

# NETWORK/SPECTRUM ANALYZERS

## RF Network/Spectrum/Impedance Analyzer, 100 kHz to 1.8 GHz/2 Hz to 1.8 GHz

### HP 4396A

- Full vector network and spectrum measurement and analysis
- Wide dynamic range network measurement with fast sweep speeds
- $\pm 0.05\text{dB}/\pm 0.3^\circ$  dynamic magnitude/phase accuracy
- Extremely fast narrow band spectrum measurement
- Impedance analysis option and test kit available
- $\pm 1.0\text{dB}$  overall level accuracy for spectrum analysis
- $-150\text{ dBm/Hz}$  sensitivity for spectrum analysis
- HP Instrument BASIC option for easy test automation
- Time-gated spectrum analysis option
- Color CRT and built-in disk drive/RAM disk



HP 4396A with HP 85046A



### HP 4396A RF Network/Spectrum Analyzer

The HP 4396A provides excellent RF vector network, spectrum, and optional impedance measurements for lab and production applications. Gain, phase, group delay, distortion, spurious, CN, and noise measurements often required for evaluating components and circuits can be measured using one instrument. When combined with a test set, the HP 4396A provides reflection measurements, such as return loss, and SWR, and S parameters. As a vector network analyzer, the HP 4396A operates from 100 kHz to 1.8 GHz with 1 mHz resolution and its integrated synthesized source provides  $-60$  to  $+20$  dBm of output power with 0.1 dB resolution. The dynamic magnitude and phase accuracy are  $\pm 0.05$  dB and  $\pm 0.3$  deg so that it can accurately measure gain and group delay flatness, which are becoming more important in modern electronics systems.

As a spectrum analyzer, the HP 4396A operates from 2 Hz to 1.8 GHz with resolution-bandwidths (RBWs) spanning 1 Hz to 3 MHz in a 1-3-10 sequence. A fully synthesized local oscillator allows stable and accurate frequency analysis. Direct A/D conversion (no LOG amplifier is used) results in  $\pm 1.0$  dB overall level accuracy. Noise sidebands fall below  $-105$  dBc/Hz offset 10 kHz from carriers below 1 GHz, while sensitivity is  $-150$  dBm/Hz at 10 MHz and  $-147$  dBm at 1 GHz. In addition, with two independent display channels available, you can simultaneously view network and spectrum (or transmission and reflection) characteristics of the device under test in split-screen format. For example, an amplifier's frequency response (network measurement) and distortion (spectrum measurement) can be shown at the same time.

### Extremely Fast Spectrum Measurement

The HP 4396A features a stepped Fast Fourier Transform (FFT) digital-signal-processing (DSP) technique for 20 to 100 times faster narrow band spectrum measurement than swept-tuned spectrum analyzers. The stepped FFT is performed when the resolution bandwidth (RBW) is set at 3 kHz or below. For example, with a 30 Hz RBW and 10 kHz span, the HP 4396A has a sweep time of 400 ms, while swept-tuned spectrum analyzers take a few tens of seconds. The stepped FFT can greatly improve the efficiency of narrow band spectrum measurement such as frequency tuning of a VCO or CN measurements.

### Time-Gated Spectrum Analysis

With Option 1D6, the HP 4396A offers time-gated spectrum analysis capability to capture and measure repetitive burst signals in video, disk drives, communication equipment, and more. The minimum gate length is 2  $\mu$ sec so that even narrow burst signals can be analyzed.

### Impedance Measurement Function and RF Impedance Test Kit

A full-featured impedance measurement function (useful for quick-check general-purpose impedance applications) can be added to the HP 4396A by adding Option 010 and the HP 43961A RF impedance test kit. Covering from 100 kHz to 1.8 GHz, impedance parameters  $|Z|$ ,  $\theta$ , C, L, Q, D, and more, are directly measured and displayed on the CRT. The basic impedance accuracy (typical value) is 3%. The HP 43961A RF impedance test kit is designed for the HP 4396A and is required to utilize the features of Option 010. An APC-7<sup>®</sup> connector is mounted on this kit for easy connection to an appropriate impedance test fixture. A wide variety of HP fixtures can be used with the test kit, including the new surface-mount-device (SMD) fixtures used with the new HP 4291A RF impedance/material analyzer. For higher accuracy, complete impedance analysis over the widest impedance ranges, and temperature effects evaluation the HP 4291A impedance/material analyzer is recommended. See page 341.

## HP 4396A Specifications Summary

### Network Measurement

#### Frequency Characteristics

Range: 100 kHz to 1.8 GHz

Resolution: 1 mHz

Accuracy:  $\pm 5.5$  ppm (Option 1D5:  $\pm 0.13$  ppm)

#### Output Characteristics

Power range: -60 to +20 dBm

Resolution: 0.1 dB

Level accuracy:  $\pm 0.5$  dB

#### Receiver Characteristics

Frequency range: 100 kHz to 1.8 GHz

Noise level: (10 Hz IFBW,  $\geq 10$  MHz,  $f$ =frequency in GHz)

$< (-125 + 3 \times f)$  dBm (A, B inputs)

$< (-100 + 3 \times f)$  dBm (R input)

Full scale input level: -5 dBm (A, B), +20 dBm (R)

IF bandwidth (Hz): 10, 30, 100, 300, 1k, 3k, 10k, 40k

#### Dynamic Accuracy

Magnitude dynamic accuracy:

Input level (relative to full scale input level)	
0 dB	$\pm 0.3$ dB
-10 to -70 dB	$\pm 0.05$ dB
-80 dB	$\pm 0.1$ dB
-90 dB	$\pm 0.3$ dB
-100 dB	$\pm 1.0$ dB
-110 dB	$\pm 0.7$ dB typical
-120 dB	$\pm 2.3$ dB typical

@ 23  $\pm$  5° C, IFBW 10 Hz, R input = -35 dBm

#### Phase dynamic accuracy:

Input level (relative to full scale input level)	
0 dB	$\pm 3$ deg
-10 dB	$\pm 0.6$ deg
-20 to -70 dB	$\pm 0.3$ deg
-80 dB	$\pm 0.7$ deg
-90 dB	$\pm 2.4$ deg
-100 dB	$\pm 7$ deg
-110 dB	$\pm 8$ deg typical
-120 dB	$\pm 25$ deg typical

@ 23  $\pm$  5° C, IFBW 10 Hz, R input = -35 dBm

#### Measurement Throughput Summary (IFBW 40 kHz, ms)

Measurement (uncorrected)	Number of points			
	51	201	401	801
(1) Magnitude	30	80	150	280
(2) Phase	30	90	160	310
(3) Group delay( $\tau$ )	35	120	220	420
(4) Magnitude and phase	45	150	290	560
(5) Magnitude and group delay	55	180	350	680
(6) Magnitude/return loss	45	140	270	530

#### Spectrum Measurement

##### Frequency Characteristics

Frequency range: 2 Hz to 1.8 GHz

##### Frequency reference

Accuracy:  $\pm 5.5$  ppm (Option 1D5:  $\pm 0.13$  ppm)

##### Resolution Bandwidth (RBW)

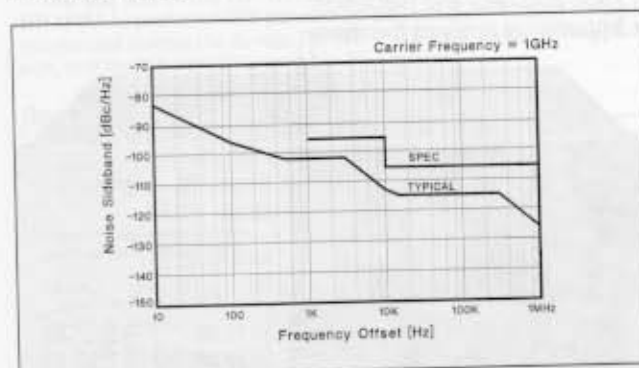
Range: 1 Hz to 3 MHz, 1-3-10 step

##### Selectivity (60 dB/3 dB):

RBW  $\geq 10$  kHz:  $< 10$

RBW  $\leq 3$  kHz:  $< 3$

## Noise Sidebands



Noise sidebands normalized to 1 Hz RBW versus offset from carrier (typical)

## Impedance Measurement (Option 010)

Measurement Parameters:  $|Z|$ ,  $\theta_z$ ,  $|Y|$ ,  $\theta_y$ , R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q,  $|\Gamma|$ ,  $\theta_\gamma$ ,  $\Gamma_x$ ,  $\Gamma_y$

Frequency Range: 100 kHz to 1.8 GHz

Measurement Port: APC-7 on the HP 43961A Test Kit

Source Level at DUT: -66 to +14 dBm

DC Bias:  $\pm 40$  V (20 mA maximum). (A 2 k $\Omega$   $\pm 5\%$  internal resistor is used for dc bias current limitation. An external dc bias source is required.) Connector: BNC (f) on HP 43961A

Calibration: OPEN(0 S)/SHORT(0  $\Omega$ )/LOAD(50  $\Omega$ ) calibration, OPEN/SHORT/LOAD compensation on test fixtures, port extension compensation

Accuracy (Supplemental Performance Characteristic): 3% basic accuracy at 23°  $\pm$  5° C, after OPEN/SHORT/LOAD calibration

## General Characteristics

Operating Temperature/Humidity: 0° to 55°C, 15% < RH < 95%

Storage Temperature: -40° to 65°C

Power Requirement: 100/120/220/240 V  $\pm 10\%$ , 47 to 66 Hz, 500 VA max

Weight: 27.2 kg (60 lb) typical

Size: 425 mm W  $\times$  235 mm H  $\times$  553 mm D

## Key Literature

HP 4396A 1.86 GHz Network/Spectrum Analyzer Data Sheet, p/n 5091-5189E.

HP 4396A Option 010 Impedance Measurement Function and HP 43961A RF Test Kit, Product Overview, p/n 5962-7971E.

## Ordering Information

	Price
HP 4396A RF Network/Spectrum Analyzer	\$34,600
Opt 1C2 HP IBASIC	\$1,120
Opt 1D5 High Stability Frequency Reference	\$1,785
Opt 1D6 Time-Gated Spectrum Analysis	\$1,675
Opt 1D7 50 $\Omega$ to 75 $\Omega$ Spectrum Input Impedance Conversion	\$920
Opt 00M RGB Output	\$224
Opt 010 Impedance Measurement Function (Requires HP 43961A)	\$1,120
HP 43961A RF Impedance Test Kit (add test fixtures listed below)	\$2,805
HP 16191A Side Electrode SMD fixture (dc to 2 GHz)	\$2,475
HP 16192A Parallel Electrode SMD fixture (dc to 2 GHz)	\$1,980
HP 16193A Small Side Electrode SMD fixture (dc to 2 GHz)	\$2,225
HP 16092A Spring Clip fixture (dc to 500 MHz)	\$755

# Complete Characterization of Linear Networks (cont'd)

## Overview

### Network Analyzer Product Line Summary

HP model	Frequency range	Source	Measurement capabilities
HP 35670A Dynamic Signal Analyzer (page 528)	122 $\mu$ Hz to 102.4 kHz (2 channel) 122 $\mu$ Hz to 51.2 kHz (4 channel)	Swept and fixed sine, random (white and pink) noise, burst random, chirp, burst and periodic chirp, and arbitrary waveform	Transfer functions, magnitude/phase, curve fit, spectrum analysis, octave analysis, order domain spectrum analysis, order tracking, histogram analysis, HP-IB programmable
HP 35665A Dual-Channel Dynamic Signal Analyzer (page 526)	122 $\mu$ Hz to 51.2 kHz	Swept and fixed sine chirp, random, burst random, and arbitrary waveform	Transfer functions, magnitude/phase, 20-pole/20-zero curve filter, frequency-response synthesis, time-domain functions, and spectrum analysis. HP-IB programmable.
HP 3589A Spectrum/Network Analyzer (page 255)	10 Hz to 150 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, group delay, S-parameters, impedance, SWR, spectrum analysis, including gating. HP Instrument BASIC optional. HP-IB programmable.
HP 87510A Gain/Phase Analyzer (page 273)	100 kHz to 300 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, insertion loss/gain, group delay, attenuation, Impedance-magnitude/phase. Electrical delay. HP IBASIC capability. Built-in 3 $\frac{1}{2}$ -in flexible disk (LIF/DOS format). HP-IB capability.
HP 8751A Network Analyzer (page 270)	5 Hz to 500 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation for linear phase. Impedance-magnitude/phase: return loss, R + jX. Full accuracy enhancement. HP Instrument BASIC capability. Built-in 3 $\frac{1}{2}$ -in flexible disk (LIF/DOS format). HP-IB capability.
HP 4195A Network/Spectrum/Impedance Analyzer (page 260)	10 Hz to 500 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, insertion loss/gain, attenuation, group delay, S-parameters, return loss, SWR, complex impedance, accuracy enhancement. HP-IB programmable.
HP 8711B/8712B HP 8713B/8714B RF Economy Network Analyzer (page 274)	300 kHz to 1.3 GHz (8711B, 8712B) 300 kHz to 3 GHz (8713B, 8714B)	Integrated synthesized source, T/R test set and receiver	Transmission/reflection measurements Phase (8712B, 8714B) 50 $\Omega$ and 75 $\Omega$ measurements HP Instrument BASIC (IBASIC) Narrowband/broadband receivers Internal calibration, averaging, limit testing, internal disk and storage registers AM delay
HP 4396A Network/Spectrum/Impedance Analyzer (page 258)	100 kHz to 1.8 GHz (network) 2 Hz to 1.8 GHz (spectrum)	Integrated synthesized source	Transfer functions, magnitude/phase, insertion loss/gain, attenuation, S-parameters, group delay, return loss, R + jX. Impedance-magnitude/phase. Electrical delay. Spectrum analysis. Complex impedance and HP Instrument BASIC optional. Built-in 3 $\frac{1}{2}$ -in flexible disk (LIF/DOS format). HP-IB programmable.
HP 8752C Network Analyzer (page 278)	300 kHz to 1.3/3.0/ 6.0 GHz	Integrated synthesized source, transmission/reflection test set and receiver	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, gain compression, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase - Return loss, r + jx, accuracy enhancement, time-domain capability. HP-IB programmable.
HP 8753D Network Analyzer (page 280)	30 kHz to 3 GHz/6 GHz	Integrated synthesized source, S-parameter test set, and receiver	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation from linear phase. Impedance - magnitude/phase - Return loss, r + jx. Full accuracy enhancement. Time-domain capability. Harmonic measurement capability. Sequencing HP-IB programmable.
HP 8719C/8720C/8722C Network Analyzers (page 285)	50 MHz to 13.5 GHz (8719C) 50 MHz to 20 GHz (8720C) 50 MHz to 40 GHz (8722C)	Integrated synthesized source (1 Hz resolution optional)	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase. Impedance - magnitude/phase - Return Loss, r + jx. Full accuracy enhancement. Time-domain capability. HP-IB programmable.
HP 8510 Series Network Analyzers (page 288)	45 MHz to 110 GHz	HP 8350 Series Sweep Oscillators HP 8360 Series Synthesized Sweepers	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase, impedance, return loss, R + jx. Active device characterization. Full accuracy enhancement. Time-domain capability. HP-IB programmable.
HP 8757D/E Scalar Network Analyzers (page 265)	10 MHz to 110 GHz	HP 8350B Sweeper HP83751A/83752A Synthesized Sweepers HP 8360 Series Synthesized Sweepers	Scalar transmission/reflection measurements 50 $\Omega$ coax measurements 10 MHz to 50 GHz 75 $\Omega$ coax measurement 10 MHz to 2.4 GHz Waveguide measurements 26.5 to 110 GHz Open/short averaging, normalization, averaging, limit testing Storage registers, HP-IB programmable

### Vector Voltmeter

HP model	Frequency range	Source	Measurement capabilities
HP 8508A Vector Voltmeter (page 287)	0.1 MHz to 1 GHz 0.3 MHz to 2 GHz	None	Voltage, impedance Transfer functions, phase and amplitude HP-IB programmable