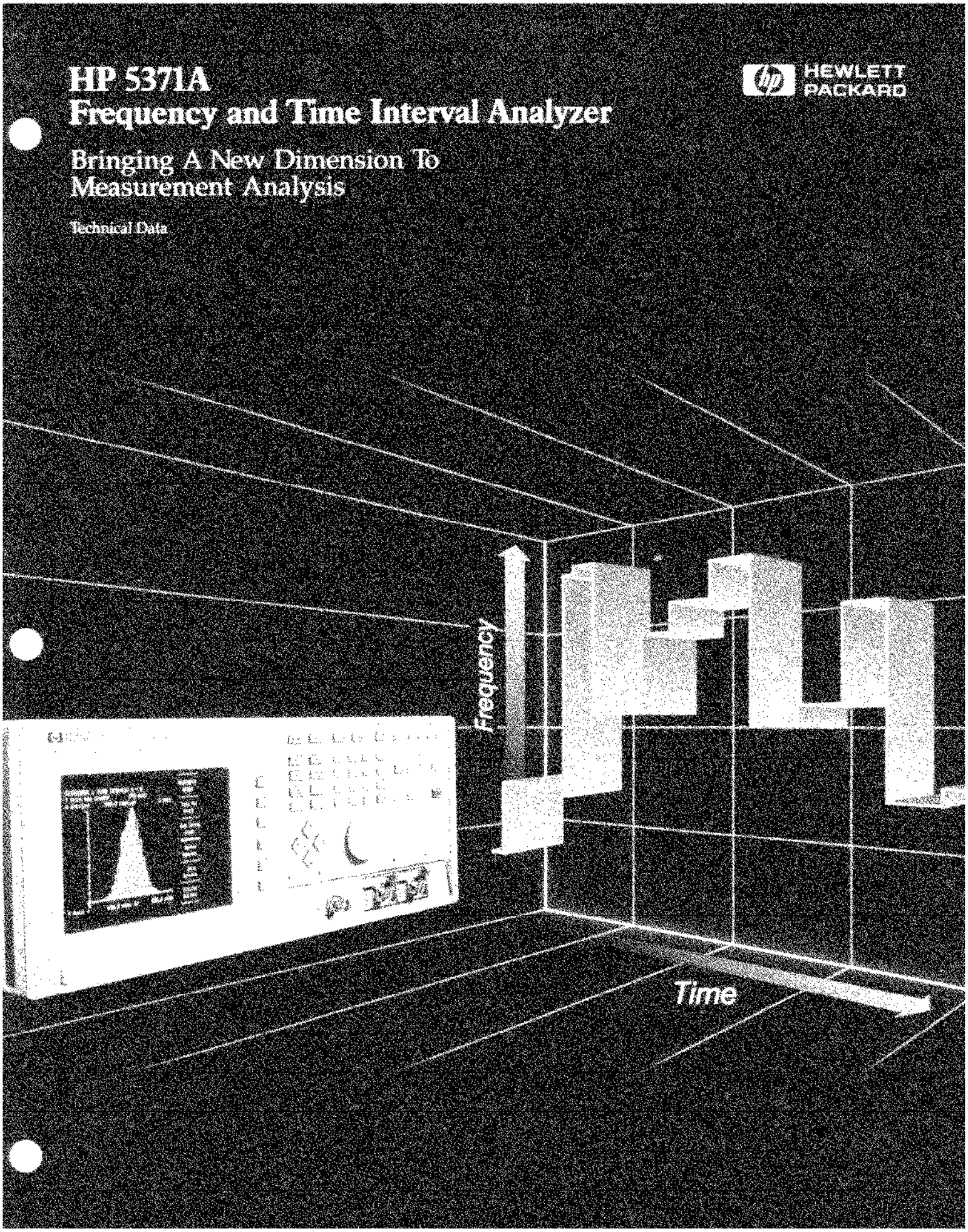
HP 5371A
Frequency and Time Interval Analyzer

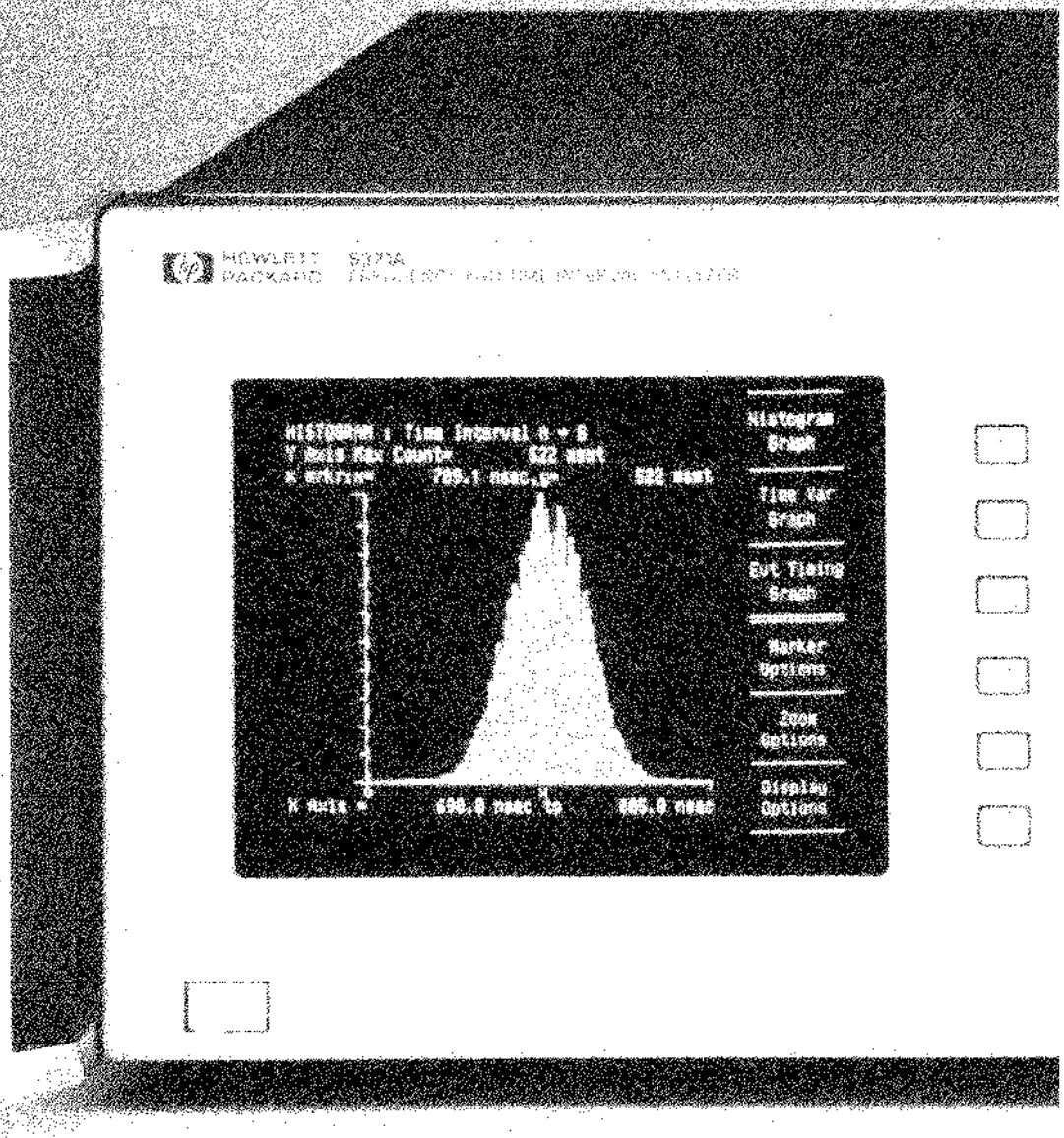
Bringing A New Dimension To Measurement Analysis

Technical Data



Introducing Continuous Measurement

New Measurement Capabilities for the 5370A



Performance

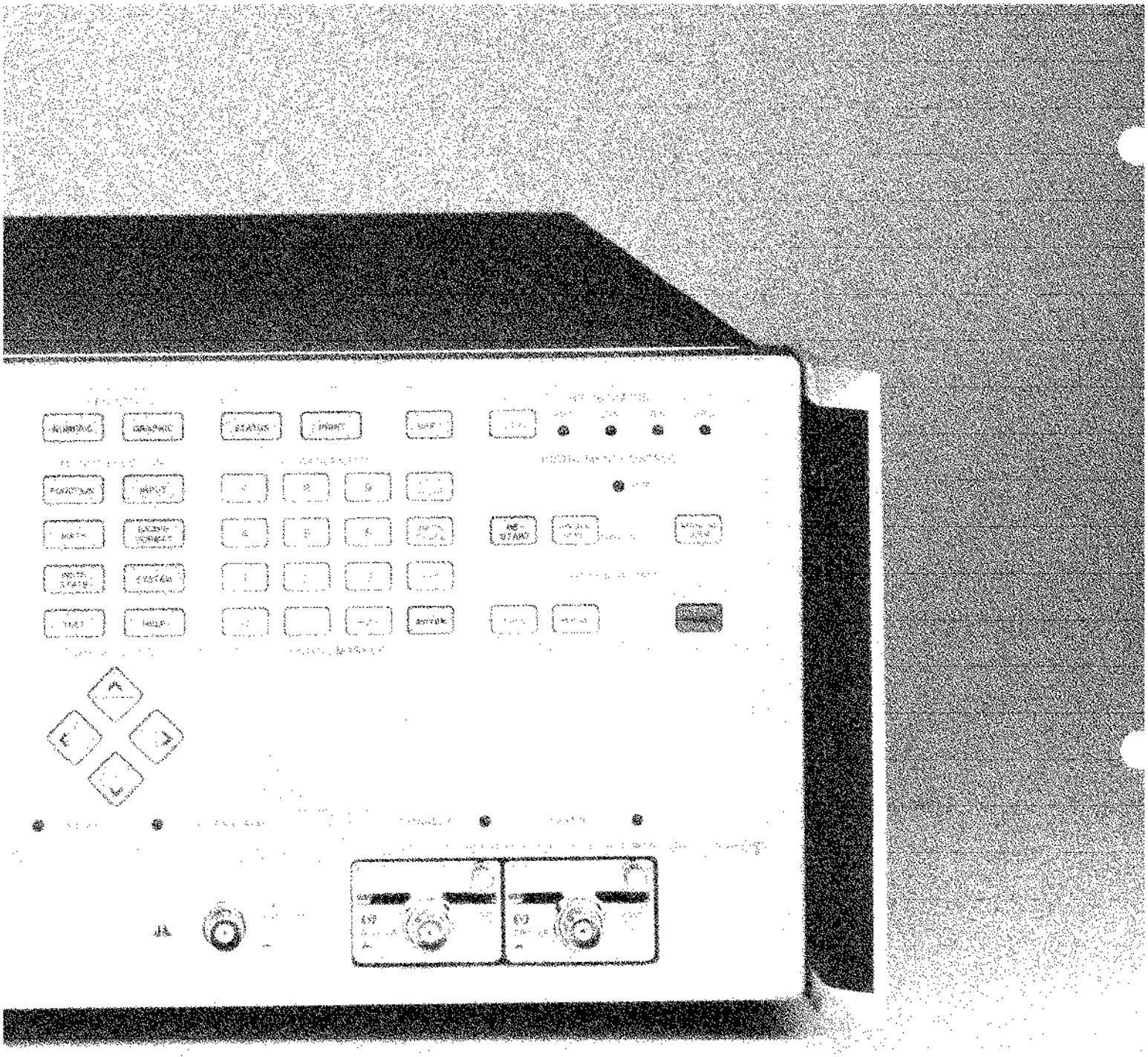
- Up to 10 Million Measurements per Second
- 500 MHz Frequency Range
- -4.0 to +4.0 Second Time Interval Range, Including 0 Seconds
- 150 ps rms Single-Shot Resolution, 10 Digits of Resolution
- 1 ns Minimum Pulse Width
- 2 mV Trigger Level Resolution
- Auto-Trigger

Arming/Triggering

- Holdoff by Time, Events, or Signal Edge
- Sample by Time, Events, Edge, Cycle, or Parity
- Arm on Any of Three Input Channels: External Arm, Input A, or Input B

Measure Selectio

- Frequenc
- Time Int Interval Interval
- Positive Pulse Wi
- Rise Tim
- Duty Cy
- Totalize
- Phase
- Peak Am



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Negative

or Full Time

Mode

HP-IB

- Up to 20,000 Measurements per Second Throughput
- Three Output Formats: ASCII, Floating Point, or Binary
- English-like HP-IB Commands
- Full Programmability
- Direct Graphics Output to Printer or Plotter

Analysis

- Time Variation of Measurements
- Histogram
- Event Timing
- Limit Test
- Statistics: Mean, Minimum, Maximum, Standard Deviation, Variance, rms
- Allan Variance, Root Allan Variance

For More Insight Into Frequency and Time Interval Analysis

The HP 5371A Frequency and Time Interval Analyzer takes a revolutionary approach to frequency and time interval analysis. Adding the dimension of time to measurements, this innovative analyzer captures frequency or time intervals at extremely high speeds. Also featured on the HP 5371A is a wide choice of arming and triggering capability, combined with built-in analysis.

Modulation analysis, jitter analysis, and frequency profiling benefit from the HP 5371A's new measurement approach. These applications require fast measurements; fast enough to see changing frequency or time intervals, not just an average. The HP 5371A uses a time sampling technique that captures and displays data quickly. As a result, you get more insight into the dynamics of frequency and time interval data.

Continuous Measurement Adds the Time Dimension

The HP 5371A's time sampling technique is called "continuous measurement" because the count hardware is not reset between measurements. Eliminating this reset time dramatically increases measurement throughput. By sampling fast enough, the time variation of frequency or time interval data can be reconstructed. This effectively adds the time dimension to measurement analysis.

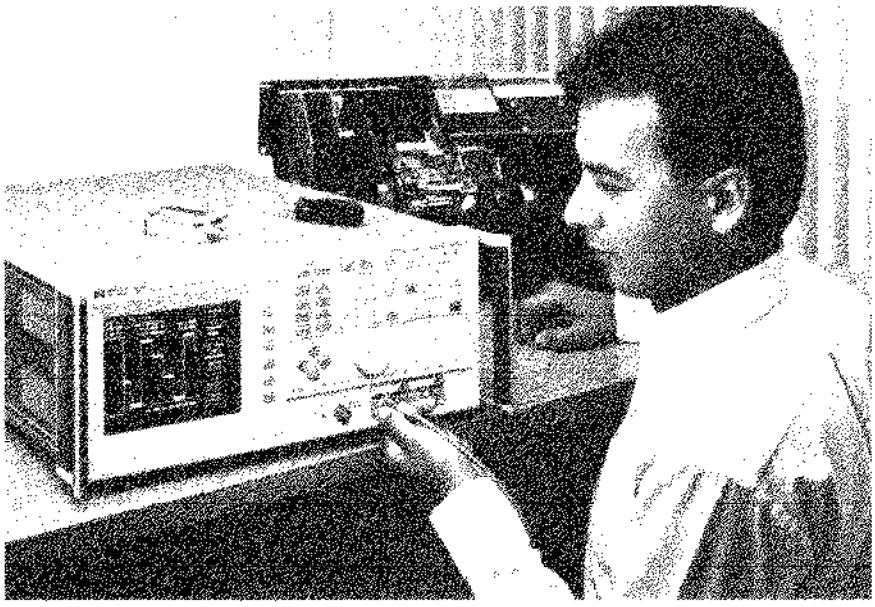
The analyzer measures carrier signals up to 500 MHz for sampling intervals as short as 100 ns. Each individual sample has 150 ps rms resolution. The sample and its precise time of occurrence are stored in the HP 5371A's internal memory.

Extensive Arming and Triggering for Measurement Control

Measurement control is simplified with the HP 5371A's extensive arming and triggering capabilities. Control measurements by time, events, an external edge, or a combination of the three. Both A and B input channels as well as the External Arm input may be used for arming and triggering. Special custom hardware is eliminated with the powerful arming and triggering capability of the HP 5371A. Analysis is fast and easy because data is gathered only during periods of interest.

Graphic Display for Viewing and Analyzing Data

Statistics, histograms, time variation of data, event timing, and limit testing turn data into useful information. Information like FM deviation, frequency stability, and pulse jitter. Because this capability is built-in, you don't have to send data to a computer or write analysis software. The HP 5371A provides analysis capability with the press of a button.



The HP 5371A introduces continuous measurement technology offering fast, precise frequency and time interval measurements.

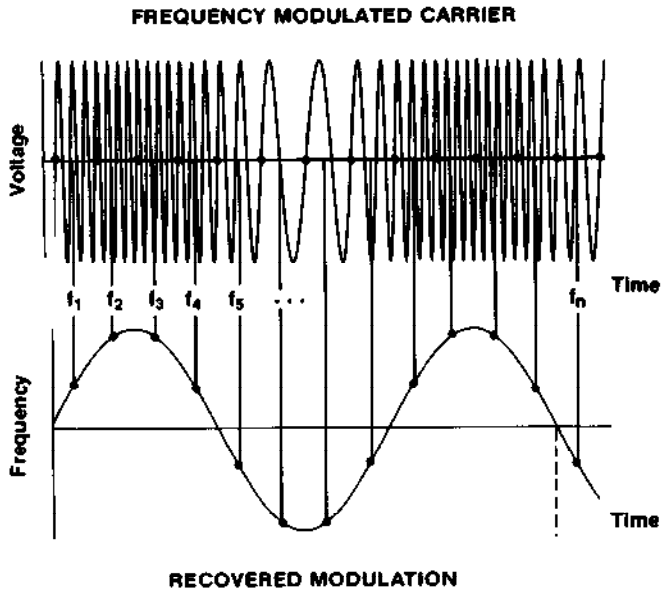
High Speed Continuous Measurements Reveal Hidden Information

The HP 5371A's continuous measurement technology dramatically increases throughput by eliminating dead time between frequency or time interval measurements. Dead time occurs with traditional measurement techniques when the instrument stops, computes a result, and prepares for the next measurement. The HP 5371A does not stop between measurements. As a result, you get previously unavailable data, as well as the precise time of each measurement.

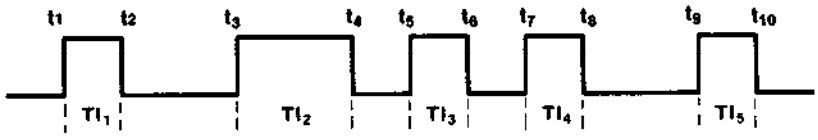
Time sampling is possible with the HP 5371A's continuous measurement technique. Just as a digitizing scope adds the time dimension to voltmeter measurements, the HP 5371A adds the time dimension to counter measurements. You can now view frequency or time interval variation with time on the HP 5371A, just as you can view voltage variation with time on an oscilloscope.

To see how useful continuous frequency measurements can be, consider measuring a frequency-modulated (FM) carrier. If frequency is measured (or sampled) often enough, the plot of these frequency samples versus time is the modulation (in this case, a sine wave). The HP 5371A effectively becomes a frequency demodulator, measuring carriers up to 500 MHz at a rate as fast as 10 million measurements per second.

Consider another example: measure the timing of data edges in a serial data stream. The time of every data edge up to 10 MHz (5 MHz for dual trigger measurements) will be recorded. If the data rate exceeds this rate, the HP 5371A tells you how many edges have not been timed. You know exactly which events have been measured.



By "sampling" a frequency or phase modulated carrier often enough, the HP 5371A can reconstruct modulation characteristics, in this case sinusoidal frequency modulation.



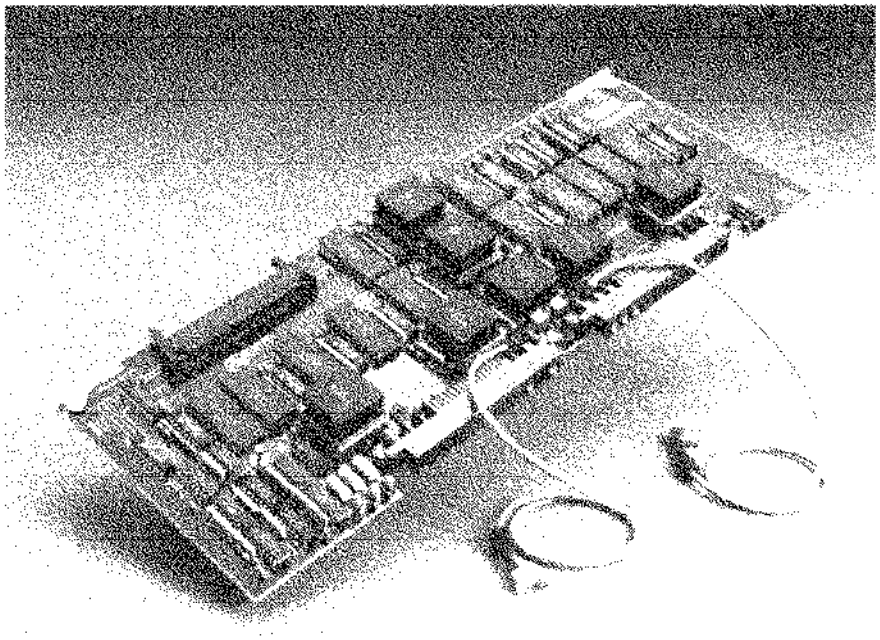
Every time interval is measured by the HP 5371A. This diagram shows how the HP 5371A measures pulse width jitter.

Continuous Measurement Technology

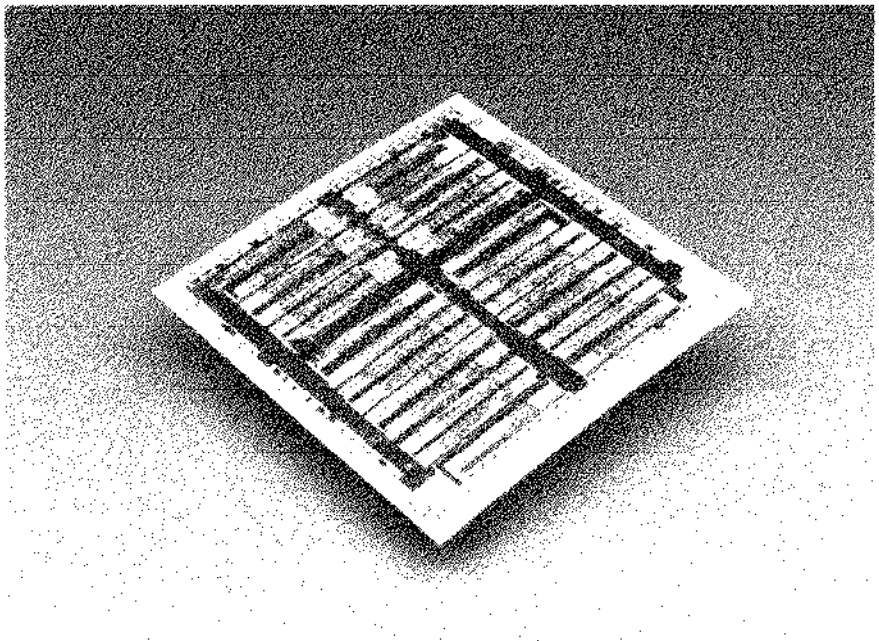
Hewlett-Packard has patented a design that lets count totals be read on-the-fly at rates to 10 MHz for input signals to 500 MHz, without interrupting the counting process. The HP 5371A's count registers are never reset from one measurement to the next. Three 32-bit count chains operate simultaneously for arming or measurements.

In addition to reading data on-the-fly, the HP 5371A interpolates the ± 1 count uncertainty to 200 ps. Results are sent to memory, and the HP 5371A re-arms for the next measurement in less than 100 ns.

These count chains, interpolators, and synchronization circuits are implemented in custom Hewlett-Packard integrated circuits. This ensures that the HP 5371A delivers outstanding performance, precision and reliability.

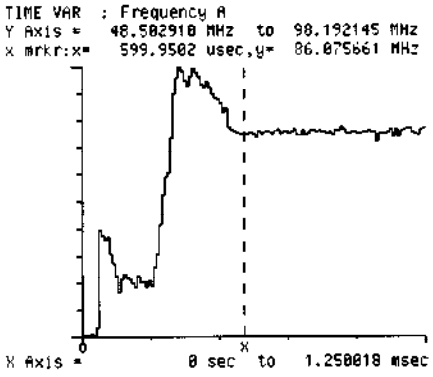


Custom integrated circuits for count hardware and control are key to HP 5371A performance.

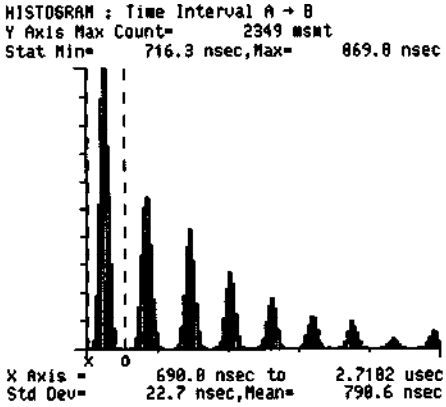


This integrated circuit controls complex arming configurations for input signals to 500 MHz using custom 5 GHz f_t EFL technology.

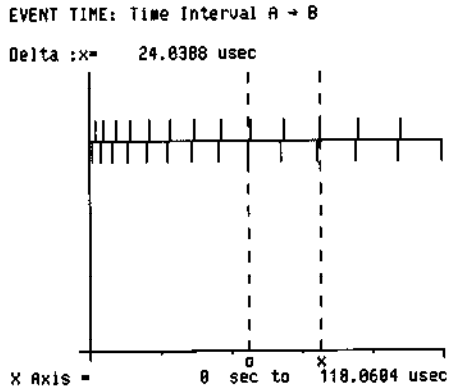
Push-Button Analysis Capability



The Time Variation plot shows frequency variations as a VCO is stepped. By adding the time dimension, you can quickly see data trends, modulation, or transients.



A Histogram of compact disc pulse width measurements with "Eight-to-Fourteen Modulation" coding can be used to statistically analyze each distribution separately.



An Event Timing plot lets you analyze time interval data graphically.

Measurement Time Variation

Time Variation or "Measurements versus Time" makes the HP 5371A Frequency and Time Interval Analyzer an excellent tool for measuring the dynamic characteristics of frequency and time interval. While an oscilloscope displays voltage versus time, the Time Variation plot displays changing frequency or time interval values as a function of time.

Measuring frequency modulation or drift is easy with the Time Variation plot. You can see when frequency or time intervals change, as well as how much. Transient measurements like VCO settling time, frequency-sweep linearity, or motor acceleration and deceleration can also be made easily.

Histograms

The histogram, a statistical distribution of measurement data, gives you detailed, quantitative information. For example, you can quickly identify skewed or bi-modal distributions. This kind of display adds visual meaning to numbers like mean and standard deviation. Using markers, you can select subsets of the data and look at individual distributions like those found in compact disc signals. There's no need for special time and frequency discriminator hardware.

Event Timing

The Event Timing display is practical for serial timing applications like serial data buses. Each "tic" mark is a timed event, or sample. You can put cursors at any pair of samples and see the time between them. Measure the time between the 1st and 5th sample, or the 3rd and 8th pulse in a data stream, or any pair of samples you choose without degrading measurement precision.

Numeric Display

The Numeric Display is a list of the measurements acquired. Examine any measurement in detail, view a statistical summary, or quickly determine samples outside of your specified limits. A bold display mode uses large characters so you can see them from a distance.

```
RESULT/STATISTICS DISPLAY
Frequency A                  01 Jan 1987 00:24:43
View Meas # 1                     100 Measurements

Meas#          Measurement
0001          420.671 053 9 MHz
0002          420.671 085 8 MHz
0003          420.671 110 0 MHz
0004          420.671 158 4 MHz
0005          420.671 175 0 MHz
0006          420.671 185 0 MHz
0007          420.671 156 5 MHz
0008          420.671 125 9 MHz
Mean          420.671 088 60 MHz
Std Dev              324.76  Hz
Max           420.671 556 6 MHz
Min           420.670 870 0 MHz
```

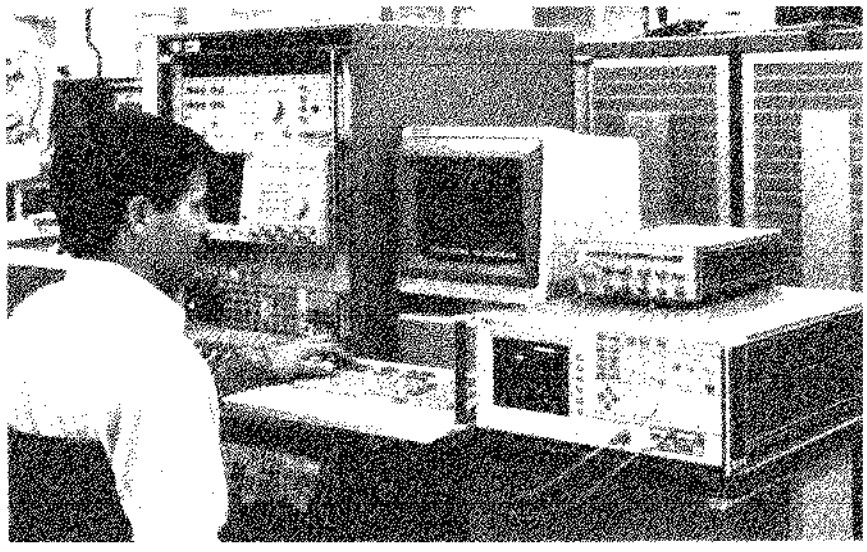
The Numeric display shows a list of acquired measurements as well as statistics.

The statistics are complete: mean, minimum, maximum, standard deviation, variance, rms. Allan Variance and Root Allan Variance ($\sigma_y(\tau)$) are computed for frequency stability applications. Math features include scale, offset, and normalize to put the results in your units; such as degrees Celsius, rpm, or the carrier frequency when you are actually measuring the IF. Set-reference features enable you to zero-out measurement offsets.

```
LIMIT STATUS DISPLAY
Frequency A                  01 Jan 1987 01:48:09
                                  1000 Measurements

Ch A High Limit =  460.0000000E+06
Ch A Low  Limit =  440.0000000E+06
 Range  Measurements  % Total   0%     50%   100%
 High:          246 [  24.6 %]
 Pass:          376 [  37.6 %]
 Low:           378 [  37.8 %]
```

A Limit Test display shows the number of measurements outside of a specified range.



Data output rates up to 20,000 measurements/second and full HP-IB programmability make the HP 5371A an excellent component for ATE systems.

Customized Analysis

The HP 5371A can send data to a computer at rates up to 20,000 measurements per second. Take advantage of the continuous measurement data format and apply your specialized signal processing such as sorting, filtering or special averaging. When using an instrument controller, the memory extends to 4095 measurements.

Arming and Triggering Flexibility Means Measurement Control

The HP 5371A offers a complete choice of arming and triggering features. Over sixty different configurations are available. These can be used to eliminate external circuitry and all of the design and support problems that go with special triggering circuits and interface boxes.

Easy-to-read menus guide you through measurement selection and arming configurations so you have complete control over how and when measurements are acquired. Measurements can be controlled by external edges, specified time delays, specified event delays, or combinations of these. In addition to a separate external arm channel, both Input A and Input B measurement channels are available as arming and triggering inputs.

Arming can be used to delay groups or "blocks" of measurements by time, events, or an external edge. Measurements within these blocks can also be controlled by time, events, or an external edge. Data is acquired by the HP 5371A in blocks of up to 1000 (4095 measurements when used with an instrument controller). Up to two million blocks can be acquired for a total of two billion measurements for histogram and statistical analysis.

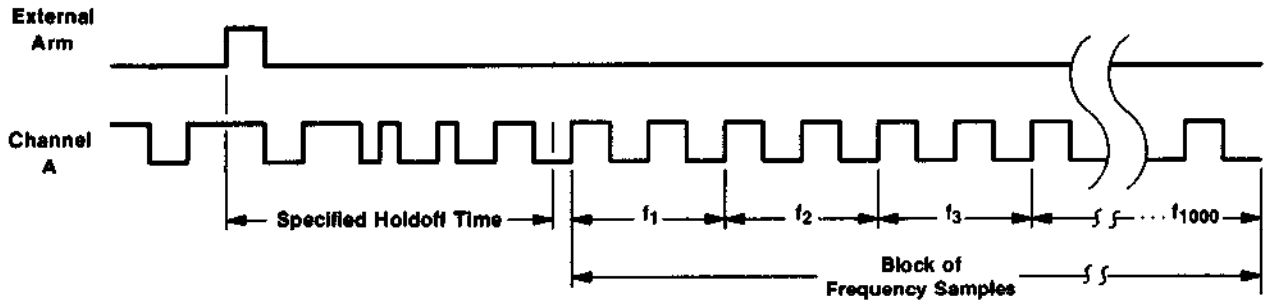
Position Measurements By Time . . .

Here's an example where the measurement block is delayed, or "held off" by a specified time. The specified number of frequency measurements are then executed continuously; that is, with back-to-back measurement gates. The time delay is triggered precisely with an external edge on any of the three channels: External Arm, Input A, or Input B. At the expiration of the specified time delay, the measurement block is armed, and the HP 5371A will sample frequency using the specified gate time, or "sampling interval." The measurement is completed after the specified number of frequency samples have been taken and stored in memory.

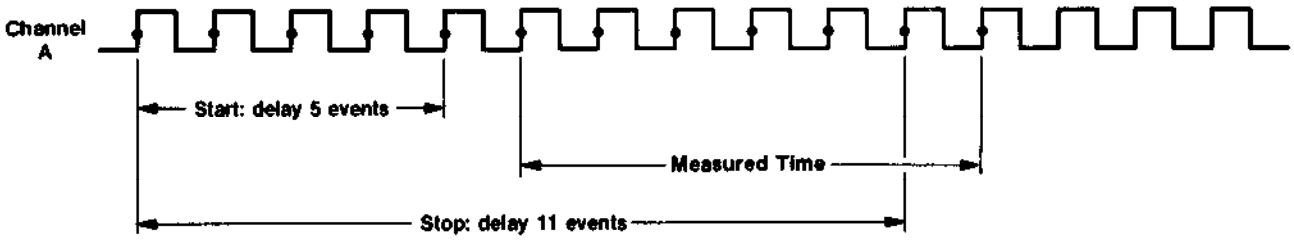
. . . Or Events

Event arming is also possible. Just as measurements can be controlled with time delays, they can also be controlled with event delays. Suppose you want to measure the time between the 6th and 12th edges in a stream of data edges. The HP 5371A can do it without additional external hardware.

The beginning of the measurement is defined by an event delay from an edge, in this case, the first pulse of the data stream. Likewise, the end of the measurement is defined by another event delay from the same first pulse of the data stream. The HP 5371A begins measuring time when the 6th edge occurs, and stops when the 12th edge occurs.



The HP 5371A's "Time Holdoff" arming mode can be used to delay groups or "blocks" of measurements by a specified time.



The HP 5371A's flexible arming lets you make complex measurements without special custom circuitry. This example shows how the time between the 6th and 12th event in a serial data stream can be measured using the "Event/Event" arming mode.

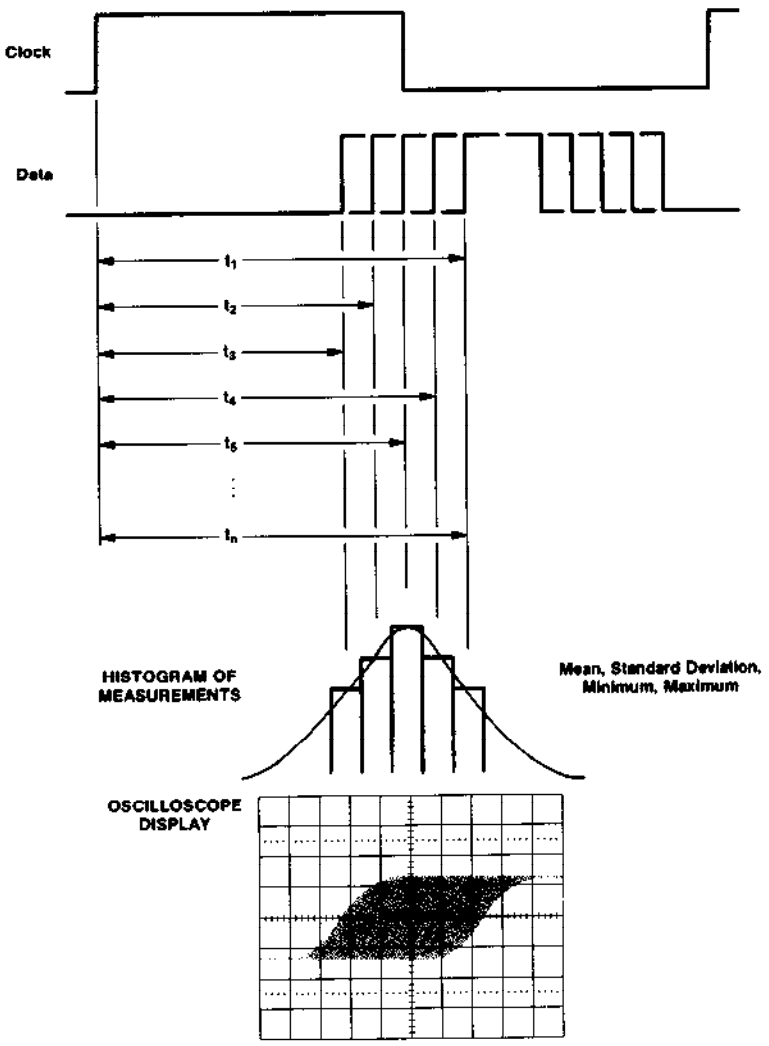
The HP 5371A Can Change the Way You Look at Measurements in Your Application

Now that you know what the HP 5371A can do, see how it fits into your application. You'll find the exceptional capability of the HP 5371A demonstrated in the following examples.

Quantitative Jitter Analysis to 500 Mbits/s

Jitter can limit the performance of your system design. Examples include higher bit error rates because of excessive timing jitter in any form of data communication or poor photocopy quality due to unstable stepper motors. Fuzzy oscilloscope traces indicate the presence of jitter, but don't give statistical information that can quantify jitter effects.

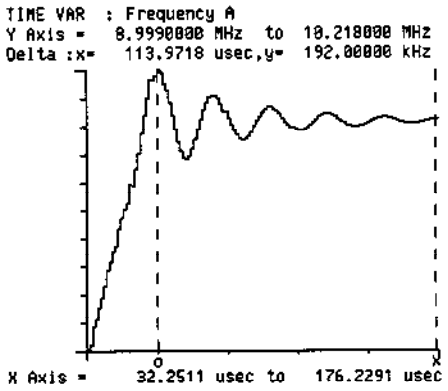
The HP 5371A solves the problem with statistical jitter analysis. A histogram of frequency or time interval measurements will quickly show whether effects are gaussian (random noise effects), or systematic such as coherent noise. Standard deviation or variance results provide an objective indication of the jitter, including bit error rate, for example. Histogram analysis is valuable in production testing where you want fast, reliable, and repeatable results, or those R&D applications where you need detailed information.



Use the HP 5371A Histogram display to quantify clock-to-data jitter in serial communication systems.

Direct VCO Characterization

The HP 5371A can characterize both the transient and steady state response of a VCO. Continuous frequency or phase measurements made at the output of a VCO when the input voltage is stepped provide a direct profile of the step response of the VCO in a single pass. The HP 5371A's time variation plot and cursors let you measure settling time and post tuning drift.

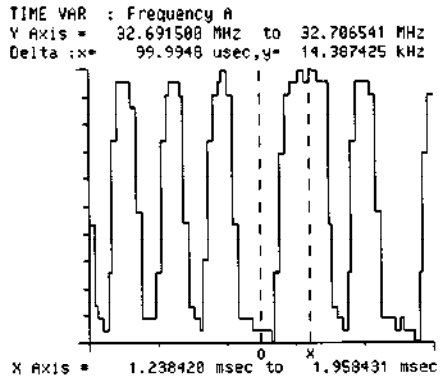


Analyze the settling time characteristics of a stepped VCO in a single shot with the HP 5371A Time Variation plot.

Wide-Band, High Data-Rate Frequency Demodulation

The HP 5371A can handle frequency modulation rates over 1 MHz per second, and peak deviations as wide as 500 MHz. Continuous measurement offers a powerful, flexible way to examine frequency or phase modulation in a single-shot manner.

An FSK (Frequency Shift Keying) modulated signal provides a good illustration. Continuous frequency measurements using a relatively short gate time directly profile the switching carrier. Histogram analysis quickly shows the distribution and mean value of each carrier frequency. A Time Variation plot displays the actual modulating signal. Sorting routines can be used to analyze each frequency "step" individually. The single-shot manner in which the HP 5371A operates gives you the capability to analyze transients such as frequency overshoots—not possible with conventional techniques.



Read characteristics such as peak-to-peak deviation, FSK rate and the recovered data itself directly from the display of a carrier with FSK modulation.

Frequency Stability with Allan Variance

Many applications specify frequency stability in the time domain, or by "Allan Variance". Allan Variance and Root Allan Variance ($\sigma_y(\tau)$) are calculated and displayed directly by the HP 5371A along with traditional statistical parameters. Frequency to 500 MHz is measured with zero dead time, assuring no lost information in the Allan Variance calculation.

STATISTICS DISPLAY
Frequency A
01 Jan 1987 03:21:52
1000 Measurements

Mean	10.001 751 3 MHz
Std Dev	114.9 Hz
Maximum	10.001 968 MHz
Minimum	10.001 432 MHz
RMS	10.001 966 1 MHz
Rt Al Var	46.9 Hz
Allan Var	2.201 8 kHz^2
Variance	13.210 4 kHz^2

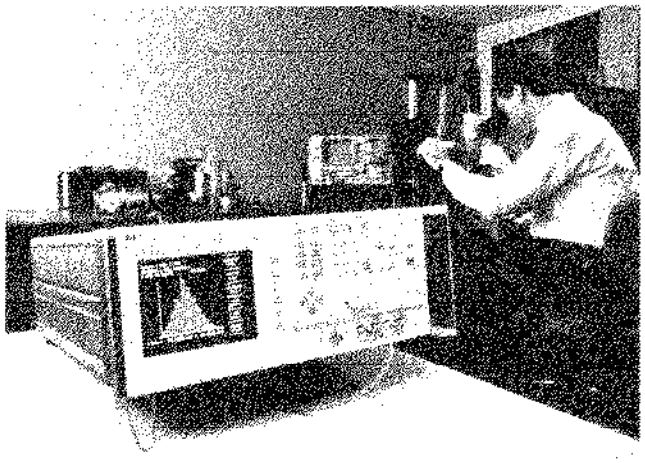
Allan Variance calculations are displayed along with other standard statistical parameters. Sample sizes up to 1000 measurements can be selected.

Measure Every Data Edge for Improved Disc Drive Characterization

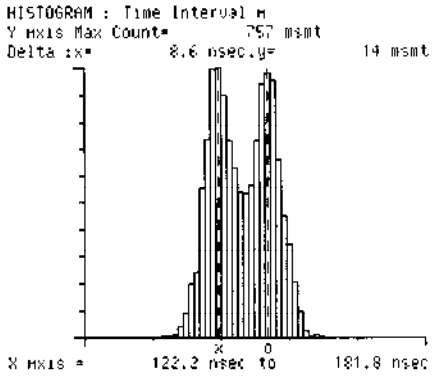
Floppy disc, hard disc, optical disc, or magnetic tape. Whatever type of computer storage peripheral you're testing, the HP 5371A is a valuable diagnostic tool. It lets you examine any single edge, or group of data edges in fine detail to determine the exact cause of problems and ultimately improve the error rate performance of the drive.

Measure clock-to-data and data-to-data timing jitter and analyze the results directly with statistical and graphical analysis. The HP 5371A gives you precise, quantitative information about peak shift and asymmetry characteristics. Peak shift can be determined using the built-in histogram capabilities. Asymmetry effects of the bipolar read signal can be quantified by separating positive and negative pulse data with continuous time-interval capability. Statistical information can then be calculated separately for each distribution.

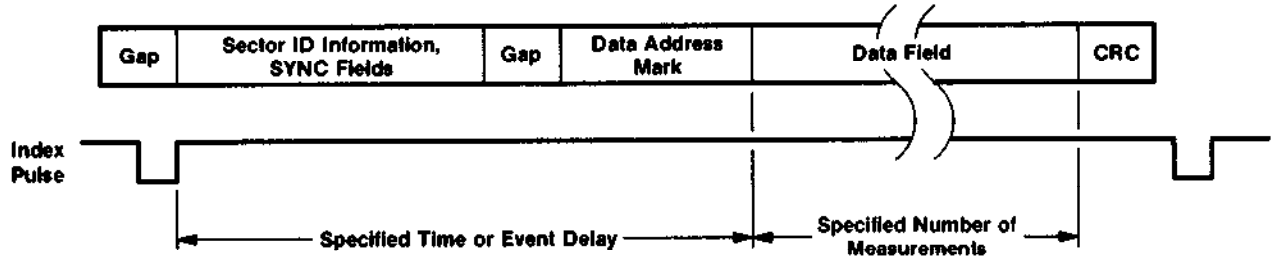
The arming and triggering capability of the HP 5371A is a real advantage for disc drive analysis. You can delay measurements from the index pulse by time or events. Then measure only in the data field, not the header or error correction code portions of the sector. Accumulate measurements sector-by-sector with continuous measurement capability so you know exactly where problems occur.



The HP 5371A is an excellent tool to characterize hard disc drives and other types of computer storage peripherals. Improve error-rate performance with the HP 5371A's extensive diagnostic capabilities.



This HP 5371A histogram clearly shows asymmetry effects. The distributions are separated by 8.6 nsec.



A time or event holdoff can be used to delay measurements from the index pulse into the data portion of the sector.

Single Shot Analysis of Agile Communication Signals

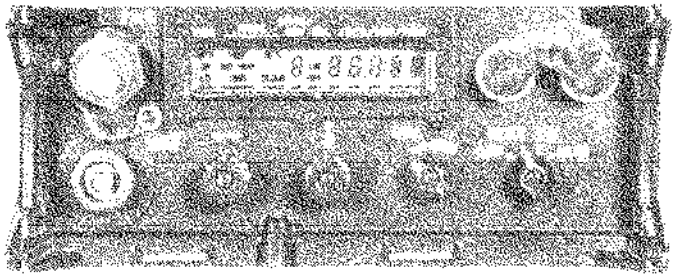
Measuring and characterizing fast hopping radio signals used in spread-spectrum communications can be difficult. The pseudo-random nature of carriers means repetitive measurement techniques cannot be used to measure hopping radio performance. The HP 5371A's single-shot capabilities are excellent for complete characterization of hopping radio transmitters.

Use the HP 5371A to measure parameters such as the settling time of frequency hops, random channel usage, and the modulation on top of agile carriers. You can now test hopping transmitters on their own merit, replacing back-to-back, or "golden unit" techniques where transmitter and receivers must be tested in pairs.

Hopping carrier techniques require the switched carrier to settle to the correct frequency within a specified time. The HP 5371A time variation plot shows the hopping characteristics and settling time directly.

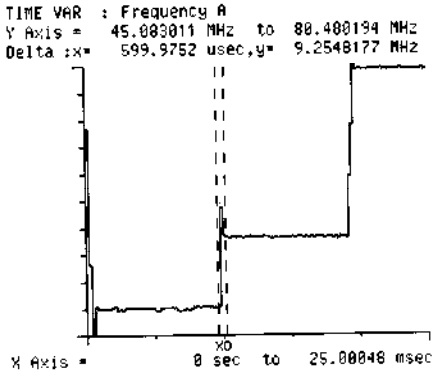
A histogram of frequencies is a clear measure of the random usage of the frequency spectrum. A "flat" histogram characteristic insures that hopping algorithms maintain the security of the radio system.

In addition to measuring the characteristics of the hopping carrier, the HP 5371A simultaneously examines details of frequency modulation, such as FSK, on the carrier. Conventional modulation analysis techniques have difficulty with the agile carrier. The HP 5371A can easily measure these parameters in a single-shot fashion.

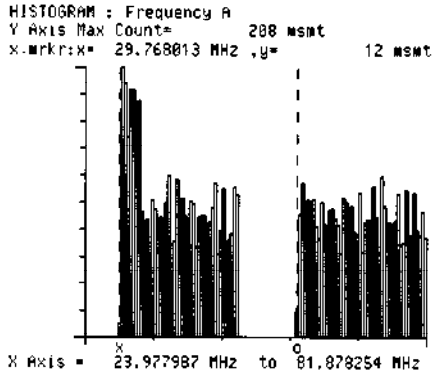


Courtesy of Rockwell International

Hopping radio transmitters can be characterized independently with the HP 5371A without the need for "golden" receivers or "back-to-back testing" techniques.



Settling time and overshoot can be examined as well as the modulation on the hopping carrier with the time variation display.



Non-random frequency usage shows up as a gap in this HP 5371A histogram of hopping transmitter frequencies.

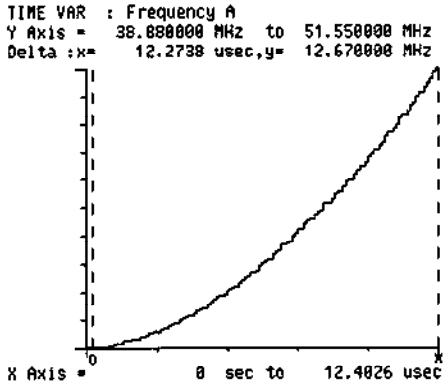
Simple and Accurate Radar Signal Characterization

Built-in statistical computations and graphical data analysis simplify pulse characterization. Pulse width histograms provide a direct measure of a radar's ability to separate closely spaced targets. Similar analysis of pulse repetition frequency (PRF) measurements indicate the maximum unambiguous range of the radar. Analysis of the RF pulse rise time quantifies the accuracy of target range measurements. The HP 5371A makes all of these measurements with 150 ps rms resolution: precision to insure accurate and reliable results.

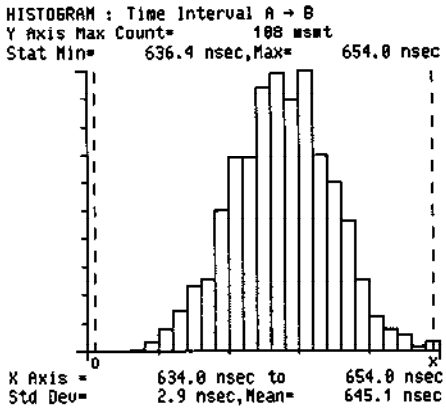
Pulse width jitter, pulse-repetition frequency, and RF pulse rise time can be measured directly with the HP 5371A to simplify radar system characterization.

The HP 5371A is an excellent transducer to measure and characterize chirp linearity; key to FMR (FM Ranging) performance. The signal is first downconverted from IF to baseband to maximize resolution, and is then measured cycle-by-cycle with the HP 5371A. Expensive and cumbersome delay line discriminators are eliminated, simplifying the measurement and dramatically reducing its cost.

These measurements are all performed without an external controller or software. Hardcopy plots of any display can be output directly to a graphics printer such as the HP ThinkJet. In addition, graphic displays can be sent to a graphics printer or HP-GL plotter.

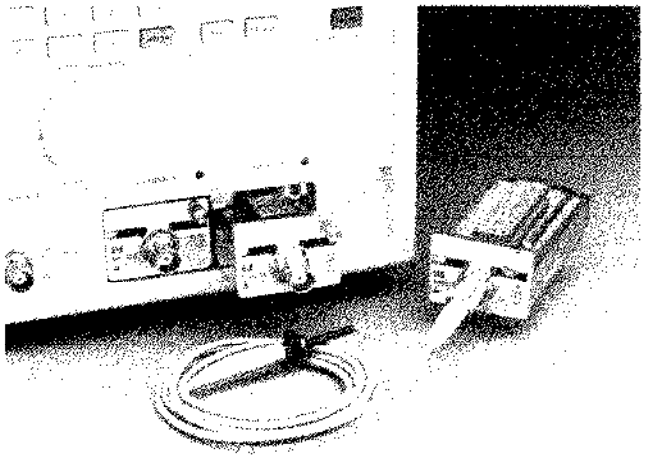


Chirp linearity characterization with the HP 5371A eliminates cumbersome delay line discriminators, dramatically reducing the measurement cost while enhancing precision.



This HP 5371A histogram of pulse width jitter provides a convenient measure of the radar's capability to separate closely spaced targets.

Accessories

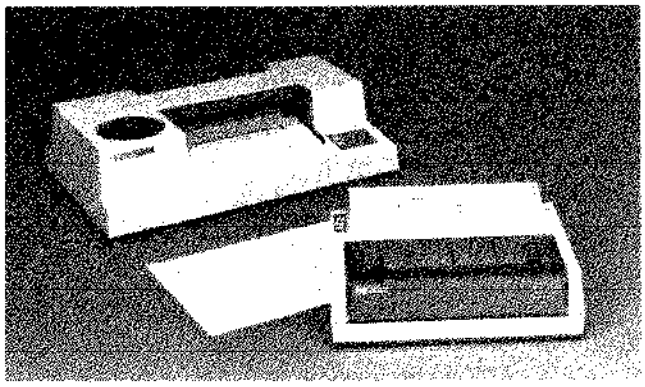


A Choice of Pods Are Key for Precision Measurements

HP 54001A Active Mini-probe Pod (optional):
High bandwidth, 10 kΩ/2pf input loading. This probe is ideal for use with high bandwidth and low capacitance applications.

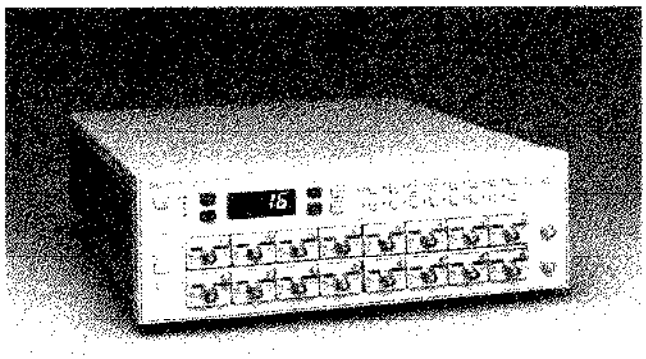
HP 54002A 50 Ω BNC Pod (standard):
Two of these pods are included standard with each HP 5371A.

HP 54003A 300 MHz 1 MΩ Pod (optional):
This pod includes a 10:1 detachable mini-tip probe and has 1 MΩ resistive and 8 pf capacitive loading.



Printers and Plotters

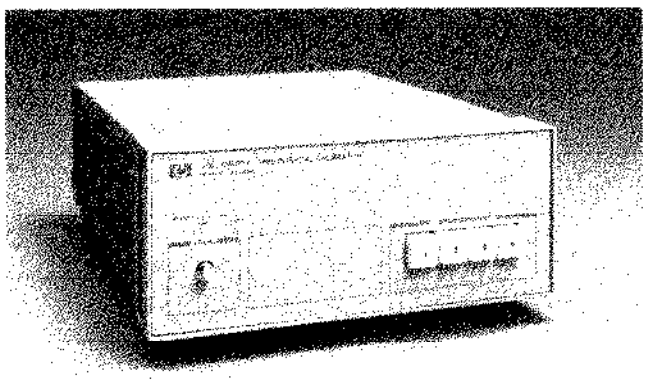
Create hardcopy plots for your notebook or presentation easily with the HP 5371A's direct print and plot features. The HP 5371A is compatible with graphics HP-IB printers and HP-GL plotters such as the HP 2225A ThinkJet Printer and the HP ColorPro 7440A Opt. 002 Plotter (shown here).



Pod Multiplexer

The HP 54300A Pod Multiplexer provides up to 16 inputs multiplexed into two 50 Ω outputs. These two outputs can be fed to the HP 5371A inputs to expand the flexibility of your measurement system. Any of the three input pods can be used with the HP 54300A.

Measurement switch routines can be stored in the internal switch sequence memory. The HP 54300A can be operated from front panel controls or over HP-IB.



Time Interval Calibrator

The HP J06-59992A Time Interval Calibrator can be used with the HP 5371A to provide up to 150 ps accuracy, traceable to the NBS. The calibrator is used to measure systematic uncertainties which are subsequently removed from measurement data. The calibrator provides a standard HP-IB interface to automate your calibration routines.

Specification Summary

Refer to the HP 5371A Product Note and Specification Guide for detailed information.

INPUT CHARACTERISTICS

INPUTS A AND B

Input Pods Specifications refer to pods installed in an HP 5371A system.

	HP 54002A	HP 54001A	HP 54003A with 10:1 probe	HP 54003A without 10:1 probe
Coupling	dc	dc	dc	dc
Input Capacitance (NOMINAL)	N/A	2 pf	8 pf	10 pf
Input Resistance (NOMINAL)	50 Ω	10 k Ω	1 M Ω	1 M Ω
Bandwidth (-3 dB)	dc to 500 MHz	dc to 500 MHz	dc to 300 MHz	dc to 300 MHz
Maximum Input x 1: Voltage x 2.5:	± 2 V ± 5 V	± 20 V N/A	± 20 V N/A	± 2 V N/A

The following specifications refer to an HP 5371A with HP 54002A pods installed.

Range: dc coupled to 500 MHz.

Sensitivity: 15 mV rms sine wave.
45 mV pk-pk for pulse input.

Minimum Pulse Width: For all measurement modes except holdoff arming: 1 ns.
Holdoff arming modes: 1.5 ns.

Attenuator: x 1 or x 2.5 selectable for HP 54002A pod, termination to ground.
x 1 only for HP 54002A pod, termination to -2V, and HP 54001A and HP 54003A.

EXTERNAL ARM INPUT

Inputs A and B may also be used for arming.

Range: dc coupled to 100 MHz.

Minimum Pulse Width: 5 ns.

Impedance: 1 M Ω NOMINAL, shunted by < 50 pf.

① See graph 1.

② See graph 2.

MEASUREMENT MODES

Function	Range
Frequency A*, B*	125 mHz to 500 MHz
Frequency A&B, A+B, A–B, B–A, A/B, B/A	250 mHz to 500 MHz
Period A*, B*	2 ns to 8.0 seconds
Period A&B, A+B, A–B, B–A, A/B, B/A	2 ns to 4.0 seconds
Totalize A, B, A&B, A+B, A–B, B–A, A/B, B/A	0 to $2^{32}-1$ events, each channel
Time Interval A, B, A->B, B->A	10 ns to 8.0 seconds
Continuous Time Interval A*, B*	100 ns to 8.0 seconds
± Time Interval A->B, B->A, A, B	–4.0 seconds to +4.0 seconds including 0 seconds
Rise and Fall Time A †	1 ns to 100 µs (auto-trigger)
Positive and Negative Pulse Width A †	1 ns to 1 ms (auto-trigger)
Duty Cycle A †	0% to 100% for pulse widths >1 ns and periods <1 ms (auto-trigger)
Phase A rel B, B rel A	> ± 360 degrees
Peak Amplitudes A, B	1 kHz to 200 MHz, 200 mV_{pk-pk} to 2 V_{pk-pk}

* Maximum sample rate for these measurements is 10 MHz (100 ns). For all others, maximum sample rate is 5 MHz (200 ns).

† Requires 8 ns setup time between each measurement.

FREQUENCY MEASUREMENT PRECISION

FOR SINGLE MEASUREMENT:

Least Significant Digit Displayed:

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

Resolution:

$$\pm \frac{150\text{ ps rms} + (1.4 \times \text{Trigger Error})}{\text{Sample Interval}} \times \text{Frequency}\ ①$$

Accuracy:

± Resolution ± (Timebase Aging x Frequency) ②

FOR CONTINUOUS FREQUENCY MEASUREMENTS (MEAN ESTIMATION):

rms Resolution:

$$\frac{\sqrt{13.5} \times (150\text{ ps rms} + 1.4 \times \text{Trigger Error})}{(\text{No. of Blocks})^{1/2} \times (\text{No. of Meas. per Block})^{3/2} \times \text{Sample Interval}} \times \text{Frequency}$$

Accuracy:

± Resolution ± (Timebase Aging x Frequency) ②

TIME INTERVAL MEASUREMENT PRECISION

Least Significant Digit Displayed:

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

Resolution:

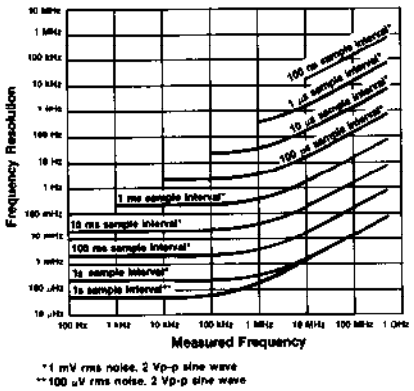
$$\frac{\pm 150\text{ ps rms} \pm \text{Start Trigger Error}\ ③ \pm \text{Stop Trigger Error}\ ③}{\sqrt{N}}$$

Accuracy:

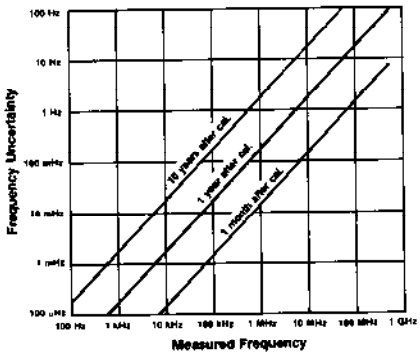
± Resolution ± (Timebase Uncertainty x Time Interval) ④
± Trigger Level Timing Error ⑤
± 1ns Systematic Uncertainty

Systematic uncertainties can be measured and removed from measurements using the HP J06-59992A Time Interval Calibrator.

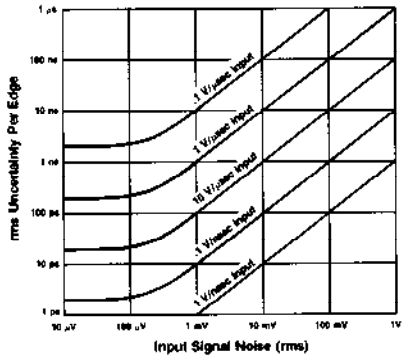
③ See graph 3.
④ See graph 4.
⑤ See graph 5.



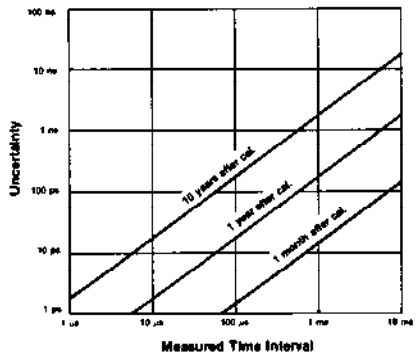
Graph 1.
Noise on the input signal will add uncertainty to Frequency or Period measurement resolution. Longer sample times and averaging will reduce the effects of random noise.



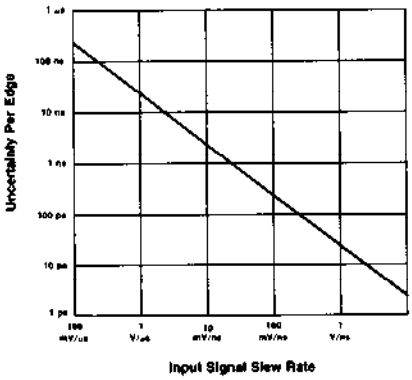
Graph 2.
Timebase crystal aging affects Frequency and Period measurement accuracy. You can further reduce aging uncertainty by using an atomic standard.



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



Graph 4.
Timebase crystal aging affects time interval measurements.



Graph 5.
Trigger level timing error varies with input signal slew rate. Uncertainty is associated with both start and stop edges.

INPUT TRIGGERING CHARACTERISTICS

	Manual Triggering	Auto Trigger Single or Repetitive
Voltage Range:		
x 1:	–2 Vdc to +2 Vdc	–2 Vdc to +2 Vdc
x 2.5:	–5 Vdc to +5 Vdc	–5 Vdc to +5 Vdc
Frequency Range:	dc to 500 MHz (HP 54001A, HP 54002A) dc to 300 MHz (HP 54003A)	1 kHz to 200 MHz
Resolution:		
x 1:	2 mV NOMINAL	1% steps (2 mV minimum)
x 2.5:	5 mV NOMINAL	1% steps (5 mV minimum)
Accuracy:	20 mV ± 1% of setting	± 20% of pk-pk amplitude (200 mV_{pk-pk} minimum)

Single Auto Trigger Mode: The HP 5371A determines voltage trigger levels automatically at the beginning of the 1st block of measurements. These trigger levels are maintained for all subsequent blocks in the measurement.

Repetitive Auto Trigger: The HP 5371A determines voltage trigger levels at the begining of each measurement block.

ARMING, GATING, AND TRIGGERING

EVENT Holdoff and/or Gate: 0 to 4 x 10^9 events.

TIME Holdoff and/or Gate: 2 ns to 8.0 seconds, 2 ns resolution (settability). Actual gate time is displayed with 200 ps LSD.

EDGE Holdoff and/or Sampling: HP 5371A becomes armed after a delay from edge as follows:

Ext Arm arms A	< 15 ns
B arms A, A arms B	< 8 ns
A arms A, B arms B	< 5 ns

INTERVAL Sampling: 600 ns to 8.0 seconds, 200 ns resolution (settability). Actual sample interval is displayed with 200 ps LSD.

CYCLE Sampling: Cycles of input signal or 500 MHz timebase in discrete steps: $2^4, 2^8, 2^{12}, 2^{16}, 2^{20}, 2^{24}, 2^{28}$.

MATH, STATISTICS, AND LIMIT TEST

Math: Normalize, Offset, Scale, Set Reference

Statistics: Mean, Minimum, Maximum, Variance, Standard Deviation, rms (Root Mean Square), Allan Variance, Root Allan Variance

Limit Test: Upper and lower limits for channel A and B may be entered separately. Measurements occuring outside of these limit values will be noted on numeric and graphic displays, as well as HP-IB.

MEMORY

1-1000 measurements for single-result functions.
1-500 measurements for dual-result functions.
1-4095 measurements for HP-IB binary mode output.
1-2047 measurements for dual-result functions in HP-IB binary mode output.

HP-IB CHARACTERISTICS

All functions programmable and accessible via HP-IB. Three data output formats are available:
ASCII
Floating Point
Binary
Measurement output rates to 20,000 measurements per second (TYPICAL) are possible using the binary output mode.

SH1, AH1, T5, TE0, L4, LE0, DT1, DC1, RL1, SR1, PP0, C0, E2

REAR PANEL

Frequency Standard Output: 10 MHz. Short term stability not specified.

Frequency Standard Input: 1,2, 5, or 10 MHz input.

Gate Outputs: Falling TTL edge indicates measurement sample.

Delay Outputs: Falling TTL edge indicates when arming stage is complete.

GENERAL

Power requirements: 100, 120, 220, or 240 VAC (+10%, –10%) 50–60 Hz; 500 VA maximum.

Weight: Net, 23.2 kg (51 lb); Shipping, 24.5 kg (54 lb.).

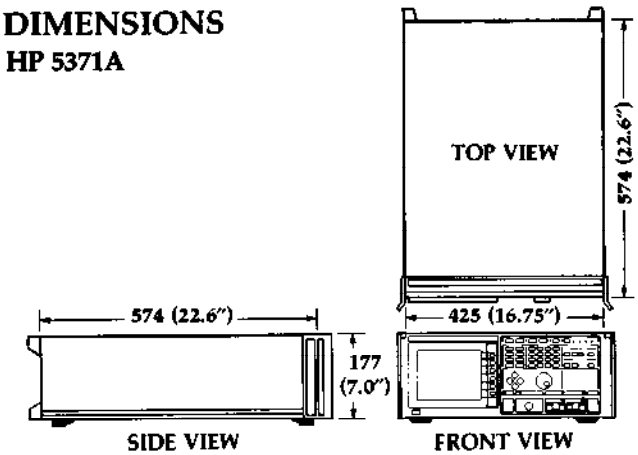
Operating Temperature: 0–40° C.

Timebase: 10 MHz ovenized oscillator.

Aging rate:	<5 x 10^{-10}/day, after 24 hour warm-up. <1 x 10^{-7}/year for continuous operation.
Short term stability:	<1 x 10^{-10} for 1 second average.
Warm-up time:	<5 x 10^{-9} of final value, 10 minutes after turn-on at 25° C.

DIMENSIONS

HP 5371A



Ordering Information

HP 5371A Frequency and Time Interval Analyzer
(includes 2 HP 54002A 50 Ω pods).

Options:

060 Rear Panel Inputs for channels A, B (50 Ω BNC) and External Arm (1 MΩ BNC). Deletes front panel inputs; rear panel BNC only.

W30 2 Additional years of "return to HP" service.

908 Rack mount kit for mounting without front handles.

913 Rack mount kit for mounting with front handles.

Accessories:

HP 54001A 10 kΩ Active Probe/Pod (10:1).

HP 54002A 50 Ω Pod.

HP 54003A 1 MΩ Pod (with 10:1 scope probe).

HP 54300A Pod Multiplexer.

HP J06-59992A Time Interval Calibrator.

HP P/N 1494-0059 Rack Slide-mount Kit.

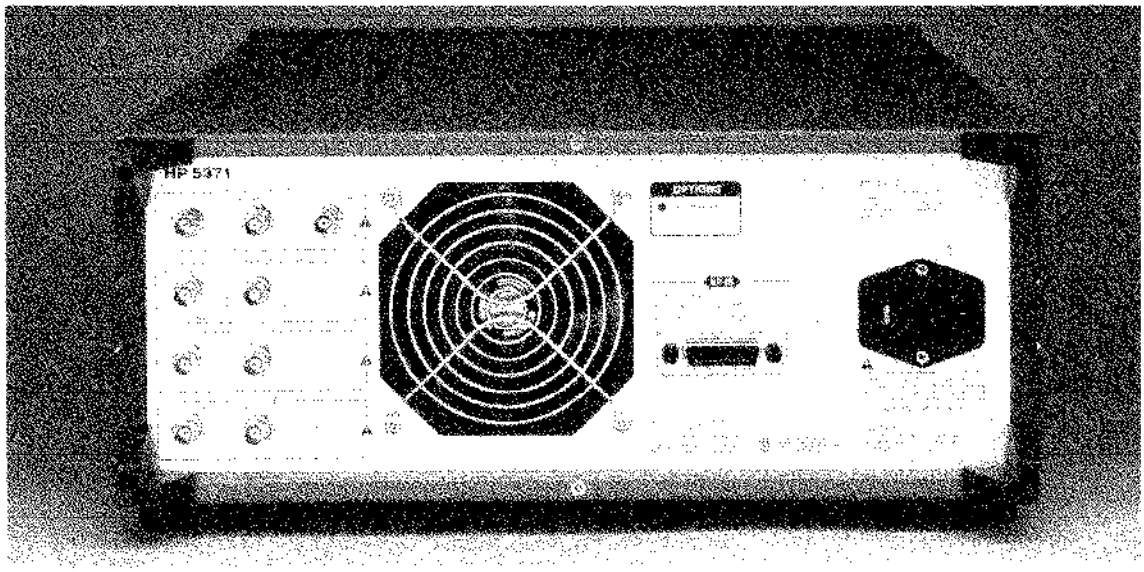
Application Literature:	**Literature No.**
Characterization of Frequency-Agile Signal Sources	#5952-7924
Jitter and Wander Analysis in Digital Communications	#5952-7925
Time Domain Characterization of Magnetic Disc Drives	#5952-7928
Product Note/Specification Guide	#5952-7959

HP Rents and Leases Instruments:

Hewlett-Packard uses its low cost of funds to offer finance plans at excellent rates.

From 12-month rentals to longer-term leases and gradual purchase plans, HP Financing can help you tailor a plan that meets your needs.

Ask your HP sales representative for details.



HP 5371A rear panel with Option 060, Rear Panel Inputs.

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

United States:
Hewlett-Packard Company
4 Choke Cherry Road
Rockville, MD 20850
(301) 258-2000

Hewlett-Packard Company
5201 Tollview Dr.
Rolling Meadows, IL 60008
(312) 255-9800

Hewlett-Packard Company
5161 Lankershim Blvd.
No. Hollywood, CA 91601
(818) 505-5600

Hewlett-Packard Company
2000 South Park Place
Atlanta, GA 30339
(404) 955-1500

Canada:
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6877 Goreway Drive
Mississauga, Ontario L4V1M8
(416) 678-9430

Japan:
Yokogawa-Hewlett-Packard Ltd.
29-21, Takaido-Higashi 3-chome
Suginami-ku, Tokyo 169
(03) 331-6111

Latin America:
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3495 Deer Creek Rd.,
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(415) 857-1501

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(03) 895-2895

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47/F China Resources Building
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(5) 833-0833

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Hewlett-Packard GmbH
Hewlett-Packard-Strasse
6360 Bad Homburg
West Germany
(49) 6172/400-0

France:
Hewlett-Packard France
Parc d'activité du Bois Briard
2, avenue du Lac
91040 Evry Cedex, France
(33) 1/60778383

United Kingdom:
Hewlett-Packard Ltd.
Miller House—The Ring
Bracknell
Berkshire RG12 1XN, England
(44) 344/424898

Italy:
Hewlett-Packard Italiana S.A.
Via G. di Vittorio, 9
20063 Cernusco S/N (MI)
Milan, Italy
(39) 2/923691

Northern Europe:
Hewlett-Packard S.A.,
P.O. Box 999,
1180 AZ Amstelveen,
The Netherlands
(31) 20/437771

Southeast Europe/Africa/ Middle East:
Hewlett-Packard S.A.
1217 Meyrin 1, Geneva
Switzerland
(41) 22/989651

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Europe/Middle East/Africa:
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Central Mailing Department,
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1180 AM Amstelveen,
The Netherlands

For all other areas:
Hewlett-Packard Company
Intercontinental Headquarters
3495 Deer Creek Rd.,
Palo Alto, CA 94304

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