NETWORK ANALYZERS
Combined RF Network/Spectrum 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
- ±0.05 dB/° 0.3° dynamic magnitude/phase accuracy
- Extremely fast narrow band spectrum measurement
- ±1.0 dB overall level accuracy
- -150 dBm/Hz sensitivity
- HP Instrument BASIC option for easy test automation
- Time-gated spectrum analysis option
- Color CRT and built-in disk drive/RAM disk

HP 4396A RF Network/Spectrum Analyzer

The HP 4396A provides excellent RF vector network and spectrum 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 ±0.05 dB and ±0.3° 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 ±10 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.

A built-in 1.44 MB floppy disk drive lets you save and recall test setups, calibration data, measurement data, and HP IBASIC programs in either LIF or MS-DOS format. An internal RAM disk (volatile memory) is useful for quick saving and recalling.

Network Analysis with Wide Dynamic Range and Fast Sweep Times

The advanced design that provides the low noise floor for spectrum analysis also results in a high speed, wide dynamic range network analyzer. For real-time tuning of test devices, the HP 4396A offers 90 dB dynamic range (typical) with 350 usec/point sweep time (70 ms sweep time with 201 display points) using 40 kHz IF bandwidth. At 10 Hz IF bandwidth, the analyzer provides 120 dB dynamic range. For easy go/no-go testing, test limit lines are available.

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.

In addition, the HP 4396A has list sweep capability for both network and spectrum measurements. This powerful feature sweeps only desired frequency spans, and allows different RBWs to greatly improve test throughput. For example, when you want to view a fundamental signal and its low-level third harmonic, you no longer have to sweep all frequency ranges with a narrow RBW and endure the long wait for results. By using list sweep and selecting only frequencies of interest (using a narrow RBW around the low-level signal and a wide RBW for the rest of the sweep), you can clearly view both the fundamental and the third harmonic in much less time compared to using conventional spectrum analyzers.

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 usec so that even narrow burst signals can be analyzed. Furthermore, since the video bandwidth (VBW) filter is digitally implemented, you can use narrow VBWs for noise smoothing without considering the response time of the VBW filter. This is very useful for time-gated CN measurement of narrow burst signals, where the filter delay of conventional analog VBW filtering would make the measurement impractical.
Easy Test Automation and Customization
You can control additional equipment (via HP-IB or TTL interface) and create test programs without an external computer. When equipped with Option 1C2, the HP 4396A includes a built-in instrument controller and HP Instrument BASIC (HP IBASIC), which is a subset of the HP BASIC programming language for instruments. An external keyboard connects directly to the HP 4396A for programming convenience. Programs can also be created by storing front-panel keystrokes. By adding some external signal sources and RF switches controlled by the analyzer, you can easily construct a cost-effective and easy-to-program test system for component characterization or production test. IBASIC provides the flexibility to tailor the system for changing needs quickly and easily. And the analysis capability coupled with flexible disk data storage provides tools for quality-monitoring baseline and calibration checks, all under program control.

![Figure 1: Integrate different instruments into a test system with the HP 4396A Opt 1C2.](image1)

![Figure 2: >120 dB wide dynamic range](image2)

![Figure 3: Stepped FFT technique improve testing speed up to 100 times for narrow RBW sweep.](image3)

![Figure 4: <-150 dBm low noise floor provides the sensitivity required for detecting low-level signal.](image4)
**NETWORK ANALYZERS**

*Combined RF Network/Spectrum Analyzer, 100k Hz to 1.8 GHz/2 Hz to 1.8 GHz (cont’d)*

**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
- **Level linearity:**
  - $\pm 0.7$ dB (20 to 20 dBm)
  - $\pm 1.0$ dB (40 to 20 dBm)
  - $\pm 1.5$ dB (60 to 40 dBm)
- **Flatness:** $\pm 1.0$ dB
- **Spectral purity:** $+$15 dBm output

**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:**

<table>
<thead>
<tr>
<th>Input level (relative to full scale input level)</th>
<th>$&lt; 0.3$ dB</th>
<th>$&lt; 0.05$ dB</th>
<th>$&lt; 0.1$ dB</th>
<th>$&lt; 0.3$ dB</th>
<th>$&lt; 1.0$ dB</th>
<th>$&lt; 0.8$ dB typical</th>
<th>$&lt; 2.5$ dB typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 dB</td>
<td></td>
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<tr>
<td>$-10$ to $-70$ dB</td>
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<tr>
<td>$-90$ dB</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$-100$ dB</td>
<td>$&lt; 1.0$ dB</td>
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<tr>
<td>$-110$ dB</td>
<td>$&lt; 0.8$ dB</td>
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<tr>
<td>$-120$ dB</td>
<td>$&lt; 2.5$ dB</td>
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</tbody>
</table>

**Phase dynamic accuracy:**

<table>
<thead>
<tr>
<th>Input level (relative to full scale input level)</th>
<th>$\leq \pm 3$ deg</th>
<th>$\leq \pm 6$ deg</th>
<th>$\leq \pm 3$ deg</th>
<th>$\leq \pm 7$ deg</th>
<th>$\leq 2.4$ deg</th>
<th>$\leq 7$ deg</th>
<th>$\leq \pm 8$ deg typical</th>
<th>$\leq \pm 25$ deg typical</th>
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<tbody>
<tr>
<td>0 dB</td>
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<tr>
<td>$-10$ dB</td>
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<tr>
<td>$-20$ to $-70$ dB</td>
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<tr>
<td>$-80$ dB</td>
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<tr>
<td>$-90$ dB</td>
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<tr>
<td>$-100$ dB</td>
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<td>$\leq 7$ deg</td>
<td>$\leq 2.4$ deg</td>
<td>$\leq 8$ deg typical</td>
<td>$\leq \pm 25$ deg typical</td>
<td>$\leq \pm 25$ deg typical</td>
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<tr>
<td>$-110$ dB</td>
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<tr>
<td>$-120$ dB</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Measurement (uncorrected)</th>
<th>51</th>
<th>201</th>
<th>401</th>
<th>801</th>
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</thead>
<tbody>
<tr>
<td>(1) Magnitude</td>
<td>30</td>
<td>80</td>
<td>150</td>
<td>280</td>
</tr>
<tr>
<td>(2) Phase</td>
<td>30</td>
<td>90</td>
<td>160</td>
<td>310</td>
</tr>
<tr>
<td>(3) Group delay(μ)</td>
<td>35</td>
<td>120</td>
<td>220</td>
<td>420</td>
</tr>
<tr>
<td>(4) Magnitude and phase</td>
<td>45</td>
<td>150</td>
<td>290</td>
<td>560</td>
</tr>
<tr>
<td>(5) Magnitude and group delay</td>
<td>55</td>
<td>180</td>
<td>350</td>
<td>680</td>
</tr>
<tr>
<td>(6) Magnitude/return loss</td>
<td>34</td>
<td>140</td>
<td>270</td>
<td>530</td>
</tr>
</tbody>
</table>

**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: $< 3$

**Video Bandwidth (VBW)**
- **Range:** 3 MHz to 3 MHz, 1-3-10 step, $1 \leq$ RBW/VBW $\leq 300$

**Noise Sidebands**
- **Center frequency:** $\leq 1$ GHz
- **Offset:**
  - $\geq 1$ kHz: $< -95$ dBc/Hz
  - $\geq 10$ kHz: $< -105$ dBc/Hz
  - $\geq 1$ MHz: $< -115$ dBc/Hz

**Residual FM (typical) (f-frequency in GHz)**
- **RBW $\leq 10$ Hz:**
  - **Standard:** $< 1 \times f$ Hz peak-peak in 10 sec
  - **Option 1D5:** $< 0.1 \times f$ Hz peak-peak in 10 sec

**RBW $< 1$ kHz:** $< 3$ Hz peak-peak in 100 ms

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![Figure 5: Noise sidebands normalized to 1 Hz RBW versus offset from carrier (typical)](image)

**Amplitude Characteristics**

**Amplitude range:** Displayed average noise level to $+30$ dBm

**Displayed average noise level (0 dB attn, VBW=RBW/100, f in GHz):**
- $<-125$ dBm/Hz (10 kHz to 10 MHz)
- $<-150 + 3 \times f$ dBm/Hz (≥ 10 MHz)

**Input attenuator range:** 0 to 60 dB, 10 dB step

**Spurious Responses**

**Second harmonic distortion** ($-35$ dBm mixer input)
- $<-70$ dBc (≥ 10 MHz)
- $<-60$ dBc (≤ 10 MHz)

**Third order intermodulation distortion**
- (each input mixer level of two tones $= -30$ dBm, separation ≥ 20 kHz)
- $<-75$ dBc (≥ 10 MHz)
- $<-65$ dBc (≤ 10 MHz)

**Other spurious** ($-30$ dBm mixer input)
- $<-70$ dBc (frequency offset ≥ 1 kHz)

**Residual Response**
- $<-100$ dBm (≥ 3 MHz, 0 dB attn)
- $<-90$ dBm (1 kHz to 3 MHz, 0 dB attn)

**Reference Level Range:** $-100$ to $+30$ dBm in 0.1 dB step
General Characteristics

Operating Temperature/Humidity: 0° to 55°C, 15% < RH < 95%
Storage Temperature: -40° to 60°C
Power Requirement: 100/120/220/240 V ±10%, 48 to 66 Hz, 500 VA max
Weight: 30 kg (66 lb) typical
Size: 425 mm W × 235 mm H × 553 mm D

Accessories
HP 85046A/B S Parameter Test Sets
HP 87512A/B Transmission/Reflection Test Kits
HP 11850C 50 3-Way Power Splitter
HP 11850D 75 3-Way Power Splitter
HP 11667A 50 2-Way Power Splitter
HP 86205A 50 RF Bridge
HP 86207A 75 RF Bridge
HP 85031B Precision 7 mm Calibration Kit
HP 85032B 50 Type N Calibration Kit
HP 85033C Precision 3.5 mm Calibration Kit
HP 85036B 75 Type N Calibration Kit
HP 11853A 50 Type N Accessory Kit
HP 11854A 50 Ω BNC Accessory Kit
HP 11855A 75 Type N Accessory Kit
HP 11856A 75 Ω BNC Accessory Kit
HP 11851B 50 Type N RF Cable Kit
HP 11857B 75 Type N Test Port Extension Cables
HP 11857D 50 Type 7 mm Test Port Extension Cables
HP 41800A 5 Hz to 500 MHz Active Probe
HP 54701A 2.5 GHz High-Impedance Probe (HP 1143A required)
HP 85024A 300 MHz to 3 GHz High Frequency Probe
HP 1141A Differential Probe (HP 1142A required)
HP 11945A Close Field Probe Set

Ordering Information
HP 4396A RF Network/Spectrum Analyzer $33,900
Opt 1C2 HP IBASIC $1,100
Opt 1D5 High Stability Frequency Reference $1,750
Opt 1D6 Time-Gated Spectrum Analysis $1,640
Opt 1D7 50 Ω to 75 Ω Spectrum Input Impedance Conversion $900
Opt 00M RGB Output $220