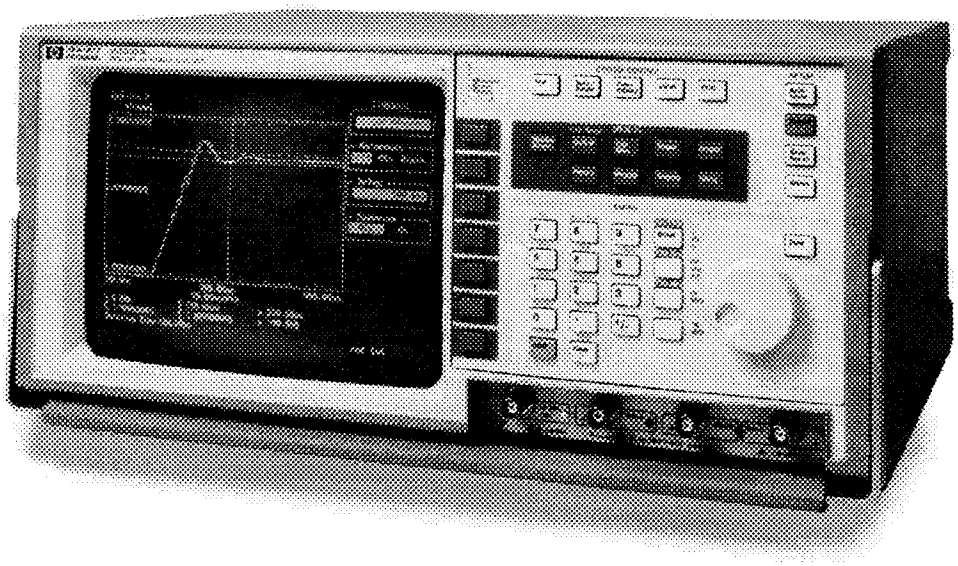
HEWLETT® PACKARD

# HP 53310A Modulation Domain Analyzer

## Technical Data



This section offers a brief description of the HP 53310A. It follows the menu structure of the product and describes its operation. For specifications, see the Product Specifications and Characteristics section.

## Function

### Frequency
Channel: A, B, or C (Optional)

### Time Interval
Measurement: + TI or ± TI
Channel: A & B (Separate)
or A only (Common)
Start: ⎍ or ⎍
Stop: ⎍ or ⎍

## Input

### Channels A and B
Voltage Threshold Range
Manual: +10 V to –10 V, settable in 2.5 mV steps.
Auto: Find 50% Threshold
Coupling: ac or dc
Impedance: 1 M Ω or 50 Ω
Hysteresis: Min to Max, settable in ten steps

### Channel C (Optional)
Voltage Threshold: 0 volts
Coupling: ac
Impedance: 50 Ω
Hysteresis: Minimum

### External Arm
Voltage Threshold: 0V, TTL (1.5 Volts), or ECL (–1.3 Volts).

## Vertical/Histogram Display Range

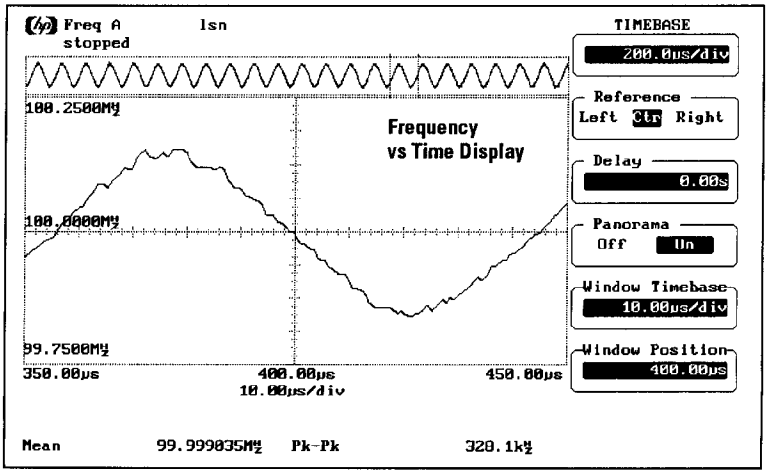
Display measurement range is settable as Center and Span, or Minimum and Maximum. For frequency measurements, the maximum display value can be selected no larger than eight times the minimum display value.

## Timebase

### Main Timebase
Range:
Panorama Off: 1 µs/div to 1 s/div
Panorama On: 1 to 20 times the window timebase setting (standard);
1 to 80 times the window timebase (Option 001)

### Window Timebase
Range: 1 µs/div to 1 s/div
Position: Adjustable throughout the Panorama

### Trigger
Display Position: Left, Center, or Right
Delay: Adjustable




**Dual timebases allow you to capture all the information you want, as shown in the panorama, while analyzing measurement details in the window.**

### Trigger

**Mode:** Auto or Triggered
Triggered
  Edge Trigger
    Slope: ⨍ or ⨍ of External
  Value Trigger
    Source: Frequency or Time Interval measurements, depending on measurement function
    Range
    Frequency: 80% of minimum display value to 120% of maximum display value
    Time Interval: full measurement range
    Slope: ⨍ or ⨍
    HF Reject: On or Off

### Display

**Type:** "vs Time" or Histogram
  Frame type: Frame, Axes, Grid, or Off

**vs Time**
Acquisition Mode: Real Time or Repetitive
Real Time Persistence: Single or Infinite
Repetitive Averaging: On or Off

**Histogram**
Probability Scale (percent): Log or Linear
Probability Scaling: Auto or Manual
Accumulate: On or Off

### Markers

Horizontal and vertical markers are available in "vs Time", and Histogram displays. Markers can be used in conjuction with automated analysis. They may also be used to delimit a portion of the measurement data for detailed analysis.

### Histogram

Histogram Type: Histogram from "vs Time" or Fast Histogram
Accumulate: On or Off
Fast Histogram
  Acquire Start: Auto, or External
    Start on ⨍ or ⨍ edge
  Number of Measurements: 1 to 16 million per acquisition, > $10^{14}$ can be accumulated.

### Sampling

**Modes:** Auto, Edge, or Time
Auto: Constant event sampling based on Timebase settings
Edge
  Channel A or B: Every 1 to 256 events
  External: Every event
Time: 400 ns - 1 second

### Utility

**HP-IB/Print setup**
Mode: Addressed or Talk Only

**Clicker:** On or Off

**Screen Saver:** On or Off

**Calibration and Diagnostic routines**

### Autoscale

Setup parameters are automatically determined to display the dynamics of the input signal. Measurement function and input conditioning should be selected prior to pressing Autoscale.

### Automated Analysis

Built-in analysis functions include: Minimum, Maximum, Peak to Peak, Mean, 1/Mean, Standard Deviation, (Modulation) Rate, 1/Rate, and Probability.

### Save/Recall

Ten measurement setups can be stored and recalled.

Both warranted specifications and operating characteristics of the HP 53310A are discussed in this section. To distinguish warranted specifications from operating characteristics, *specifications are highlighted throughout in italics.*

### Frequency Measurements

**Range**
Channel A: *10 Hz to 200 MHz*
Channel B: *10 Hz to 100 MHz*
Channel C: *50 MHz to 2.5 GHz*
CH·C DIVIDE BY 64 THEN FEED TO CH A.

**Maximum Measurement Rate**
Fast Histogram: 1.5 MHz
Other Modes: 1 MHz

**Resolution:** *Maximum Available Measurement Resolution or Display Resolution, whichever is greater*

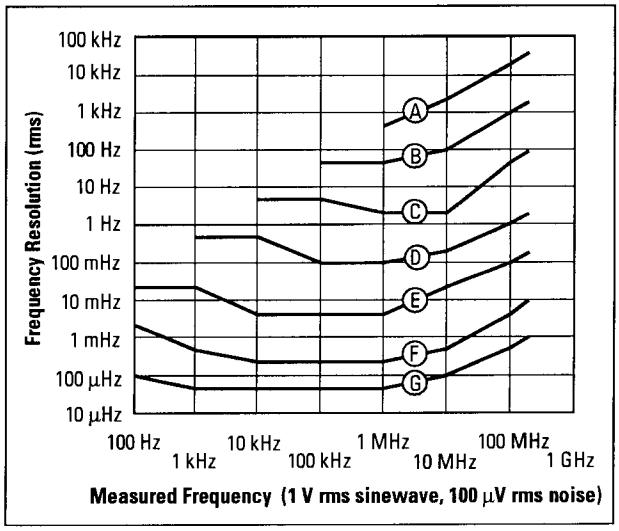
Maximum Available Measurement Resolution (Auto Sampling):
*See Graph 1 for Channels A and B*
*See Graph 2 for Option 030 Channel C*

**Note:** Option 031 High Resolution 2.5 GHz Channel C offers superior measurement resolution. Refer to "Dynamic Frequency and Jitter Analysis at the Touch of a Button", HP 53310A brochure.

Display Resolution
vs Time, or Histogram of vs Time
Window Off:
Display Span/256
Window On:
Display Span/224
Fast Histogram:
Display Span/450

**Accuracy:** ± *(Resolution + (Frequency × Reference Error)* †*)*

† Refer to Graph 3

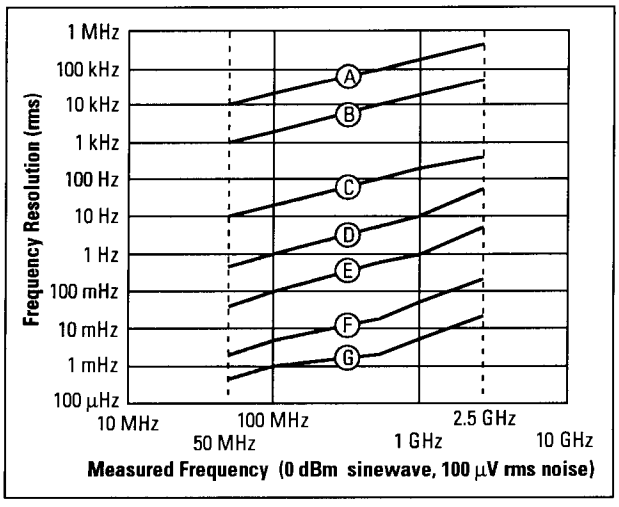



**Graph 1. Maximum Available Frequency Resolution for Channels A and B. Larger timebase settings and averaging will reduce the effects of random noise and improve resolution.**

### Legend for Graphs 1 and 2

| | Timebase Setting (Interval at Center: Auto) | Interval at Center Setting (Interval at Center: Manual) |
|---|---|---|
| A | 20 µs/Div | 1 µs |
| B | 200 µs/Div | 10 µs |
| C | 2 ms/Div | 100 µs |
| D | 20 ms/Div | 1 ms |
| E | 200 ms/Div | 10 ms |
| F | | 100 ms |
| G | | 0.5 s |

2.5 MHz (MAX SAMPLE)
1/2.5 MHz = .4 usec




**Graph 2. Maximum Available Frequency Resolution for Option 030 2.5 GHz Channel C. Larger timebase settings and averaging will reduce the effects of random noise and improve resolution.**

## Time Interval Measurements

**+ Time Interval**
Range: *+20 ns to +1 second*
Maximum Measurement Rate
Fast Histogram: 2.5 MHz
Other Modes: 1.25 MHz

**± Time Interval**
Range: *–0.5 s to +0.5 second*
Maximum Measurement Rate
Fast Histogram: 2.0 MHz
Other Modes: 1.25 MHz

**Resolution:** *Maximum Available Measurement Resolution or Display Resolution, whichever is greater*

Maximum Available Measurement Resolution:

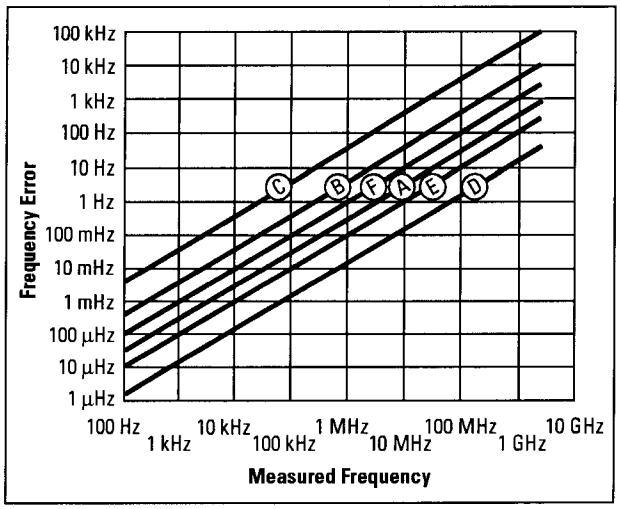
$$\sqrt{(200\,\text{ps rms}\ ^{*})^2 + \left(\text{Threshold Trigger Errors}^{\dagger\dagger\dagger}\right)^2}$$

**Note:** 1) Threshold Trigger Errors are usually negligible for input slew rates > 5V/µs.
2) Through averaging, Maximum Available Measurement Resolution can be significantly improved.

Display Resolution
vs Time, or Histogram of vs Time
Panorama Off:
Display Span/256
Panorama On:
Display Span/224
Fast Histogram:
Display Span/450

**Accuracy:** ± *Resolution*
± *(Time Interval × Reference Error)* ††
± *Start Threshold Level Timing Error* ‡
± *Stop Threshold Level Timing Error* ‡
± *1 ns Systematic Error*

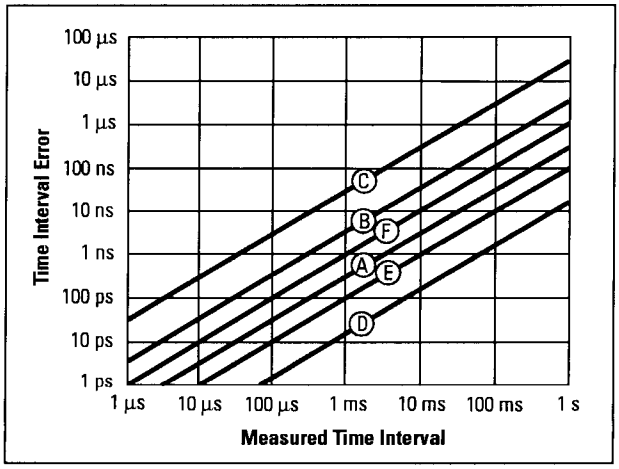
* 125 ps rms typical
†† Refer to Graph 4
††† Refer to Graph 5
‡ Refer to Graph 6




**Graph 3. Frequency Reference Error. Crystal aging will affect your Frequency accuracy.**

**Legend for Graphs 3 and 4**

| Time Since Last Calibration | Standard Reference | Option 010 Reference |
|---|---|---|
| 1 Month | Ⓐ | Ⓓ |
| 1 Year | Ⓑ | Ⓔ |
| 10 Years | Ⓒ | Ⓕ |




**Graph 4. Time Interval Reference Error. Crystal aging will affect your Time Interval accuracy.**

## Time Axis in vs Time

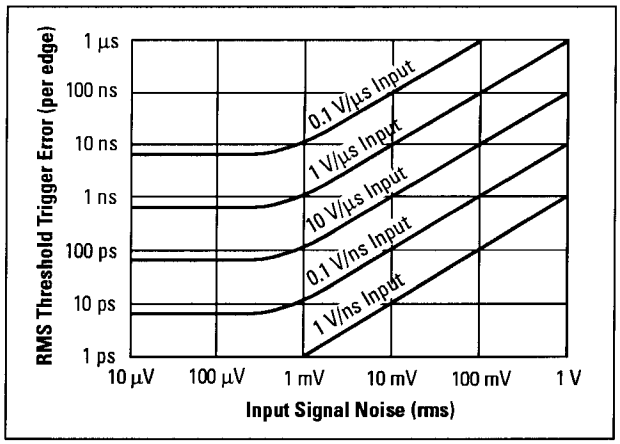
**Resolution:**
Main Timebase Setting / 45, with panorama off
Window Timebase Setting/ 45, with panorama on
**Accuracy:** Resolution

Note: Time aliasing can occur when time between measurements exceeds 360 divisions.

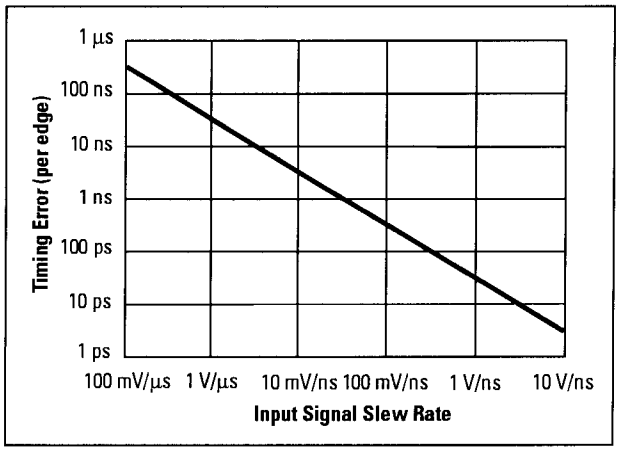
## Inputs

### Channel A and B

Sensitivity (minimum hysteresis): *20 mV rms sine wave to 100 MHz (25 mV rms sine wave for Freq A from 100 MHz to 200 MHz)*
Minimum Pulse Width: 5 ns at *60 mV p-p (2.5 ns at 75 mV p-p for Frequency A measurements above 50 MHz)*
Input Amplifier Noise: 600 µV rms
Threshold Drift: ±3 mV after warm-up at 25°C
Voltage Threshold Accuracy: *±(25 mV + 1% of Threshold Value)*
Maximum Hysteresis: Increases the minimum input signal amplitude required by a factor of three, providing additional 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 p-p to 5 V p-p*
Signal Operating Range (dc)
1 MΩ: *±10 volts*
50 Ω: *±5 volts*
Damage Level
1 MΩ: *40 V rms for < 5 kHz, 5 V rms for > 5 kHz*
50 Ω: *5 V rms*




**Graph 5. Noise on the input signal will add error to time-interval measurements. Error is associated with both start and stop edges.**




**Graph 6. Voltage Threshold Level Timing Error varies with input slew rate. Error is associated with both start and stop edges.**

**Channel C (Option 030)**
Sensitivity: *–25 dBm to 1.5 GHz, –20 dBm from >1.5 GHz to 2.0 GHz, –15 dBm from >2.0 GHz to 2.5 GHz*
Maximum Input Level: *+7 dBm*
Damage Level: *+15 dBm*
**Note:** For specifications on the Option 031 High Resolution 2.5 GHz Channel C, refer to "Dynamic Frequency and Jitter Analysis at the Touch of a Button," HP 53310A brochure.

**External Arm**
Impedance: 1 MΩ
Delay: <10 ns
**Note:** Sensitivity, Minimum Pulse Width, Signal Operating Range and Damage Level of the External input are the same as that of Channel B.

**Frequency Reference**

**Standard Crystal**
Temperature Stability: $<8 \times 10^{-6}$, *referenced to 25°C*
Short Term Stability: $<4 \times 10^{-9}$ *for 1 second average*
Aging Rate: $<3 \times 10^{-7}$/*month*

**Option 010 High Stability Oven Reference**
Temperature Stability: $<7 \times 10^{-9}$, *referenced to 25°C*
Short Term Stability: $<4 \times 10^{-11}$ *for 1 second average*
Aging Rate: $<5 \times 10^{-10}$/*day*, $< 1 \times 10^{-7}$/*year*
Warmup: *Within* $5 \times 10^{-9}$ *of final value*, 10 minutes after turn-on**.*
When:
1) HP 53310A is operated in a 25°C environment
2) Oscillator off-time** was less than 24 hours
3) Oscillator aging rate was $<5 \times 10^{-10}$ per day prior to turnoff**

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

** "Turn-off","turn-on", and "off-time" apply to periods when power is disconnected from the HP 53310A rear panel.

## Rear Panel Connectors

**HP-IB**
Controls: The HP 53310A provides full programmability. All instrument settings and operating modes, except specific self test routines, may be remotely programmed via HP-IB (IEEE Std 488.1-1987). The programming codes and formats comply with IEEE Standard Codes, Formats, Protocols, and Common Commands (IEEE Std 488.2-1987), and Standard Commands for Programmable Instruments (SCPI) Standard, Version 1990.0.

Data Acquisition and Transfer Rate: A 450 point data record can be acquired and transferred to a computer at a rate ~17 times per second, as tested with an HP 9000, Series 300 controller. For this test, a 1-MHz carrier was applied to the analyzer with a timebase setting of 40 µs /division.

Data Transfer Rates: ~175 kByte/s

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

**Test Limit Output**
The Test Limit Output will go high when measurements fall outside the display range of the Fast Histogram. In "vs Time" mode, it will indicate each time the Value Trigger condition is met following the pre-trigger delay.

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 p-p to 5 V p-p, into 1 kΩ
Damage Level: 10 V rms

**Frequency Standard Output**
Frequency: 10 MHz, or the External Reference if the Frequency Standard Input is used.
Operating Range (ac coupled)
50 Ω: >1 V p-p square wave
1 MΩ: >2 V p-p square wave

**Power Requirements**
Voltage: 115/230 Vac (–25% to +15%)
Frequency: 48 to 66 Hz
Maximum Power: 300 VA

## General

**Operating Temperature:**
0 to 55°C

**Weight:** 10 kg net, 18 kg shipping

**Dimensions:** 425 mm W × 194 mm H × 363 mm D (440 mm D with handle extended)

## Warranty

The HP 53310A Modulation Domain Analyzer comes with a one-year return-for-service warranty.

Both warranted specifications and operating characteristics of the HP 53310A are discussed in this section. To distinguish warranted specifications from operating characteristics, *specifications are highlighted throughout in italics.*

### Input Conditions

Range: *50 MHz to 2.5 GHz*
Sensitivity:
*–13 dBm 50 MHz to 200 MHz*
*–17 dBm 200 MHz to 2 GHz*
*–12 dBm 2 GHz to 2.5 GHz*
Maximum Input Level:
*+20 dBm*
Damage Level:*+23 dBm*
Impedance: 50 Ω
Coupling: ac
RF Burst Width: 50 µs to CW

### Maximum Measurement Rate

Fast Histogram: 1.5 MHz
Other Modes: 1 MHz
Fast Sampling: 8 MHz
(repetitive)

### External Local Oscillator Input

Level: +6dBm (±1dB)
Impedance: 50 Ω
Frequency Range: 150 MHz to 2.5 GHz

### Resolution

Maximum available measurement resolution or display resolution, whichever is greater.

Maximum Available Measurement Resolution (Auto Sampling): *see Graph A*
Display Resolution:
vs Time or Histogram of vs Time
Window Off:
Display Span/256
Window On:
Display Span/224
Fast Histogram:
Display Span/450

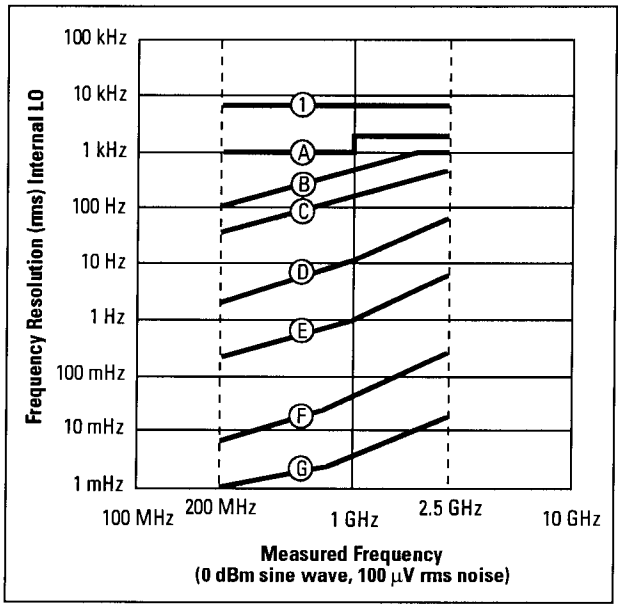
**Accuracy:** ± *[Resolution + (Frequency × Reference Error*)]*

### RF Envelope Trigger

Level: Adjustable in 100 steps (e.g., –25 dBm to 0 dBm @ 1 GHz)

Output: 0 to 0.4 volt into 50 Ω or TTL level into high impedance

### Maximum Available Frequency Resolution




**Graph A. Maximum available frequency resolution for Option 031 Channel C. Larger timebase setting and averaging will reduce the effects of random noise and improve resolution. Please refer to Graph 2 on page 5 for resolution over the 50 MHz - 200 MHz band.**

| | Timebase Setting Interval @ center: Auto | Interval @ Center Setting (Interval @ Center: Manual) | Frequency Resolution (Ext. LO)† |
|---|---|---|---|
| 1 | | 125 ns†† | 7 kHz |
| A | ≤ 20 µs/Div | 1 µs | 1 kHz |
| B | 200 µs/Div | 10 µs | 20 Hz |
| C | 2 ms/Div | 100 µs | 5 Hz |
| D | 20 ms/Div | 1 ms | 2 Hz |
| E | 200 ms/Div | 10 ms | 50 mHz |
| F | | 100 ms | 5 mHz |
| G | | 0.5 s | 2 mHz |

† Typical resolution over the 200 MHz to 2.5 GHz range using an HP 8663A Synthesizer as an external LO.
†† Fast Sampling mode

## Specifications — Option 305

### Minimum system requirements:

HP 53310A. Works with any option, but Fast (repetitive) Sample Rate is not supported
IBM-compatible PC:
- 386-based with coprocessor
- 4 Mbyte RAM
- 2 Mbyte hard disk space
- MS-DOS® 5.0
- Windows® 3.1
- IEEE 488.2 Interface:
  - HP-IB:
    - HP 82335A or HP 82341A
  - GPIB:
    - National Instruments AT-GPIB or AT-GPIB/TNT with NI-488.2 version 2.1.1 drivers for Windows

### Performance Characteristics

### Typical Performance (1 GHz Carrier)

| Off. Freq | IF | Noise Floor |
|---|---|---|
| <10 Hz | 20 Hz | –180 dB |
| 100 Hz | 200 Hz | –170 dB |
| 1 kHz | 2 kHz | –160 dB |
| 10 kHz | 20 kHz | –150 dB |
| 100 kHz | 200 kHz | –140 dB |
| 500 kHz | 1 MHz | –130 dB |

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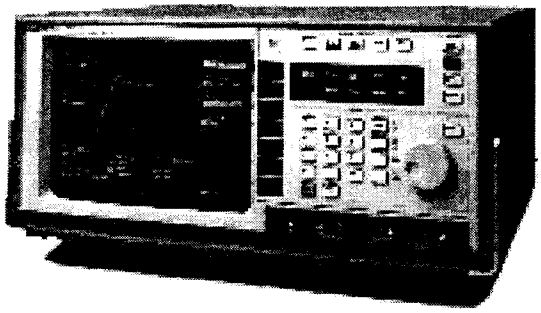
# Flexible Phase Analysis for RF Communications Speeds Time to Market

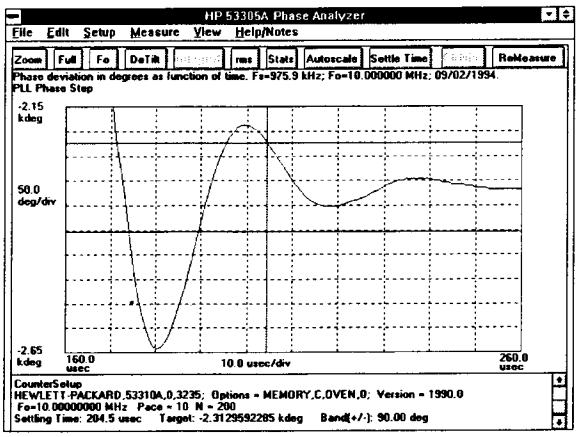
## Product Overview



**HP 53310A Modulation Domain Analyzer**

**Option 305 Phase Analysis Software**

also available separately as
**HP 53305A Phase Analysis Software** $ 575.00 ea




**Enhance your HP 53310A with powerful phase analysis software that runs on your PC.**

The HP 53310A Modulation Domain Analyzer's Option 305 Phase Analysis Software adds the power of phase analysis in the Modulation Domain to your HP 53310A. Now you can better understand your design through direct phase analysis by measuring phase settling time, phase noise (phase spectrum), phase deviation and phase trajectory. If you already own an HP 53310A, purchase the software separately as the HP 53305A Phase Analysis Software.

The software runs on any IBM-compatible PC with Microsoft® Windows. Simply connect your PC to the HP 53310A using IEEE 488.2.

With the software, you can measure and display frequency, frequency deviation and phase deviation. From these displays, you can analyze settling time characteristics, view histograms and statistics, and even perform an FFT to get phase noise and jitter spectrum.

### Minimum system requirements:

HP 53310A. Works with any option, but Fast (repetitive) Sample Rate is not supported
IBM-compatible PC:
- 386-based with coprocessor
- 4 Mbyte RAM
- 2 Mbyte hard disk space
- MS-DOS® 5.0
- Windows 3.1
- IEEE 488.2 Interface:
  - HP-IB:
    - HP 82335A or HP 82341A
  - GPIB:
    - National Instruments AT-GPIB or AT-GPIB/TNT with NI-488.2 version 2.1.1 drivers for Windows

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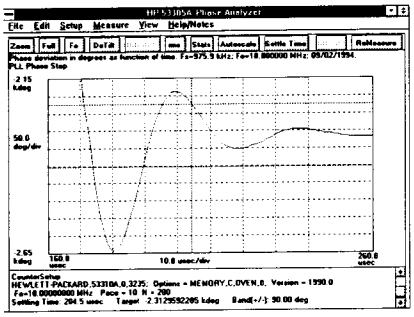
## Automatic Settling Time Measurements

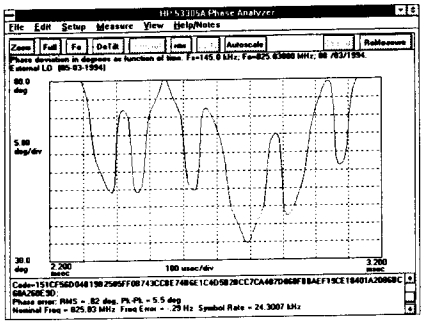
External downconversion and discriminators are a thing of the past. With the HP 53310A Option 305, you can directly measure the phase detector output, without the need for calibration. You simply enter the tolerance band and target frequency or phase (or let the analyzer track the target value for you), and the analyzer automatically calculates the settling time from its frequency, frequency deviation, or phase deviation display. The synthesizer step command is typically used as a "time-zero" reference to trigger the analyzer.



**Take the drudgery out of PLL characterization with automatic phase settling time measurements.**

## Modulation Analysis

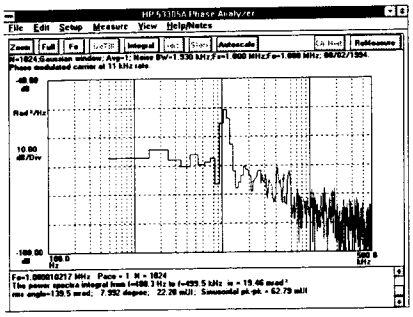
Many new digital RF communication systems employ complex frequency and phase modulation techniques. The HP 53310A Option 305 provides direct frequency and phase versus time views of your complex modulation. The high resolution RF input (Option 031) allows you to directly profile both wide and narrow band modulations up to a 500 kHz modulation rate. This eliminates the need for external downconversion, saving you time and effort.



**Gain a better understanding of your RF system performance with the phase modulation display (Pi/4 DQPSK shown).**

## Phase Noise

Modulation rates, spurious modulation, and total integrated noise over the modulation bandwidth are easily uncovered with the Phase Power Spectral Density (phase noise) display. This display is simply a calibrated version of the FFT of a phase deviation display.



**Uncovering spurs or measuring total integrated noise over the modulation bandwidth is a snap with the Phase Power Spectral Density display.**

**Typical Performance—1 GHz Carrier**

| Off. Freq | IF | Noise Floor |
|---|---|---|
| <10 Hz | 20 Hz | –180 dB |
| 100 Hz | 200 Hz | –170 dB |
| 1 kHz | 2 kHz | –160 dB |
| 10 kHz | 20 kHz | –150 dB |
| 100 kHz | 200 kHz | –140 dB |
| 500 kHz | 1 MHz | –130 dB |

## Ordering Information

**HP 53310A** Modulation Domain Analyzer

Option 001 Extended Measurement Memory
Option 010 High Stability Oven Time Base
Option 030 2.5 GHz Channel C
Option 031 Digital RF Communications Analysis/High Resolution 2.5 GHz Input
**Option 305** Phase Analysis Software

If you already own an HP 53310A, order the software separately as:

**HP 53305A** Phase Analysis Software

This data sheet is a supplement to the HP 53310A Modulation Domain Analyzer data sheet. It details features and applications of Option 305. Please consult the HP 53310A data sheet for further product information and specifications:

HP 53310A Technical Data Sheet, pub. no. 5091-2596E.
HP 53310A Option 031 Data Sheet Insert, pub. no. 5091-2597E.

**Data Subject to Change**
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