

# Agilent 53310A

## Modulation Domain Analyzer

Data Sheet



**Agilent Technologies**  
Innovating the HP Way

## Product Description

This section offers a brief description of the Agilent Technologies 53310A Modulation Domain Analyzer. 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  $\pm$ TI

Channel: A and B (Separate) or A only (Common)

Start:  $f$  or  $\bar{f}$

Stop:  $f$  or  $\bar{f}$

## 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 $\Omega$  or 50  $\Omega$

Hysteresis: Min to Max, settable in ten steps

### Channel C (Optional)

Voltage Threshold: 0 volts

Coupling: ac

Impedance: 50  $\Omega$

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  $\mu$ s/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

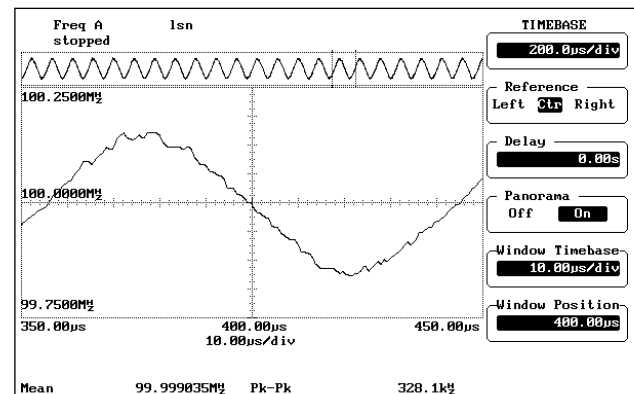
Range: 1  $\mu$ s/div to 1 s/div

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:  $\uparrow$  or  $\downarrow$  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:  $\uparrow$  or  $\downarrow$

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 conjunction 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  $\uparrow$  or  $\downarrow$  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

**GPIO/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.

## Product Specifications and Characteristics

Both warranted specifications and operating characteristics of the Agilent 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

### 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,” Agilent 53310A brochure.

Display Resolution:

vs Time, or Histogram of vs Time

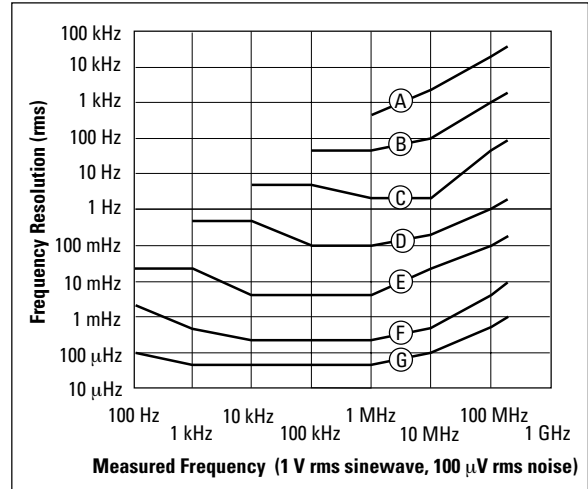
Window Off: Display Span/256

Window On: Display Span/224

Fast Histogram: Display Span/450

**Accuracy:**  $\pm[\text{Resolution} + (\text{Frequency} \times \text{Reference Error})^\dagger]$

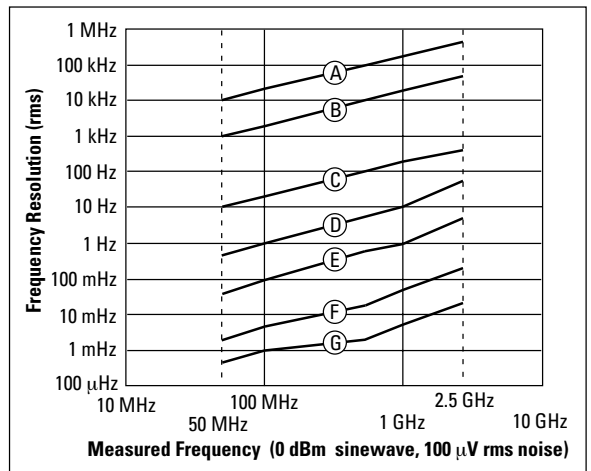
<sup>†</sup> Refer to Graph 3.



**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



**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:

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

### Notes

- 1) Threshold trigger errors are usually negligible for input slew rates >5V/μs.
- 2) Through averaging, maximum available measurement resolution can be significantly improved.

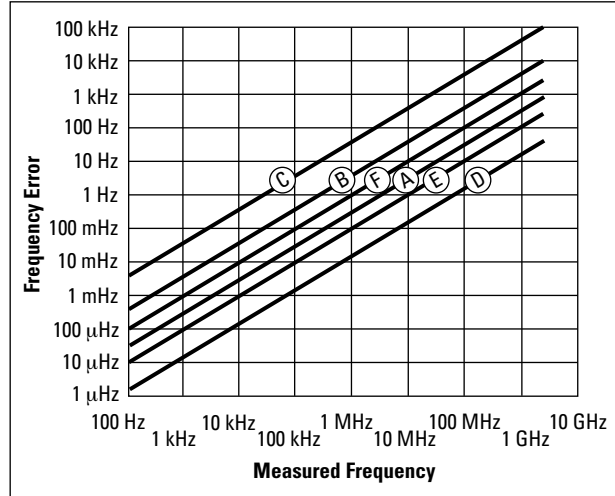
Display Resolution:

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 x Reference Error) <sup>††</sup>  
 ±Start Threshold Level Timing Error <sup>‡</sup>  
 ±Stop Threshold Level Timing Error <sup>‡</sup>  
 ±1 ns Systematic Error

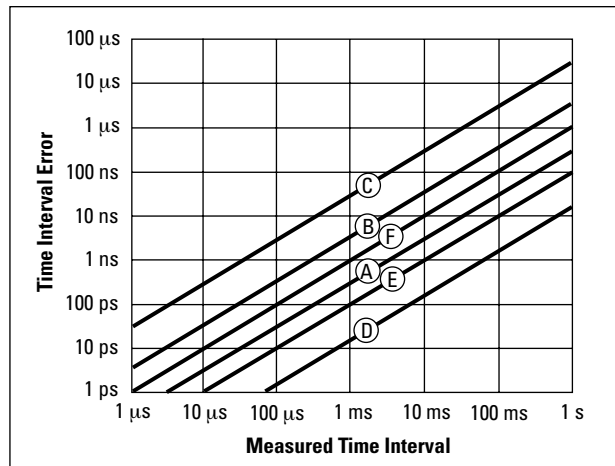
\* 125 ps rms typical  
 †† Refer to Graph 4.  
 ††† Refer to Graph 5.  
 ‡ Refer to Graph 6.



**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	(A)	(D)
1 Year	(B)	(E)
10 Years	(C)	(F)



**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  $\mu$ V rms

Threshold Drift:  $\pm 3$  mV after warm-up at 25°C

Voltage Threshold Accuracy:  $\pm(25 \text{ mV} + 1\% \text{ of Threshold Value})$

Maximum Hysteresis: Increases the minimum input signal amplitude required by a factor of three, providing additional noise immunity.

Impedance: 50  $\Omega$  or 1 M $\Omega$  (500 k $\Omega$  in common)

ac Coupling: 100 Hz cutoff frequency

Capacitance (1 M $\Omega$ ): <20 pF (<30 pF in common)

Dynamic Range (ac): 60 mV p-p to 5 V p-p

Signal Operating Range (dc):

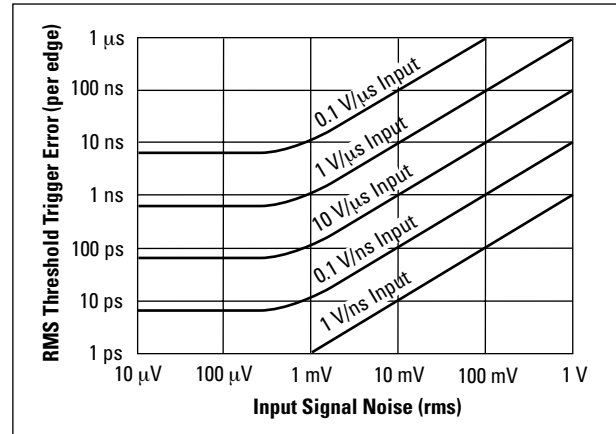
1 M $\Omega$ :  $\pm 10$  volts

50  $\Omega$ :  $\pm 5$  volts

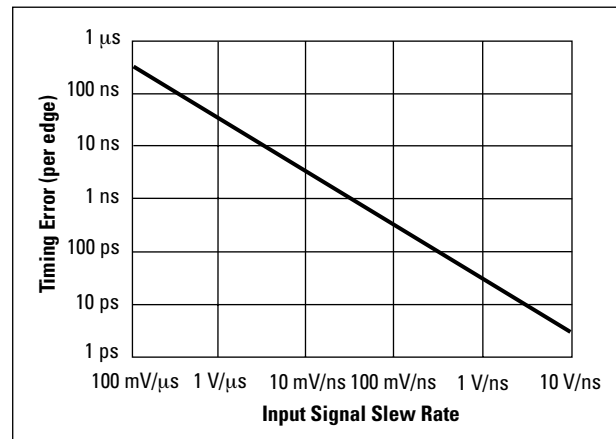
Damage Level:

1 M $\Omega$ : 40 V rms for <5 kHz, 5 V rms for >5 kHz

50  $\Omega$ : 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," 53310A brochure.

### External Arm

Impedance: 1 M $\Omega$

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) 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 turn-off\*\*

### Rear Panel Connectors

#### GPIO

Controls: The Agilent 53310A provides full programmability. All instrument settings and operating modes, except specific self-test routines, may be remotely programmed via GPIO (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.

\* "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 53310A rear panel.

Data Acquisition and Transfer Rate: A 450 point data record can be acquired and transferred to a computer at a rate  $\sim 17$  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  $\mu$ s/division.

Data Transfer Rates:  $\sim 175$  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  $\Omega$

### Frequency Standard Input

Frequency: 5 MHz or 10 MHz

Operating Range: 1 V p-p to 5 V p-p, into 1 k $\Omega$

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  $\Omega$ :  $>1$  V p-p square wave

1 M $\Omega$ :  $>2$  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 x 194 mm H x 363 mm D (440 mm D with handle extended)

### Warranty

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

### Specifications — Option 031

Both warranted specifications and operating characteristics of the Agilent 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

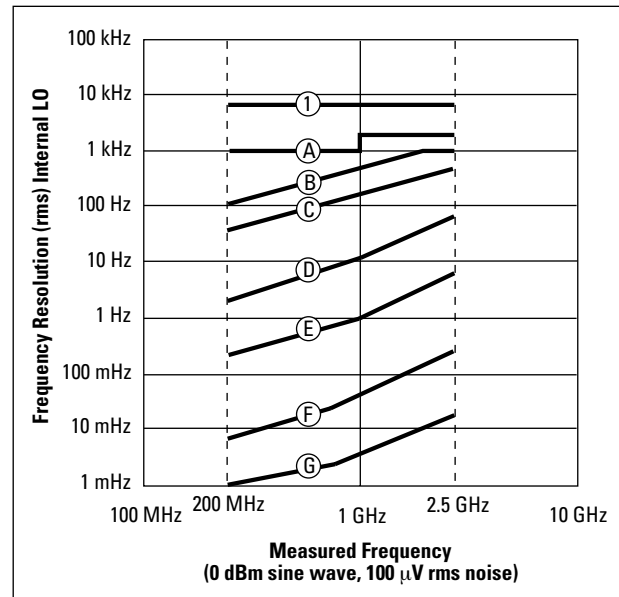
**Accuracy:** ±[Resolution + (Frequency × Reference Error\*)]

#### 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 4 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
Ⓐ	≤ 20 μs/Div	1 μs	1 kHz
Ⓑ	200 μs/Div	10 μs	20 Hz
Ⓒ	2 ms/Div	100 μs	5 Hz
Ⓓ	20 ms/Div	1 ms	2 Hz
Ⓔ	200 ms/Div	10 ms	50 mHz
Ⓕ		100 ms	5 mHz
Ⓖ		0.5 s	2 mHz

† Typical resolution over the 200 MHz to 2.5 GHz range using an Agilent 8663A Synthesizer as an external LO

†† Fast Sampling mode



## Specifications — Option 305

### Minimum System Requirements

Agilent 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 82335A or HP 82341A

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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