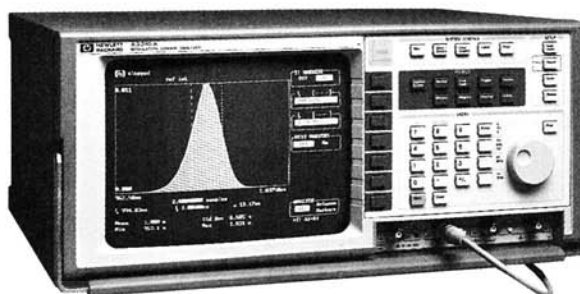- Characterize frequency, phase, and time-interval versus time
- Fast time-interval histogram analysis
- Jitter spectrum analysis

- 150 ps rms single-shot resolution, 2 ps resolution with averaging
- Choice of products to fit project requirements and budgets
- DECT, CT2, CT3 mobile communications measurements

HP 5372A

HP 53310A

The Modulation Domain: Viewing Complex Signals

Hewlett-Packard modulation domain analyzers offer a view of information that traditional measurement techniques miss. The modulation domain—mapping frequency, phase, or time-interval vs. time—can more effectively characterize:

- Data storage products
- Radar systems
- Communication systems
- Electromechanical systems
- Frequency stability
- VCOs
- Frequency agile systems

This new view of data is intuitive and offers a direct view of jitter or modulation. The HP modulation domain analyzers provide insight into changes of frequency or time intervals.

A Choice of Solutions

Choose from four HP modulation domain analyzers based on your project requirements.

Affordability and Ease of Use

The most affordable modulation domain analyzer, the HP 53310A, includes many innovations for ease of use. Characterization of modulation and jitter is easier with built-in analysis. Parameters such as peak-to-peak deviation, carrier frequency, and modulation rate are all quickly and automatically displayed. Jitter analysis is simplified with automated mean, standard deviation, and probability functions.

Measurement Versatility

In addition to offering expanded functionality, the HP 5371A and HP 5372A can analyze signals ranging up to 500 MHz, or (with an optional configuration of the HP 5372A) up to 2 GHz. Up to eighteen measurement functions and increased display modes offer the versatility to handle a broad range of situations. With a new hardware option, the HP 5372A can compute and display a spectral presentation of jitter data without the need for an external computer or special processor.

Based on the same technology, the HP 5372A is a superset of the HP 5371A. Choose the lower-priced HP 5371A or more powerful HP 5372A based upon your project constraints.

Pulsed Systems Design and Analysis

The HP 5373A Modulation Domain Pulse Analyzer minimizes the design and testing effort for radar systems, and enhances design efforts for EW, ELINT, IFF, and related equipment and components. The analyzer measures modulation and carrier frequency on pulsed RF signals to 500 MHz. A detector channel can precisely measure envelope parameters such as pulse width and PRT, peak envelope power, percent AM, jitter, and more. The HP 5373A is easy to use and attractively priced compared to specialized or home-grown test sets used for radar and related advanced systems design.
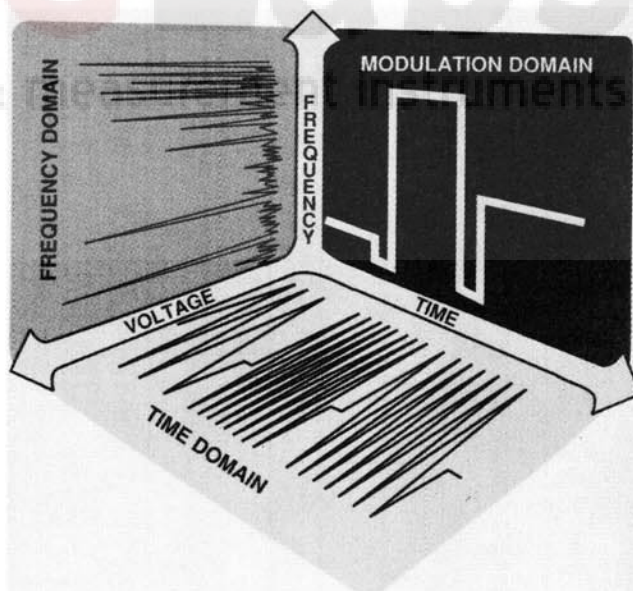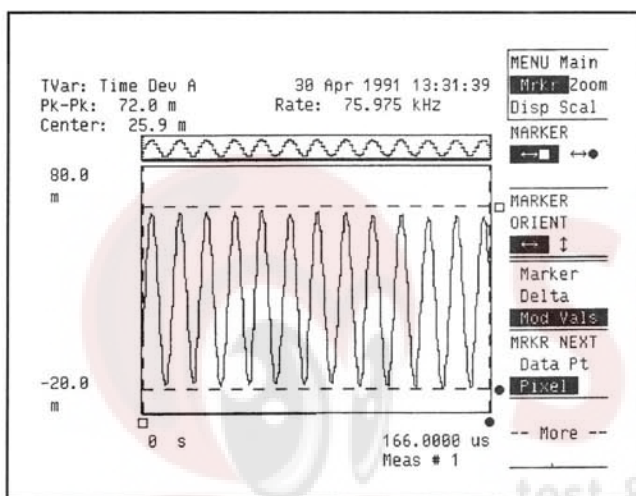
ELECTRONIC COUNTERS
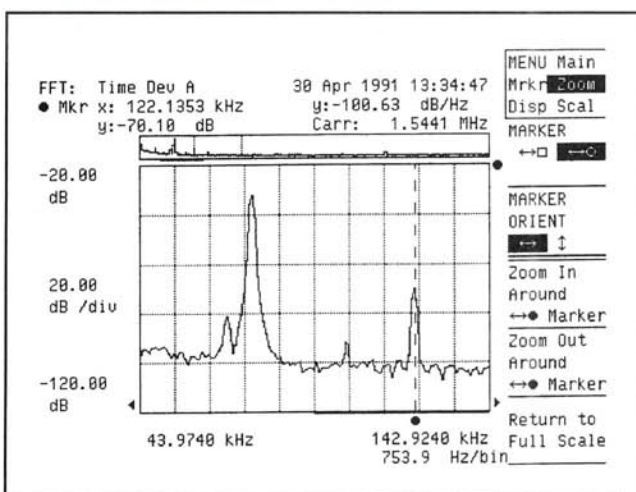## Modulation Domain Analyzers (cont'd)
HP 5371A, 5372A, 5373A, 53310A

Flexible Jitter Spectrum Analysis for Digital Communications

The HP 5371A and HP 5372A frequency and time-interval analyzers can be used to characterize jitter or phase noise in digital communications, oscillators, and other serial data systems. The HP 5371A measures and displays the variations of period jitter with time or in a histogram. The HP 5372A adds the capability to display jitter as the variation of the significant instants from the ideal timing position (the time deviation function).

With the new Jitter Spectrum Analysis feature (Option 040) of the HP 5372A, jitter spectrum measurements are possible with higher resolution than current jitter test sets. Any clock rate, including nonstandard rates, can be accommodated or measurements made without the presence of a clock. The jitter bandwidth can exceed 2 MHz. The Jitter Spectrum Analysis option is ideal for characterizing the phase noise performance of low-cost oscillators and synthesizers. This new option of the HP 5372A eliminates the need for an external computer for analysis.

Modulation Analysis for Mobile Communications

The HP 53310A's new Option 031 "Digital RF Communications Analysis/High Resolution 2.5 GHz Input" provides automatic measurements of synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK peak deviation on DECT, CT2, and CT3 radios. Features for optimizing RF designs include:

- **High resolution measurements**—built-in downconversion provides superior frequency resolution for RF signals.
- **RF envelope trigger**—simplifies measurement setup by automatically triggering on a detected TDMA burst.
- **Automatic measurements**—synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK deviation.

Jitter as a function of time. A strong periodic component is shown in this jitter vs. time graph. The rate of the jitter and the peak-to-peak jitter are displayed in Unit Intervals.

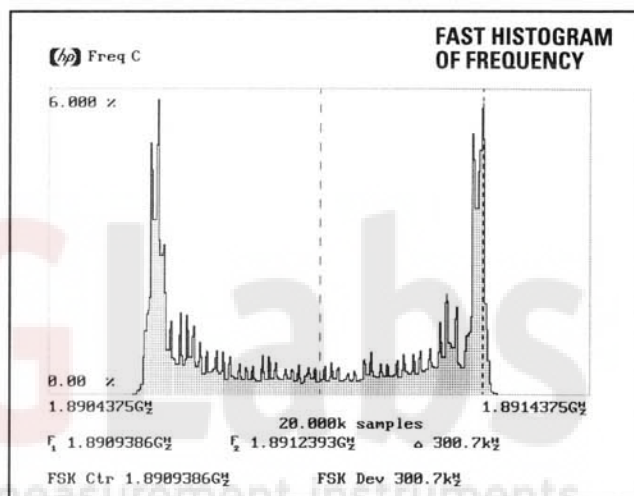Center Frequency and Peak Deviation are automatically calculated from frequency histograms.

The jitter spectrum shows the large component of jitter as well as a smaller spur. The HP 5372A Jitter Spectrum Analysis (Option 040) enables the viewing of all components of jitter.
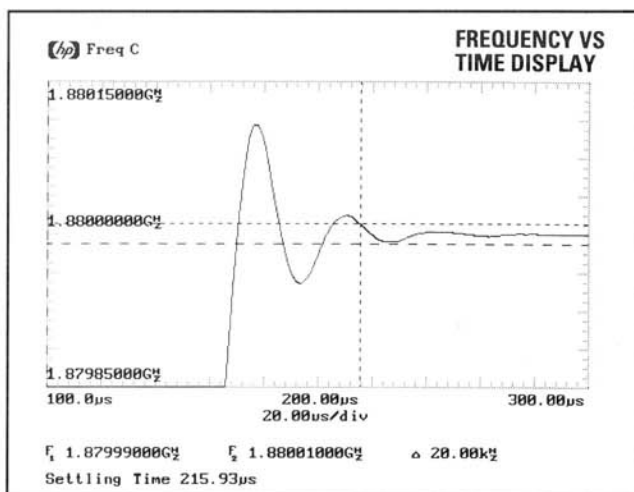

Settling Time is displayed automatically on this direct measurement of the synthesizer step.

Powerful Radar Signal Characterization

Combining the HP 5364A microwave mixer/detector with an HP modulation domain analyzer and a local oscillator extends the modulation domain to 18 GHz.

The HP 5364A microwave mixer/detector is designed to ensure downconversion with minimal distortion and group delay over its 500-MHz IF bandwidth. Configure the HP 5364A with your own local oscillator or an HP source such as the HP 8671A synthesized CW generator, the HP 8673C synthesized signal generator, or the HP 8673E synthesized signal generator. In addition to the IF channel, the HP 5364A provides a video detector output to trigger the HP 5373A. The video output can also be used to directly measure pulse width, rise and fall time, and PRF/PRI.

Radar chirp-linearity is easily characterized in the modulation domain. The HP 5364A microwave mixer/detector can be used to downconvert the chirp to baseband, maximizing measurement resolution. A frequency vs. time display clearly shows deviation from linearity. The HP 5373A features display-averaging which dramatically improves the resolution of measurements on repetitive signals.
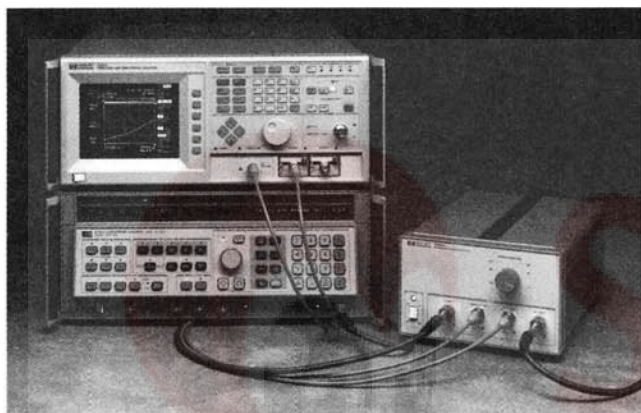
Use the HP 5364A microwave mixer/detector (shown, right, with the HP 5373A) to bring the modulation domain to microwave frequencies between 2 and 18 GHz. The HP 5364A can be used with any modulation domain analyzer.
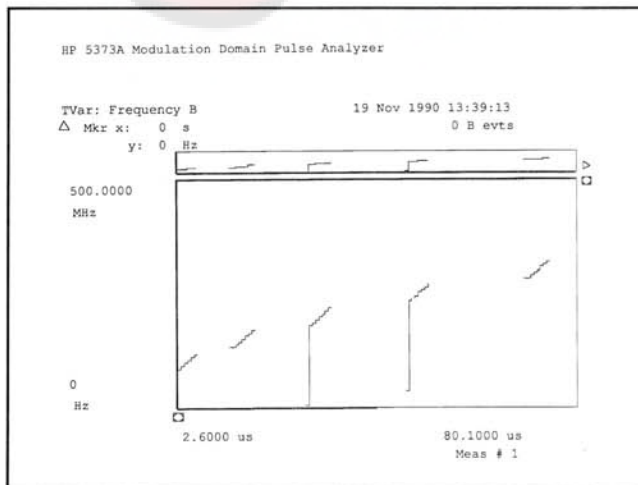

The power of modulation domain analysis can be seen with this HP 5373A frequency vs. time graph of a frequency chirp on an agile carrier with a varying PRI.

Characterize Motion Control Systems

Pulse encoders for motion control systems deliver pulse streams that correspond to linear or rotary position. Position and velocity can be analyzed by characterizing the timing of pulses delivered by the encoder.

Continuous time-interval and frequency measurements with the HP 53310A give insight about positioning system performance. Variations in velocity or rotational non-linearities can be easily analyzed by viewing the time variation display: a plot of velocity versus time. For closed-loop systems, factors such as system damping, overshoot, and response time can be quickly verified—independently of the system's control.

• Rotational or linear velocity vs. time profiles
• Position control analysis
• Analyze damping, overshoot, and response time
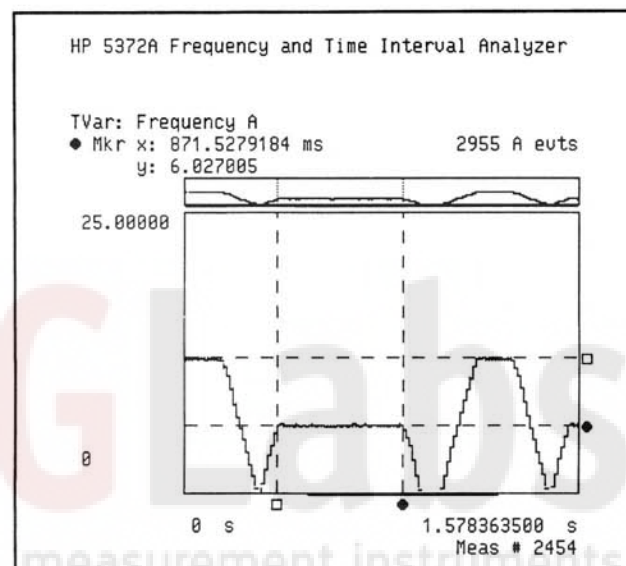
The velocity (frequency) vs. time graph allows easy analysis of the print sweep and double-speed return of a motion-control servo used in a graphics printer.

HP 5371A, HP 5372A, and HP 5373A Summary

Basic Performance
- Continuous measurements to a 10 MHz rate (13.3 MHz rate using the HP 5372A or HP 5373A fast-measurement mode)
- 125 mHz to 500 MHz frequency range. 100 MHz to 2 GHz in optional Channel C (HP 5372A or HP 5373A)
- −4.0 to +4.0 s or 10 ns to 8 s time-interval range
- 150 ps rms single-shot time-interval resolution, 10 digits per second frequency resolution
- 1 ns minimum input pulsewidth
- 2 mV trigger level resolution; auto-trigger capabilities
- Selection of input pods: 50 Ω, 1 MΩ, or 10 kΩ, 2 pf active

Arming and Triggering Capabilities
- Measurement holdoff by time, events, or signal edge
- Measurement sample by time, events, signal edge, or parity
- Arm on any of 3 input channels: external arm, input A, or input B

Measurements

Function	Range
Frequency A[1], B[1]	125 mHz to 500 MHz 8 kHz to 500 MHz[3]
Frequency C[1] (HP 5372A/73A)	100 MHz to 2 GHz
Frequency A&B, A&C, B&C, A+B, A+C, B−A, C−A, B+C, C−B, A/B, B/A, A/C, C/A, B/C, C/B	250 mHz to 500 MHz (A and B) 16 kHz to 500 MHz (A and B)[3] 100 MHz to 2 GHz (C)
Period A[1], B[1]	2 ns to 8 seconds 2 ns to 131 μs[3]
Period C[1] (HP 5372A/73A)	500 ps to 10 ns
Period A&B, A&C, B&C, A+B, A+C, B−A, C−A, B+C, C−B, A/B, B/A, A/C, C/A, B/C, C/B	2 ns to 4.0 s (A and B) 2 ns to 65 μs (A and B)[3] 500 ps to 10 ns (C)
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−>A	10 ns to 8.0 seconds 10 ns to 131 μs[3]
Continuous time interval A[1], B[1]	100 ns to 8.0 seconds 75 ns to 131 μs[3]
± Time interval A, B, A−>B, B−>A	−4.0 s to +4.0 s including 0 s −65 μs to +65 μs including 0 s[3]
Rise and fall time A[2]	1 ns to 100 μs (auto-trigger)
Positive and negative pulsewidth A[2]	1 ns to 1 ms (auto-trigger)
Duty cycle A[2]	0% to 100% for pulsewidths > 1 ns and periods < 1 ms (auto-trigger)
Phase A rel B, B rel A	0° to > ±360°
Peak amplitudes A, B	1 kHz to 200 MHz, 200 mV peak-to-peak to 2 V peak-to-peak

[1] Maximum sample rate for these measurements is 10 MHz (100 ns), and up to 13.3 MHz (75 ns) using the HP 5372A or HP 5373A fast-measurement mode. For all other measurements, maximum sample rate is 5 MHz (200 ns) in the normal measurement mode and 7.7 MHz (135 ns) in the fast-measurement mode.
[2] Requires 8 ns setup time between measurements.
[3] Fast measurement mode values (HP 5372A or HP 5373A).

HP-IB Performance and Features
- Up to 20,000 measurements/second throughput (HP 5371A), 25,000 for HP 5372A and HP 5373A (binary format)
- Three output formats: ASCII, floating-point, or binary
- Full programmability
- Direct graphics output to printer or plotter

Analysis Features
- Time variation of measurements: frequency versus time, time interval versus time, and phase versus time. Averaged plots to improve vertical resolution are obtainable using the HP 5372A or HP 5373A.
- Histogram
- Fast time-interval histogram (HP 5372A or HP 5373A; histograms computed at measurement rate)
- Event timing plots
- Limit test
- Statistics: mean, minimum, maximum, standard deviation, variance, rms
- Allan variance, root Allan variance
- Window margin analysis (HP 5372A only)
- Modulation parameters: center frequency, peak-peak deviation, modulation rate
- Frequency deviations from a linear chirp (HP 5373A only)
- Function keys for pulsed signal analysis: PRF, PRI, % AM envelope measurements (HP 5373A only)
- Jitter spectrum analysis (HP 5372A only)

HP 5364A Microwave Mixer/Downconverter
- 2 to 18 GHz input frequency range
- 10 to 500 MHz IF output range
- 2.2 GHz to 18 GHz local oscillator input range
- Built-in manual attenuator
- 73 dB RF input dynamic range for pulse signals, 53 dB for CW signals
- APC 3.5 (m) connectors for RF and LO inputs
- < 7.5 ns video output risetime
- Less than 1 ns group delay over 500 MHz IF output range

HP 53700A Continuous Measurement Software
These compiled subroutines simplify and speed binary programming for the HP 5371A and HP Series 300 computers. Sample programs are included. Software is supported with the HP 5371A only.

Ordering Information

	Price
HP 5371A Frequency and Time Interval Analyzer	$27,500
HP 5372A Frequency and Time Interval Analyzer The HP 5371A and HP 5372A both include two HP 54002A 50 Ω input pods.	$30,500
HP 5373A Modulation Domain Pulse Analyzer Includes one HP 53702A 500 MHz envelope detector, one HP 54002A 50 Ω input pod.	$32,500

Options (HP 5371A, HP 5372A, HP 5373A)

Opt W30 Extended Repair Service (see page 624)	Call HP
Opt W32 Calibration Service (see page 624)	Call HP

Options (HP 5371A, HP 5372A only)

Opt 060 Rear-Panel Inputs (50 Ω BNC) for channels A and B. 1 MΩ BNC for external arm. Deletes front panel inputs.	$0

Options (HP 5372A, HP 5373A only)

Opt 020 FastPort Data Output	+ $1,600
Opt 030 2 GHz Channel C (front-panel input)	+ $2,400
Opt +36A Productivity Assistance Training ½ day	+ $1,010

Options (HP 5372A only)

Opt 040 Jitter Spectrum Analysis	+ $3,000
Opt 090 Rear Panel Inputs for Channels A, B, and C. 1 MΩ BNC for External Arm, 50 Ω BNC for channels A and B, type N connector for C. Deletes front panel inputs.	+ $2,400
HP 5364A Microwave Mixer/Detector	$14,000
HP 53700A Continuous Measurement Software (supported with HP 5371A only)	$1,300

Accessories

HP 54001A 1-GHz Active Pod (10:1, 10K)	$830
HP 54002A 50 Ω Pod	$160
HP 54003A 1 MΩ Pod (with 10:1 scope probe)	$720
HP J06-59992A Time Interval Calibrator	$3,000

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HP 53310A Modulation Domain Analyzer

With the HP 53310A, HP advances modulation domain technology in two directions: affordability and ease of use. Key features of this newest frequency and time-interval analysis product include:

- **Automated setup:** A single button can set up the HP 53310A for measurement. Settings are selected by automatic signal evaluation.
- **Single-touch measurements:** Peak-to-peak deviation, carrier frequency, and modulation rate are easily and quickly measured for quantifying jitter and modulation. The Save/Recall function stores up to 10 measurement steps for fast repeat operations.
- **One-button statistics:** Mean, standard deviation, and probability functions are simplified for easy jitter analysis.
- **Softkey-driven menus:** Measurement parameters and analysis functions are easily selected while measurement data is displayed.
- **Large display:** The expanded screen displays measurement results clearly and aids analysis.
- **Low cost:** The HP 53310A is priced to fit budget-constrained projects and departments.

Product Description

The HP 53310A offers powerful analyzer features:

- **Dual timebases:** A main timebase and a window timebase allow data capture while viewing measurement details in the window.
- **Auto or triggered operation:** Select auto, edge-triggering (rising or falling), or a new, unique feature: measurement value triggering (frequency or time-interval). Value triggering can eliminate the need for and expense of external sync signal generation. This can shorten project time and lower costs.
- **Display vs. time or histogram:** Select the appropriate view.
- **Fast histograms:** Up to 16 million measurements/acquisition.
- **Automated measurements:** Autoscale selects appropriate setup parameters; built-in analysis functions eliminate calculations.

Specifications*

Frequency Measurements
Range: 10 Hz to 200 MHz (Channel A)
10 Hz to 100 MHz (Channel B)
50 MHz to 2.5 GHz (Channel C)
Maximum Measurement Rate:
1 MHz (1.5 MHz for fast histograms)
8 MHz (repetitive)

Time Interval Measurements
+ Time interval: Range: $+20$ ns to $+1$ s
Maximum measurement rate: 1.25 MHz (2.5 MHz for fast histograms)
± Time interval: Range: -0.5 s to $+0.5$ s
Maximum measurement rate: 1.25 MHz (2.0 MHz for fast histograms)

Time Axis in Versus Time
Resolution:
Main timebase setting/45 (with panorama off)
Window timebase setting/45 (with panorama on)

Inputs
Channels A and B
Sensitivity (minimum hysteresis): 20 mV rms sinewave to 100 MHz (25 mV rms sinewave for Freq A from 100 to 200 MHz)
Minimum pulse width: 5 ns at 60 mV peak-to-peak (2.5 ns at 75 mV peak-to-peak for Freq A ≥ 50 MHz)
Input amplifier noise: $600\,\mu V$ rms
Threshold drift: ± 3 mV after warmup at 25° C
Voltage threshold accuracy: $\pm (25$ mV $+ 1\%$ of threshold value)
Maximum hysteresis: Increases the minimum input signal amplitude required by factor of 3 (increased noise immunity)
Impedance: 50 Ω or 1 MΩ (500 kΩ in common)
ac coupling: 100 Hz cutoff frequency
Capacitance (1 MΩ): <20 pF (<30 pF in common)
Dynamic range (ac): 60 mV peak-to-peak to 5 V peak-to-peak
Signal operating range (dc): ± 10 V (1 MΩ), ± 5 V (50 Ω)
Damage level: 5 V rms (50 Ω); 40 V rms for <5 kHz, 5 V rms for >5 kHz (1 MΩ)

Channel C (Opt 030)
Sensitivity: -25 dBm to 1.5 GHz, -20 dBm from >1.5 to 2.0 GHz, -15 dBm from >2.0 to 2.5 GHz
Maximum input level: $+7$ dBm
Damage level: $+15$ dBm
External Arm
Impedance: 1 MΩ
Delay: <10 ns
Note: Sensitivity, minimum pulse width, signal operating range and damage level of external input are the same as for Channel B.

Frequency Reference
Standard Crystal (see page 198)
Temperature stability: $<8 \times 10^{-6}$, referenced to 25° C
Short-term stability: $<4 \times 10^{-9}$ for 1 second average
Aging rate: $<3 \times 10^{-7}$ per month
Opt 010: High-stability oven reference (see page 198)
Temperature stability: $<7 \times 10^{-9}$ referenced to 25° C
Short-term stability: $<4 \times 10^{-11}$ for 1 second average
Aging rate: $<5 \times 10^{-10}$ per day, $<1 \times 10^{-7}$ per year
Warm-up: Within 5×10^{-9} of final value (frequency 24 hours after turn-on) 10 minutes after turn-on.

Rear-Panel Connectors
HP-IB
Full programmability: All instrument settings and operating modes except specific self-test routines
Data acquisition and transfer rate: For 450-point data record, approximately 17 times/sec with an HP 9000 Series 300 (when measuring, for example, a 1-MHz carrier with a timebase setting of $40\,\mu s$/division)
Data transfer rate: Approximately 175 kB/s
Interface capabilities: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2
Test Limit Output
Operation: Goes high when measurements fall outside the display range of the fast histogram
Operating range: Low < 0.6 V and high > 1.5 V into 50 Ω
Frequency Standard Input
Frequency: 5 MHz or 10 MHz
Operating range: 1 V peak-to-peak to 5 V peak-to-peak into 1 kΩ
Damage level: 10 V rms
Frequency Standard Output
Frequency: 10 MHz, or External Reference if frequency standard input selected
Operating range (ac-coupled): >1 V peak-to-peak square wave (50 Ω), >2 V peak-to-peak square wave (1 MΩ)
Power Requirements
Voltage: 115/230 V ac (-25% to $+15\%$)
Frequency: 48 to 66 Hz
Maximum power: 300 VA

General
Operating Temperature: 0° to 55° C
Size: 194 mm W $\times$ 425 mm H $\times$ 363 mm D (440 mm D, handle extended)
Weight: Net, 10 kg; shipping, 18 kg

Ordering Information

	Price
HP 53310A Modulation Domain Analyzer	$9,950
Opt 001 Extended Measurement Memory (4 X)	$500
Opt 010 High-Stability Oven Timebase	$1,750
Opt 030 2.5 GHz Channel C	$1,600
Opt 031 Digital RF Communications	$5,000
Opt W30 Extended Repair Service (see page 624)	$235
Opt W32 Calibration Service (see page 624)	$380
HP 5364A 2 to 18 GHz Mixer/Detector	$14,000
HP J06-59992A Time Interval Calibrator	$3,000

*For complete specifications on the HP 53310A see data sheet #5091-2596. For specifications on Option 031 see data sheet #5091-2597.

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