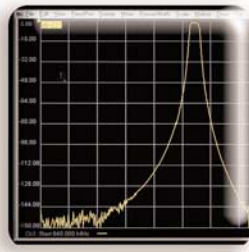
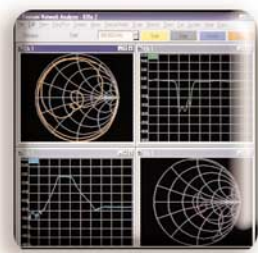
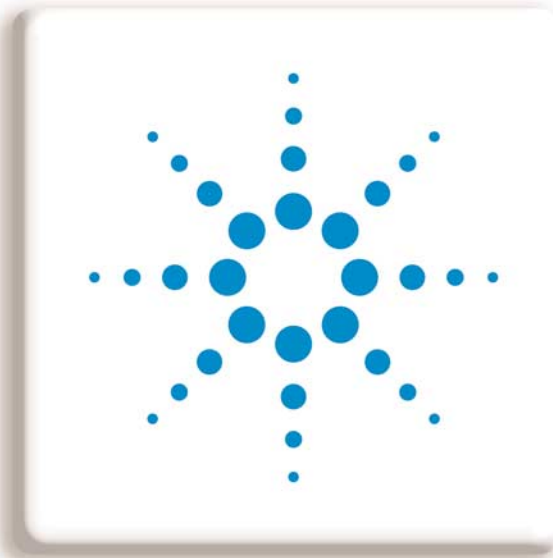
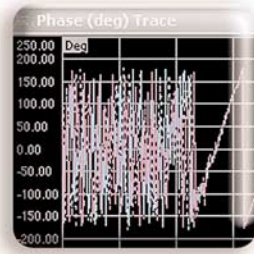


# Agilent

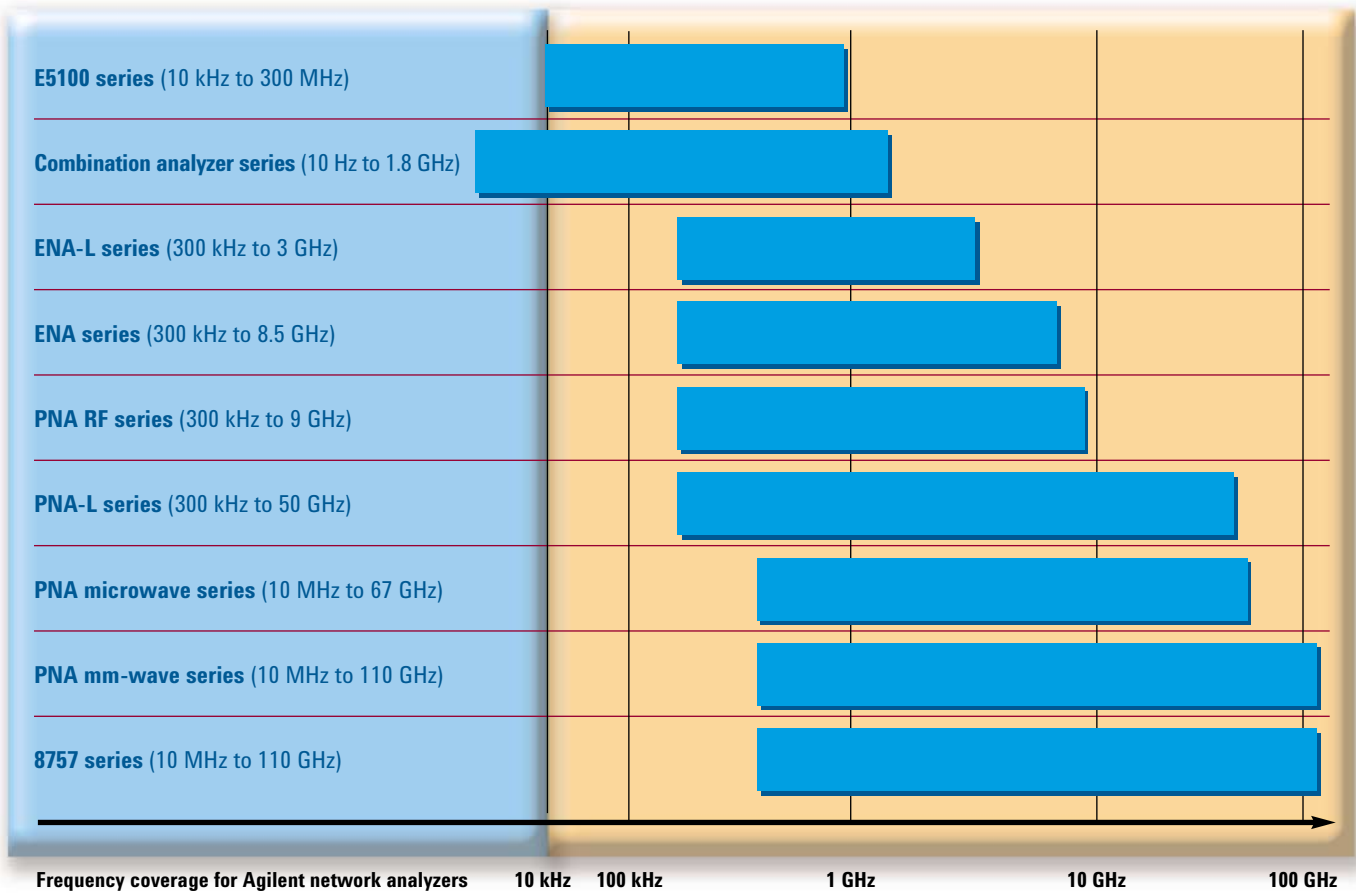
## Network Analyzer Selection Guide



Agilent Technologies

# Network Analyzers to Meet Your Needs

*Agilent offers a variety of network analyzers with the frequency, performance, and versatility to meet your measurement needs. To help you determine which network analyzer is right for you, this selection guide provides an overview and side-by-side comparison of all our network analyzers. In addition, you will find a discussion of the typical network analyzer applications, the measurement needs of each, and how Agilent network analyzers meet those needs.*



NOTE: The 8510 and the 871x network analyzers have been discontinued. Although not listed here, the 872x and the 8753 network analyzers are still available for purchase. For more information about these products, visit [www.agilent.com/find/na](http://www.agilent.com/find/na).

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## High Throughput for Filter and Resonator Testing

### **E5100 network analyzers** E5100A

The Agilent E5100A network analyzer has a frequency range of 10 kHz to 300 MHz and is best fit for production line testing of crystal/ceramic filters and resonators, as well as other electronic components, where very high test throughput is required.

The E5100A improves manufacturing efficiency by providing exceptionally fast measurement capabilities (up to 0.04 ms/point), built-in waveform analysis commands, and a part-handler interface.

The E5100A provides versatile analysis capabilities to fit your requirements for better yield and higher productivity throughout your entire manufacturing test process. The E5100A realizes high quality and high-speed tests with its fine IF bandwidth (IFBW) selection and low-noise circuitry. Convenient analysis and processing functions improve your productivity; especially in final test.



### **Features**

- 0.04 ms/point measurement speed
- handler interface for mass-production
- filter and resonator waveform analysis commands

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[www.agilent.com/find/e5100](http://www.agilent.com/find/e5100)

## Network, Spectrum, and Impedance Analyzers in One Box

### Combination analyzer series

4395A, 4396B

The Agilent combination analyzer series merges three analyzer functions into one powerful instrument: a vector network analyzer, a spectrum analyzer, and an optional impedance analyzer. The combination analyzer makes no compromise between vector-network, spectrum, and impedance performance. Use one analyzer for multiple testing needs when you want high speed and accuracy. Save equipment cost and bench space, while avoiding time-consuming, awkward cable hook-up to multiple instruments.

The Agilent 4395A/96B provides excellent LF/RF measurements for lab and production applications. In the lab, evaluate your designs completely and accurately with one instrument. Reduce test time with precise measurements and improved efficiency. On the production line, increase your throughput with the 4395A/96B by quickly and easily switching between different measurement types or tests. The 4395A/96B are breakthroughs in test instruments, delivering outstanding performance at an attractive price.



### Features

- network, spectrum and optional impedance analysis
- fast narrowband spectrum measurement
- time-gated spectrum analysis option

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[www.agilent.com/find/combo](http://www.agilent.com/find/combo)

## New Standard for Low-Cost Basic RF Network Analysis

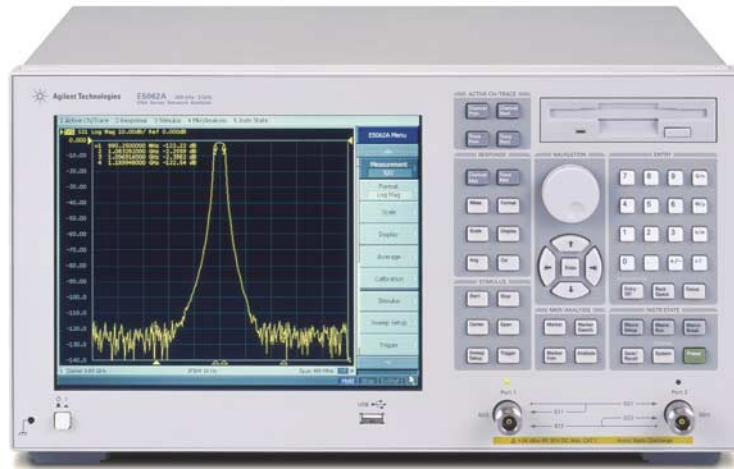
### ENA-L RF network analyzers

E5061A, E5062A

Providing the latest in modern technology and flexibility, the Agilent ENA-L network analyzers provide basic vector network analysis in a wide range of industries and applications such as wireless communication, cable TV, automotive, education, and more. Designed to reduce tune and test times, these analyzers provide increased throughput to improve your measurement productivity.

The ENA-L offers all of the critical performance and features needed in R&D, manufacturing, and service to test RF components such as: filters, amplifiers, antennas, cables, CATV taps, and distribution amplifiers.

The affordably priced ENA-L, equipped with the core functions of the industry-standard ENA, includes many easy-to-use features and is optimized for efficient measurements and high reliability.



### Features

- S-parameter or T/R test set models
- 50 ohm or 75 ohm system impedance available
- easy-to-use features for productivity
- optional electronic calibration (ECal) module simplifies and speeds your calibration process

[www.agilent.com/find/ena](http://www.agilent.com/find/ena)

## Industry Standard for Multipurpose RF Network Analysis

### ENA RF network analyzers E5070B, E5071B

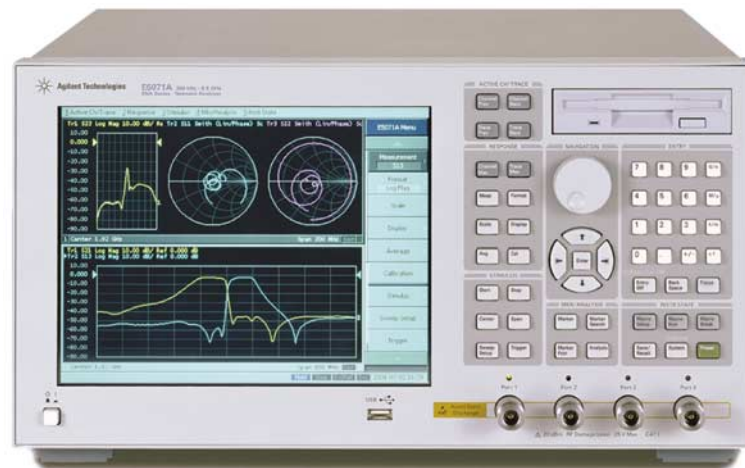
The Agilent ENA offers fast, accurate measurements for multiport components such as duplexers and couplers. Up to four built-in test ports, are available for both the E5070B (3 GHz) and the E5071B (8.5 GHz).

The ENA offers a built-in balanced measurement capability, which enables you to test advanced handset components such as balanced SAW filters. It provides mixed-mode S-parameter measurements with a fixture simulator function that includes matching circuit embedding/de-embedding and impedance conversion capabilities.

In addition, the ENA provides frequency-offset mode to characterize your mixers and converters accurately.

Efficient measurements can be easily made in manufacturing. Using the built-in Microsoft® Visual Basic for Application (VBA) you can quickly develop test routines or automation programs. In addition, the parts-handler interface makes it easy to integrate the ENA into an automation system and enables fast communication.

These integrated measurement capabilities provide the lowest test cost per component and dramatically improve test throughput of multiport and balanced components.



### Features

- 8753x successor for general purpose use
- 2-, 3- or 4-port measurements with full port calibration
- built-in balanced measurement capability
- fixture simulator for balanced component analysis
- frequency-offset mode for mixer measurements
- optional electronic calibration (ECal) module simplifies and speeds your calibration process

[www.agilent.com/find/ena](http://www.agilent.com/find/ena)

## High-Performance, Versatile RF Network Analyzers

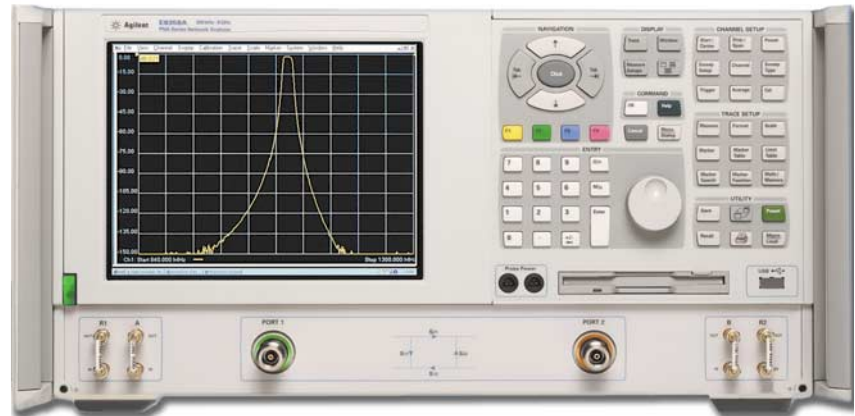
### PNA RF network analyzers

E8356/7/8A, E8801/2/3A, N3381/2/3A

Agilent PNA RF network analyzers offer an unsurpassed combination of performance, speed, and outstanding interconnectivity capabilities to meet the challenges of component testing.

The E8356/7/8A are two-port models (3, 6, or 9 GHz) that provide you the highest performance available from Agilent network analyzers. They offer 128 dB dynamic range at the test ports and 143 dB with direct receiver access. They also provide through-reflect-line (TRL)/ line-reflect-match (LRM) calibration capability for in-fixture and on-wafer devices. The configurable test set option enables you to customize the test set signal path. The E8801/2/3A models are also two-port, but offer three receivers and optional functionality, which provides you the opportunity to configure a more economical instrument that meets your needs. The N3381/2/3A are three-port models with full three-port calibration that enable fast, accurate measurements of all nine S-parameters.

The PNA RF series offers several capabilities that can increase your design and test efficiency dramatically. The Windows® operating system provides the possibility of expanding the instrument's connectivity. From the Windows desktop you can install measurement tools, which reduce the need for a dedicated PC. Use on-line help to quickly refer to programming and user documentation. Furthermore, COM/DCOM provides a powerful automation function.



### Features

- 143 dB dynamic range with direct receiver access
- 2- or 3-port measurements with full port calibration
- expandability with configurable test set
- advanced connectivity to PC environment

[www.agilent.com/find/pna](http://www.agilent.com/find/pna)



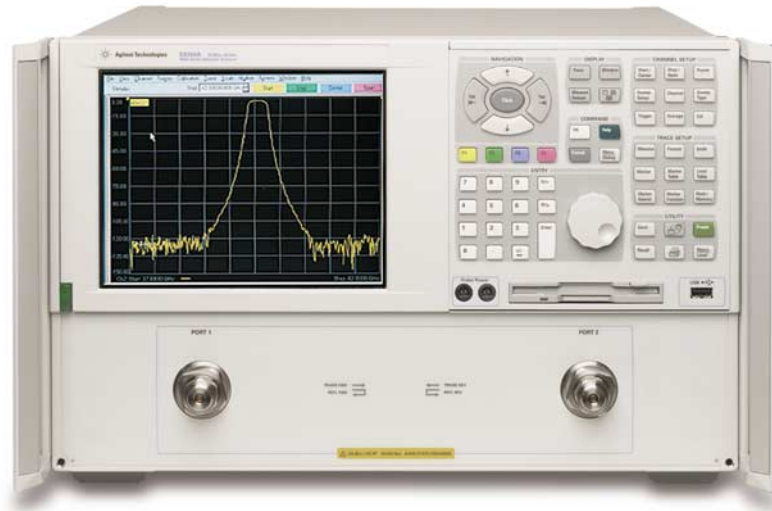
## New Standard for General Purpose Network Analysis

### **PNA-L network analyzers** N5230A

The PNA-L is designed for your general-purpose network analysis needs and priced for your budget. Advanced features help you work quickly, easily, and accurately. With the same firmware as the PNA, the PNA-L offers the perfect balance of value and performance.

The PNA-L is available with frequency coverage from 300 kHz to 6 and 13.5 GHz, 10 MHz to 20, 40, or 50 GHz and offers capabilities that can dramatically increase your design and test efficiency. The Windows operating system provides the ability to expand the instrument's connectivity and provides tools for maximum flexibility. From the Windows desktop you can install measurement tools, which reduce the need for a dedicated PC. Use embedded Help to quickly refer to programming and user documentation from within the instrument. Furthermore, COM/DCOM programming provides a powerful automation environment.

PNA-L provides efficiency and flexibility in both manufacturing and R&D applications for industries ranging from Wireless LAN components to Aerospace & Defense.



### **Features**

- measurement speeds as fast as 4 to 9  $\mu$ s per point
- superior performance and advanced connectivity compared to our 872x series network analyzers
- optional time-domain and frequency-offset capabilities
- optional electronic calibration (ECal) modules allow you to calibrate 10 times faster than mechanical calibration
- up to 32 independent measurements channels

[www.agilent.com/find/pnal](http://www.agilent.com/find/pnal)

## High-Performance Microwave Measurements

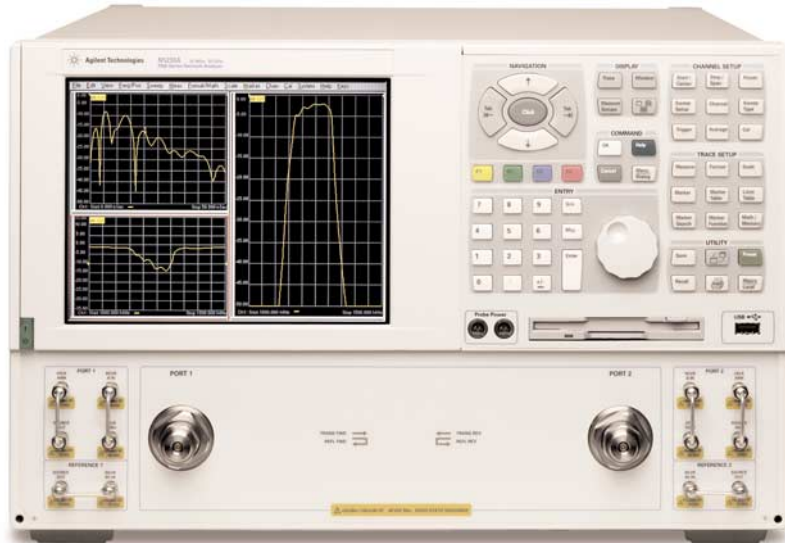
### **PNA microwave (MW) network analyzer**

E8361A, E8362/3/4B

The Agilent E8361A and E8362/3/4B are the microwave frequency models from the PNA series of network analyzers. These models offer an unsurpassed combination of high performance, speed, and outstanding interconnectivity capabilities to meet the challenges of component testing.

The microwave PNA network analyzers cover 10 MHz to 20, 40, 50 and 67 GHz frequency ranges with excellent accuracy. These analyzers are suitable for high-performance microwave devices, such as satellite communication components. They offer 123 dB dynamic range at the test ports and 136 dB with direct receiver access. They also provide TRL/LRM calibration capability for in-fixture and on-wafer devices. In addition, the receiver architecture enables frequency-offset mode to characterize your mixers and converters. The configurable test set allows you to connect external test sets easily and make accurate multipoint measurements.

The Windows operating system provides the ability to expand the instrument's connectivity and provides tools for maximum flexibility. In addition, from the Windows desktop you can install measurement tools, which reduce the need for a dedicated PC, and use on-line Help to quickly refer to programming and user documentation. Furthermore, COM/DCOM provides a powerful automation function. These functions can increase your design and test efficiency dramatically.



### **Features**

- 136 dB dynamic range with direct receiver access
- expandability with configurable test set
- optional advanced mixer and converter test
- optional electronic calibration (ECal) modules allow you to calibrate 10 times faster than mechanical calibration
- optional antenna and pulsed-RF measurements

[www.agilent.com/find/pna](http://www.agilent.com/find/pna)

## Affordable Scalar Network Analyzers

### **8757 scalar network analyzer** 8757D

The Agilent 8757D is a scalar transmission/reflection network analyzer with three or four detector inputs and four independent color display channels, which can process the signals from detectors and directional bridges. The 8757D offers fast measurement speed, limit testing, and external-disk save/recall. AC detection improves measurement accuracy and provides greater than 76 dB dynamic range.

You can combine the 8757D with two external sources and use it to measure conversion loss and compression of mixers. For amplifier testing, in addition to measuring gain, flatness, and return loss, the 8757D can measure 1 dB gain compression with near-power-meter accuracy. For characterizing the power accuracy of the 85037 series precision detectors, you can add an internal power calibrator (Option 8757D-002) to the 8757D.

A complete scalar system includes a 8757D, a swept source, a directional bridge or coupler, and detectors. For higher frequencies, Agilent offers millimeter-wave source modules and waveguide accessories.



### **Features**

- scalar measurements
- three or four detector inputs
- optional power calibrator

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[www.agilent.com/find/8757](http://www.agilent.com/find/8757)

## 110 GHz Benchtop System for High-Performance Millimeter-Wave Measurements

### PNA mm-wave network analyzers N5250A

The Agilent N5250A is the millimeter-wave frequency model of the PNA series of network analyzers. This model offers an unsurpassed combination of high performance, speed, and outstanding interconnectivity to meet the challenges of coaxial and on-wafer device testing to 110 GHz. Banded solutions are also available to cover frequencies up to 325 GHz.

The N5250A allows you to minimize space and maintenance costs with compact test heads and two built-in synthesizers. It provides TRL/LRM calibration capability for in-fixture and on-wafer devices. In addition, optional bias-tees can be added in the combiner assembly very near the device under test, which can greatly improve device stability. The bias-tees have tri-axial connectors for force, sense, and ground. With a single sweep from 10 MHz to 110 GHz, you can maximize your frequency coverage. It offers 123 dB dynamic range at the test ports and can achieve sweep speeds up to 42 times faster than the 8510XF network analyzer.

If you only need a specific band of millimeter-wave frequency coverage, you can customize the most cost-effective solution. This solution consists of a microwave PNA, N5260A test set controller, and banded test heads from Oleson Microwave.



### Features

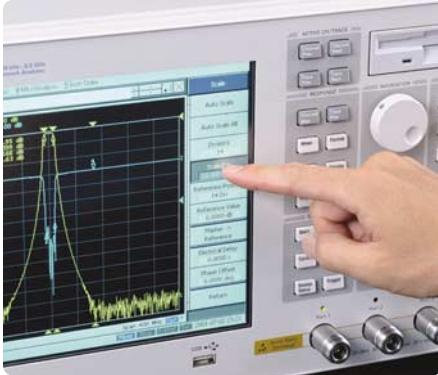
- single sweep from 10 MHz to 110 GHz
- compact test heads and two built-in synthesizers
- 29 IFBW settings, 32 independent channels, 64 traces, and 16,001 points
- optional frequency coverage up to 325 GHz
- Agilent 8510 to PNA code conversion assistant

[www.agilent.com/find/pna](http://www.agilent.com/find/pna)

## Measurement Solutions for Your Application

### Research and development

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### Network analysis and more

S-parameter measurements are the most common measurement parameters for network analysis. However, if you only need to measure transmission or reflection characteristics, you might consider a network analyzer with a T/R test set to help manage costs. In some cases, you might want to make additional types of measurements like absolute power, spectrum, impedance, time-domain and pulsed-RF. Time-domain and pulsed-RF measurements are often used for R&D activities to evaluate filters or high-power devices, respectively. Agilent's network analyzers offer a wide range of capabilities - providing you with convenient and cost-effective solutions tailored to your measurement needs.

### Connector types and calibration accuracy

In an actual measurement environment, your devices might not have coaxial connectors, such as when you perform on-wafer measurements, or your devices might not have insertable connector types. In either case, it is difficult to perform an accurate calibration, which will affect measurement accuracy. Agilent network analyzers have various calibration functions, such as TRL, adapter-removal calibration, and embedding/de-embedding to ensure measurement accuracy in these types of situations. TRL enables our network analyzers to perform accurate on-wafer or in-fixture measurements. Adapter-removal calibration or our electronic calibration (ECal) modules make it possible to perform calibration for non-insertable co-axial connectors. Embedding/de-embedding allows for the mathematical removal of fixtures. These functions will help you produce accurate measurements.

### Expanding your system or using measurement data to write reports

Automation capabilities are critical for making complex component measurements. Internal and external programming capabilities like Visual Basic and Agilent VEE make it easier to develop automation programs and even control other instruments as a system.

Another common, time-consuming task for R&D engineers is incorporating analysis data into simulations and reports. Agilent network analyzers provide linkages to design tools such as Advanced Design System (ADS), that let you simulate and analyze a system without hardware – saving you valuable time and money. In addition, many of our network analyzers are compatible with IntuiLink Connectivity Software, which enables you to easily incorporate measurement results into Microsoft applications.

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**ADS:** [www.agilent.com/eesof-eda](http://www.agilent.com/eesof-eda)

**VEE:** [www.agilent.com/find/vee](http://www.agilent.com/find/vee)

**IntuiLink:** [www.agilent.com/find/intuilink](http://www.agilent.com/find/intuilink)

**ECal:** [www.agilent.com/find/ecal](http://www.agilent.com/find/ecal)

# Measurement Solutions for Your Application

## Research and development

Research and development	E5100 series	Combo series	ENA-L series	ENA series	PNA RF series	PNA-L series	PNA MW series	PNA mm-wave series	8757 series
<b>Basic measurements</b>									
S-parameters	● <sup>1</sup>	● <sup>1</sup>	●	●	●	●	●	●	
Transmission and reflection with T/R test set	● <sup>1</sup>	● <sup>1</sup>	●						●
Absolute power	●	●		●	●	●	●	● <sup>2</sup>	●
Spectrum analyzer function		●							
Impedance analyzer function		●							
Frequency-offset mode				●		●	●	●	
Antenna						●	●		
<b>Non-coaxial devices</b> <sup>3</sup>									
TRL calibration (on-wafer measurement)				●	●	●	●	●	
Waveguide measurements					●	●	●	●	●
<b>Non-insertable devices</b> <sup>4</sup>									
Adapter-removal calibration using mechanical calibration				●	●	●	●	●	
Different connector types supported by ECal			●	●	●	●	●	● <sup>2</sup>	
<b>Applications</b>									
Time-domain mode/gating			● <sup>5</sup>	●	●	●	●	●	
TOI and harmonics						●	●	● <sup>2</sup>	
Pulsed-RF testing							● <sup>6</sup>	● <sup>2</sup>	
Frequency conversion application				●			●	● <sup>2</sup>	
Materials measurement <sup>7</sup>			●	●	●	●	●	●	
<b>Programming and connectivity</b>									
Windows-OS			● <sup>8</sup>	● <sup>8</sup>	● <sup>9</sup>	● <sup>9</sup>	● <sup>9</sup>	● <sup>9</sup>	
LAN interface			●	●	●	●	●	●	
Internal programming capability <sup>10</sup>	●	●	●	●	● <sup>11</sup>	● <sup>11</sup>	● <sup>11</sup>	● <sup>11</sup>	
ADS linkage				●	●	●	●	●	
VEE linkage		● <sup>12</sup>			●	●	●	●	●
IntuiLink		●	●	●	●	●	●	●	

1. Requires an external S-parameter test set or T/R test set.

2. Functions up to 67 GHz.

3. For example, on-wafer, in-fixture, or waveguide applications.

4. A non-insertable device is a device that cannot be inserted in place of a zero-length through. For example, a device that has the same connectors on both ports (type and sex) or different types of connectors on each port (for example, waveguide on one port and coaxial on the another).

5. Time domain gating is not supported.

6. Requires Option H08.

7. For more information, see page 23.

8. Closed environment, which does not allow access to a Windows desktop operating system.

9. Open environment, which allows access to a Windows and enables you to install software and manage data for easy post-measurement analysis.

10. Includes Agilent VEE, LabView, C++, Visual Basic, and Visual Basic for Applications.

11. The PNA's open architecture enables you to install any programming software.

12. Available on the 4395A only.



### Optional electronic calibration (ECal) modules for easy, accurate calibration

Unlike the traditional mechanical calibration technique, Agilent's ECal modules only require one set of connections to perform full two-port calibration. Controlled through the front panel USB port, and requiring only one set of connections, ECal drastically simplifies the calibration process for non-technical operators.

An ENA or PNA controls the ECal module to perform the entire calibration, providing:

- faster calibration and reduced complexity
- reduced chance of operator error
- reduced wear on connectors

### Sweep and data analysis

Total measurement speed can be divided into several different components such as sweep speed, display processing, data analysis, and data transfer. In low-volume manufacturing, the data analysis and display speeds are unimportant. After the measurement, a limit test or a marker function is typically used. Conversely, in high-volume manufacturing the sweep speed and data analysis speed are important. In many cases, analysis needs to be done quickly using internal programming capability or waveform analysis commands, and the analyzer must send pass/fail results to an automated system. In both cases, the sweep speed can be maximized using segment sweep speed. For automation, you can choose from a variety of Windows-compatible programming environments like VBA, VB or Agilent VEE. In case you want to transfer all data to an external computer quickly, COM/DCOM provides a seamless environment between your instruments and external computers.

### Communication interfaces

It is becoming more common to have a LAN interface in test and measurement instruments. A LAN is convenient to send data from your manufacturing line to your office, or to monitor measurement status, or have a central data server, or use network printers.

For high-volume automation applications, fast communication with an automated handler system is important. A parts handler interface is commonly used for this purpose. It has a dedicated pin assignment in the I/O interface so that triggers measurement-end status, and limit-test results are communicated quickly between the instrument and the automated handler system.

# Measurement Solutions for Your Application

## Manufacturing test

Manufacturing test	E5100 series	Combo series	ENA-L series	ENA series	PNA RF series	PNA-L series	PNA MW series	PNA mm-wave series	8757 series
<b>Programming</b>									
Internal programming capability <sup>1</sup>	●	●	●	●	● <sup>2</sup>	● <sup>2</sup>	● <sup>2</sup>	● <sup>2</sup>	
Fast data transfer <sup>3</sup>			●	●	●	●	●	●	
<b>Calibration</b>									
Adapter-removal calibration <sup>4</sup>				●	●	●	●	●	
ECal support			●	●	●	●	●	● <sup>5</sup>	
<b>Measurement and analysis</b>									
Segment sweep <sup>6</sup>	●	●	●	●	●	●	●	●	
Pass/fail testing	●	●	●	●	●	●	●	●	●
Embedding and de-embedding <sup>7</sup>				●	●	●	●	●	
Waveform analysis command <sup>8</sup>	●		●	●					
<b>Interface</b>									
LAN			●	●	●	●	●	●	
I/O port	●	●	●	●	●	●	●	●	
Parts handler interface <sup>9</sup>	●	●	●	●	●	●	●	●	
VGA output	●	●	●	●	●	●	●	●	●

1. Includes Visual Basic, and Visual Basic for Applications.

2. The PNA's open architecture enables you to install any programming software.

3. COM/DCOM provides faster data transfer than GPIB.

4. The calibration technique used for non-insertable devices such as those with the same connectors on input and output ports.

5. Functions up to 67 GHz.

6. Segment sweep includes sweep types that are known as list and fast-sweep list.

7. Functions to embed or de-embed a fixture's characteristics.

8. Programming commands to quickly retrieve parameters of filters and resonators.

9. The parts handler interface is an I/O-port specialized for communication with an automatic parts handler system.



## Measurement Solutions for Your Application

### Filter and duplexer measurements



### Dynamic range, IF bandwidth and sweep time

Dynamic range requirements vary among applications. Agilent offers a variety of network analyzers with different dynamic ranges, so you can choose the best one for your application. For wide dynamic range, Agilent's RF PNA series network analyzers are a good choice. The PNA series offers 122 dB dynamic range at test port. In addition, many analyzers offer segment sweep – a convenient function that manages dynamic range and sweep speed. This function enables you to set different IFBW's for the pass band or rejection band, and the sweep speed can be optimized for your measurement needs.

### Calibration for filter testing

Agilent network analyzers provide various functions that help you perform efficient, accurate filter evaluations, which can help shorten your design cycles. For instance, the adapter removal calibration functions make it possible to accurately calibrate non-insertable devices. Interpolated calibration is convenient if the measurement frequency is unknown.

### Time domain, multiport, and balanced measurement capabilities for advanced devices

Today's wireless devices require test instruments that have advanced measurement functionality. For example, a time-domain function is needed to easily tune coupled-cavity-resonator bandpass filters. Duplexer or front-end modules for handsets often require multiport and balanced measurement capabilities. For more details on multiport and balanced testing, see page 19.

## Measurement Solutions for Your Application

### Filter and duplexer measurements

Filter and duplexer measurements	E5100 series	Combo series	ENA-L series	ENA series	PNA RF series	PNA-L series	PNA MW series	PNA mm-wave series	8757 series
<b>Dynamic range</b>									
Wide dynamic range <sup>1</sup>	●	●		●	●	●	●	●	
Direct receiver access to obtain widest possible dynamic range					●	●	●	●	
<b>Calibration</b>									
Adapter removal calibration				●	●	●	●	●	
Interpolated calibration	●	●	●	●	●	●	●	●	
<b>Measurement and analysis</b>									
Segment sweep <sup>2</sup>	●	●	●	●	●	●	●	●	
Four-parameter display	●	●	●	●	●	●	●	●	●
Marker statistics function <sup>3</sup>	●	●	●	●	●	●	●	●	
<b>Other functions</b>									
Time domain measurement			● <sup>4</sup>	●	●	●	●	●	
Balanced measurement capability <sup>5</sup>				●	● <sup>6</sup>	● <sup>6</sup>	● <sup>6</sup>	● <sup>6</sup>	
Multi-port measurement capability <sup>5</sup>			● <sup>7</sup>	● <sup>7</sup>	● <sup>7</sup>	● <sup>7</sup>	● <sup>7</sup>	● <sup>7</sup>	

1. Wide dynamic range is defined as greater than 120 dB for RF analyzers and greater than 90 dB for microwave analyzers.

2. Segment sweep includes sweep types that are known as list and fast swept list.

3. Obtains real-time calculations of device characteristics such as maximum/minimum, center frequency, and 3 dB bandwidth.

4. Time gating is not supported.

5. For more details about balanced and multi-port tests, see page 20.

6. Balanced measurement capability requires an external test set and software.

7. An external test set may be required to achieve these functionalities.

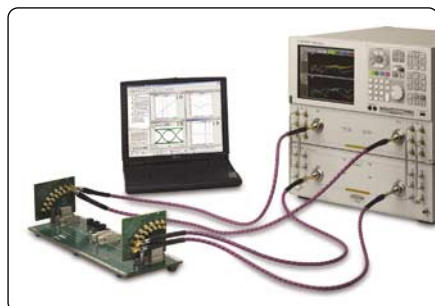
## Measurement Solutions for Your Application

### *Multiport and balanced testing*

### Balanced measurement solutions for RF and microwave frequencies



**ENA E5070B/1B ENA network analyzer with E5091A multiport test set**



**The Agilent N1957B Physical Layer Test System is used for 4-port 50 GHz signal integrity measurements**

[www.agilent.com/find/balanced](http://www.agilent.com/find/balanced)  
[www.agilent.com/find/multiport](http://www.agilent.com/find/multiport)  
[www.agilent.com/find/plts](http://www.agilent.com/find/plts)

### Multiport testing for communication components

Many modern components have more than two ports. In order to test these devices efficiently, network analyzers with multiple ports are required. Agilent offers numerous multiport instruments for you to choose from. One example is the Agilent ENA series. The ENA has built-in three- or four-port measurement capability – enabling fast and accurate multiport measurements.

### Calibration for multiport measurements

When doing multiport measurements, you need to use the proper calibration method to achieve accurate measurements. Agilent offers a three- or four-port, full calibration function together with multiport measurement capability. Four-port ECal modules are available as well, so that calibration can be done easily and quickly. When it is not possible to place coaxial connectors on your design, Agilent PLTS systems provide TRL and LRM calibration techniques to ensure accuracy for balanced, on-wafer measurements.

### Balanced measurements for balanced components

Balanced components are commonly used in communications devices to maintain RF signal quality. The ENA series has a built-in balanced capability to make fast and easy balanced measurements. It also has a fixture simulation function, including matching circuit embedding/de-embedding and impedance conversion capabilities.

The ENA network analyzer series provides a high-speed, integrated balanced measurement solution up to 8.5 GHz. If you require higher frequency coverage, the N1900B series Physical Layer Test System (PLTS) will meet your needs. PLTS solutions combine a vector network analyzer (VNA) with an S-parameter test set and Windows-based software for balanced measurements up to 50 GHz.

### Multiport testing for CATV components

Many CATV components, including taps, dividers, and distribution amplifiers, have multiple ports. Network analyzers with multiport test sets drastically increase the test efficiency of these components. The ENA-L network analyzer with the 87075C 75 ohm multiport test set is specifically designed for testing multiport CATV components.

### External test set for multiport and balanced testing

In order to expand flexibility and capability, Agilent also offers multiport and balanced measurement solutions that use external test sets. For example, several multiport test sets and the N1900B Physical Layer Test System can be used with the PNA series network analyzers. For details, visit [www.agilent.com/find/multiport](http://www.agilent.com/find/multiport)

## Measurement Solutions for Your Application

### *Multiport and balanced testing*

Multiport and balanced devices	E5100 series	Combo series	ENA-L series	ENA series	PNA RF series	PNA-L series	PNA MW series	PNA mm-wave series	8757 series
<b>Multiport measurements</b>									
Built-in 4-port measurement capability				●		●			
Built-in 3-port measurement capability				●	●	● <sup>1</sup>			
Multiport measurement capability with external test set <sup>2</sup>			●	●	●	●	●		
<b>Multiport calibration</b>									
Full 4-port calibration				●	● <sup>3</sup>	● <sup>3</sup>	● <sup>3</sup>		
Full 3-port calibration				●	●	● <sup>1</sup>			
<b>Balanced measurement</b>									
Built-in balanced measurement capability				●		●			
Balanced measurement capability with external test set <sup>4</sup>					●		●		
Fixture simulation/embedding and de-embedding				●	●	●	●	●	

1. 3-port measurements can be made using the 4-port test set.

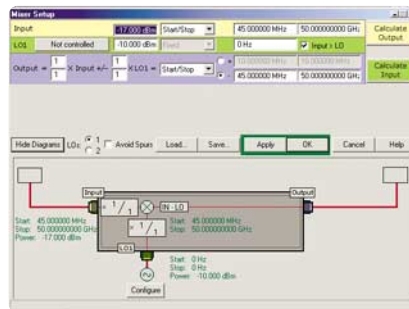
2. Agilent 87050A/E, 87075C, Z5621A, E5091A, and N4419/20/21B are available as external multiport test sets. Refer to Test Solutions for Multiport and Balanced Devices brochure (literature number 5988-2461EN available on the [www.agilent.com/find/pna](http://www.agilent.com/find/pna) Web site) for more details.

3. Available only when used with external test sets and software.

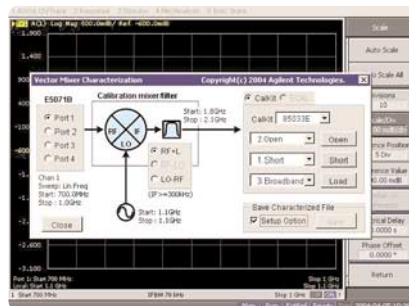
4. The external test set and software are provided in the Agilent N1900B Series Physical Layer Test System. For more details, refer to the Agilent Physical Layer Test Systems Data Sheet (literature number 5988-5288EN) available on the PLTS Web site: [www.agilent.com/find/plts](http://www.agilent.com/find/plts)

## Measurement Solutions for Your Application

### Mixer and amplifier measurements



**The PNA Frequency Converter Application simplifies setup and calibration for advanced mixer measurements such as absolute phase and group delay.**



**The ENA Frequency-Offset Mode offers vector mixer calibration technique that enables you to perform accurate absolute group delay measurements for frequency-translating devices.**

## Mixer measurements

Frequency-translation devices such as mixers, converters, and tuners are critical components in most RF and microwave communication systems. They present unique measurement challenges because their input and output frequencies are different. Network analyzers used for testing these devices need to have a frequency-offset mode to detect output frequencies different from the input.

The PNA microwave and mm-wave series offer the Frequency Converter Application (FCA), an easy-to-use graphical user interface and advanced calibration technique. The FCA automates the measurement process, making it possible for users without extensive knowledge of mixer measurements to set up, calibrate, and characterize devices quickly and accurately. For more information, visit: [www.agilent.com/find/fca](http://www.agilent.com/find/fca)

The ENA offers the frequency-offset mode (FOM) that provides frequency-offset sweep, external signal source control, and fixed IF/RF measurement capabilities. The ENA FOM option supports both scalar- and vector-mixer calibrations with inherited mixer measurement techniques from the microwave PNA. These measurement techniques are key to making extremely accurate measurements. Also, this option provides harmonics measurement capabilities for non-linear devices such as amplifiers, semiconductor switches, and front-end modules.

## Amplifier measurements

Agilent network analyzers easily measure commonly specified amplifier parameters like gain, gain compression, isolation, return loss, and group delay. The power sweep function is often required to make amplifier measurements, and harmonic distortion is commonly used to understand the amplifier's non-linear behavior. Additional amplifier information and detailed application notes are available on our PNA Series Web site: [www.agilent.com/find/pna](http://www.agilent.com/find/pna)

## Power meter calibration

For both mixer and amplifier testing, power meter calibration provides leveled absolute power to devices that are sensitive to absolute input or output levels. This function automatically controls power meters to set the power anywhere in the test setup with power meter accuracy, or to calibrate the network analyzer's receivers for accurate absolute-power measurements.

# Measurement Solutions for Your Application

## Mixer and amplifier measurements

	E5100 series	Combo series	ENA-L series	ENA series	PNA RF series	PNL-L series	PNA MW series	PNA mm-wave series	8757 series
<b>Mixer measurements</b>									
<b>Measurement and analysis</b>									
Magnitude measurement <sup>1</sup>				●		●	●	●	●
Phase measurement									
Relative phase						●	●	●	
Absolute phase				●			●	● <sup>2</sup>	
Power sweep				●	●	●	●	● <sup>2</sup>	●
Internal control of multiple sources				● <sup>3</sup>		●	●	●	
<b>Calibration</b>									
Power meter calibration <sup>4</sup>				●		●	●	● <sup>2</sup>	
<b>Amplifier measurements</b>									
<b>Measurement and analysis</b>									
Power sweep	●	●	●	●	●	●	●	● <sup>3</sup>	●
Log sweep		●	●	●	●	●	●	●	
Internal bias-tee					●		●	●	
High-power measurements	●	●			●	●	●		
Four-parameter display	●	●	●	●	●	●	●	●	●
Direct receiver access to connect customer-provided high-power test set	●	●			●	●	●	●	
Frequency-offset mode				●		●	●	●	●
<b>Calibration</b>									
Power meter calibration <sup>4</sup>				●	●	●	●	● <sup>2</sup>	●

1. Frequency-offset modes of the 8753, 8720, ENA and PNA series let the source and receiver operate at different frequencies. Both magnitude and phase measurements can be made.
2. Functions up to 67 GHz.
3. ENA supports one signal source.
4. Transfers the accuracy of the power meter to the network analyzer, providing very accurate absolute power measurements.

## Related Network Analyzer Products

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### Electronic calibration (ECal) modules

ECal is a precision, single-connection calibration technique for 2- or 4-port Agilent vector network analyzers. Agilent ECal modules are fully traceable and verifiable against electronic impedance standards and can simplify your daily calibration routine. ECal modules are available for Type N-50, N-75, 7 mm, 3.5 mm, Type F, and 7-16 (300 kHz to 9 GHz) connectors. Modules are available in microwave frequency ranging from 10 MHz to 67 GHz for 7 mm, Type N-50, 3.5 mm, 2.92 mm, 2.4 mm and 1.85 mm. Both 2-port (RF and microwave) and 4-port (RF only) modules are available.

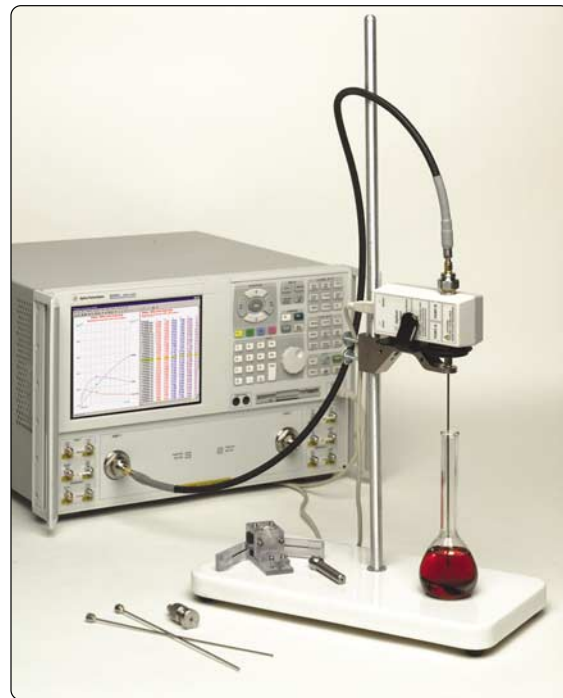


[www.agilent.com/find/ecal](http://www.agilent.com/find/ecal)

### 85070E Dielectric Probe Kit and 85071E Materials Measurement Software

The Dielectric Probe Kit and Materials Measurement Software convert S-parameter network analyzer measurements to complex permittivity and permeability. A friendly graphical user interface sets up the measurements and results are displayed in seconds.

Complex permittivity and permeability are determined by a material's molecular structure, so they can be related to other properties of interest as well. Measuring them can provide critical insight to applications in many industries. It can be useful in all stages of a product's lifecycle: design, incoming inspection, process monitoring, and quality assurance. For example, it is useful for improving ferrite, radome, and absorber designs. It can provide important information about materials used in state-of-the-art RF and microwave electronic components. Even biomass, bulk density, bacterial content, and chemical concentration can be related to a material's electromagnetic properties. Let Agilent Technologies materials measurement products provide critical insight into your application.



[www.agilent.com/find/materials](http://www.agilent.com/find/materials)

### N1900B Series Physical Layer Test Systems (PLTS)




Agilent's PLTS solutions provide the highest accuracy and most comprehensive tool set for model extraction and characterization of single-ended and differential physical-layer interconnects, or balanced RF and microwave components with frequency coverage up to 50 GHz. These test solutions offer single-ended, balanced, and mixed-mode measurements in both frequency and time domain, eye-diagram analysis, and RLCG transmission-line parameter extraction.



[www.agilent.com/find/plts](http://www.agilent.com/find/plts)

## Specification and Feature Comparison

### RF network analyzers

	<b>E5100 series</b>	<b>Combination analyzer series</b>
<b>Model number</b>	E5100A 	4395A  4396B 
<b>Frequency range</b>	E5100A: 10 kHz to 180 MHz/300 MHz	4395A: 10 Hz to 500 MHz 4396B: 100 kHz to 1.8 GHz
<b>Number of ports<sup>1</sup></b>	2 <sup>2</sup>	2
<b>Balanced measurements<sup>1</sup></b>	no	no
<b>System impedance</b>	50 ohm	50 or 75 ohms
<b>System dynamic range</b>	120 dB	4395A: 115 dB 4396B: 120 dB
<b>Power at test port</b>	-48 dBm to +22 dBm (Opt.001 and 010) -65 dBm to +5 dBm (at RF OUT 2 with Option 600)	4395A: -50 to +15 dBm 4396B: -60 to +20 dBm
<b>Power sweep range</b>	70 dB (Power Opt. 010)	20 dB
<b>Sweep type</b>	linear, segment <sup>3</sup> , power	linear, log, segment <sup>3</sup> , power
<b>Error correction</b>		
Full 2-port	no	yes
Full 3 or 4-port	no	no
TRL	no	no
Adapter-removal	no	no
ECal support	no	no
<b>Measurement channels</b>	2	2
<b>Maximum number of data traces</b>	4	4
<b>Windows-OS</b>	no	no
<b>Internal automation</b>	IBASIC	IBASIC
<b>I/O</b>	GPIB, VGA, parallel, mini-DIN	GPIB, VGA, parallel, mini-DIN
<b>ADS linkage</b>	no	no
<b>Built-in source attenuator</b>	yes (with Option 801/2/3)	no
<b>DC bias input</b>	no	no
<b>Time domain</b>	no	no
<b>Corrected specifications<sup>4</sup></b>	do not specify system performance	do not specify system performance
<b>Trace noise</b>	0.01 dB rms (1 kHz IFBW)	4395A: 0.005 dB rms (300 Hz IFBW) 4396B: 0.002 dB rms (300 Hz IFBW)
<b>Measurement speed<sup>5</sup> (1 sweep, 201 points)</b>	8 ms (1-port cal, ramp-sweep) 64 ms (1-port cal, step-sweep)	165 ms (response cal, gain, 30 kHz BW) 215 ms (response cal, gain and phase, 30 kHz BW)

1. Table shows the capabilities of the stand-alone instrument. Possible to add capabilities with external test sets. See page 19.

2. See the Network Analyzer brochure for the port configuration details.

3. Segment includes sweep types that are known as list and fast swept list.




4. Dir = directivity; SM = source match; LM = load match; Refl trk = reflection tracking; Trans trk = transmission tracking

5. Includes system retrace time, but does not include source bandswitch times. Refer to product data sheets for detailed measurement conditions.



## Specification and Feature Comparison

### RF network analyzers

	ENA-L RF series	ENA RF series	PNA RF series
<b>Model number</b>	E5061A E5062A 	E5070B E5071B 	E8356/7/8A E8801/2/3A N3381/2/3A 
<b>Frequency range</b>	E5061A: 300 kHz to 1.5 GHz E5062A: 300 kHz to 3 GHz	E5070B: 300 kHz to 3 GHz E5071B: 300 kHz to 8.5 GHz	E8356A/E8801A/N3381A: 300 kHz to 3 GHz E8357A/E8802A/N3382A: 300 kHz to 6 GHz E8358A/E8803A/N3383A: 300 kHz to 9 GHz
<b>Number of ports<sup>1</sup></b>	2	2, 3 or 4	2 or 3
<b>Balanced measurements<sup>1</sup></b>	no	yes	no
<b>System impedance</b>	50 ohms or 75 ohms	50 ohms	50 ohms
<b>System dynamic range</b>	115 dB	120 dB (to 1.5 GHz) 122 dB (to 4 GHz) 118 dB (to 6 GHz) 113 dB (to 7.5 GHz) 106 dB (to 8.5 GHz)	123 dB (to 1 MHz) 128 dB (to 3 GHz) 118 dB (to 6 GHz) 113 dB (to 9 GHz) (Direct receiver access increases dynamic range 15 dB in each frequency range)
<b>Power at test port</b>	-5 to +10 dBm -45 to +10 dBm (Option 1E1, 250 or 275)	-50 dBm to +10 dBm	-85 dBm to +10 dBm Available with E8356/7/8A (Opt. UNL)
<b>Power sweep range</b>	15 dB	25 dB	20 to 25 dB
<b>Sweep type</b>	linear, log, segment <sup>2</sup> , power, CW	linear, log, segment <sup>2</sup> , power, CW	linear, log, segment <sup>2</sup> , power, CW
<b>Error correction</b>			
Full 2-port	yes (S-parameter test sets only)	yes	yes
Full 3 or 4-port	no	yes	yes
TRL	no	yes	yes
Adapter-removal	no	yes	yes <sup>3</sup>
ECal support	yes	yes	yes
<b>Measurement channels</b>	4	16	32 <sup>3</sup>
<b>Maximum number of data traces</b>	16	81	64
<b>Windows-OS</b>	yes (Closed) <sup>4</sup>	yes (Closed) <sup>4</sup>	yes (Open) <sup>5</sup>
<b>Internal automation</b>	VBA, SCPI, COM	VBA, SCPI, COM	SCPI, COM/DCOM <sup>6</sup>
<b>I/O</b>	LAN, USB, GPIB, VGA, parallel, handler, mini-DIN	LAN, USB, GPIB, VGA, parallel, handler, mini-DIN	LAN, USB, GPIB, VGA, parallel, handler, RS-232
<b>ADS linkage</b>	no	File format supported	Software driver supported
<b>Built-in source attenuator</b>	yes (ES: standard, ET: option)	yes (with option)	yes (E835xA: standard, other models: option)
<b>DC bias input</b>	no	no	yes
<b>Time domain (with Option 100)</b>	yes <sup>7</sup>	yes (with Opt. 010)	yes (with Opt. 010)
<b>Corrected specifications<sup>1</sup></b>	(type-N, 50 ohms, 2-port cal) Dir 46 to 49 dB SM 40 to 41 dB LM 46 to 49 dB Refl trk ±0.011 to ±0.021 dB Trans trk ± 0.015 to ±0.018 dB	(2-port cal, type-N, 50 ohms) Dir 47 to 52 dB SM 36 to 45 dB LM 39 to 47 dB Refl trk ± 0.040 to 0.070 dB Trans trk ± 0.039 to 0.136 dB	(2-port cal, type-N, 50 ohms, E835xA model) Dir 47 to 54 dB SM 36 to 45 dB LM 39 to 47 dB Refl trk ±0.040 to ±0.070 dB Trans trk ±0.039 to ±0.135 dB
<b>Trace noise</b>	0.005 dB rms @ 3 kHz IFBW >= 1 MHz	0.001 dB rms (3 MHz to 4.25 GHz) (3 kHz BW)	0.002 dB rms (1 kHz BW)
<b>Measurement speed (1 sweep, 201 points)</b>	35 ms (2-port cal, 30 kHz BW)	8 ms (2-port cal) (100 kHz BW)	29 ms (2-port cal) (35 kHz BW)

1. Includes system retrace time, but does not include source bandswitch times. Refer to product data sheets for detailed measurement conditions.

2. Segment includes sweep types that are known as list and fast swept list.

3. For E8356/7/8A, these functions are available with firmware revision A.02.50 or later.

4. The ENA series does not allow you to access a Window desktop operating system.





5. The PNA's open architecture allows you to access the operation system and install software, such as Visual Basic.

6. DCOM enables you to have a seamless programming environment between the instrument and a PC.

7. Time domain gating is not supported.

## Specification and Feature Comparison

### Microwave network analyzers

	PNA-L series	PNA MW series	8757 series	PNA mm-wave series
<b>Model numbers</b>	N5230A 	E8362B  E8363B E8364B E8361A	8757D 	N5250A 
<b>Frequency range</b>	300 kHz to 6 GHz (Option 020, 025) 300 kHz to 13.5 GHz (Option 120, 125) 300 kHz to 20 GHz (Option 240, 245) 10 MHz to 20 GHz (Option 220, 225) 10 MHz to 40 GHz (Option 420, 425) 10 MHz to 50 GHz (Option 520, 525)	E8362B 10 MHz to 20 GHz E8363B 10 MHz to 40 GHz E8364B 10 MHz to 50 GHz E8361A <sup>1</sup> 10 MHz to 67 GHz	10 MHz to 110 GHz, depends on configuration	10 MHz to 110 GHz, depends on configuration
<b>Number of ports<sup>2</sup></b>	2/4 <sup>2</sup>	2	2	2
<b>Balanced measurements<sup>2</sup></b>	no yes <sup>3</sup> (Option 240, 245)	no	no	no
<b>System impedance</b>	50 ohms	50 ohm	50 ohms	50 ohms
<b>System dynamic range (at 20 GHz)</b>	108 dB (Option 220, 225) depends on configuration	94 to 125 dB (max. 136 dB with direct receiver access)	75 dB/70 dB (AC/DC detection modes)	111 dB
<b>Power at test port (at 20 GHz)</b>	-27 to +3 dB (Option 220, 225) depends on configuration (60 dB source attenuator option expands min. power to -82 dBm at 10 GHz) 10 dBm at 6 GHz (Option 020)	-25 to +5 dBm at 10 GHz (60 dB source attenuator option expands min. power to -82 dBm at 10 GHz)	depends on signal source: +10 or +17 dBm (to 26.5 GHz) +6 dBm (to 40 GHz)	-5 dBm
<b>Power sweep range</b>	25 dB/37 dB (Option 020)	31 dB	25 dB	20 dB <sup>3</sup>
<b>Sweep type</b>	linear, log CW, power, CW, segment	linear, log CW, power, segment	linear, power, CW	linear, log CW, power, segment
<b>Error correction</b>				
Full 2-port	yes	yes	no	yes
TRL	yes	yes	no	yes
Adapter-removal	yes	yes	no	yes
ECal support	yes	yes	no	yes <sup>4</sup>
<b>Measurement channels</b>	32	32	2	32
<b>Maximum number of data traces</b>	64	64	4	64
<b>Windows-OS</b>	yes <sup>5</sup>	yes <sup>5</sup>	no	yes <sup>5</sup>
<b>Internal automation</b>	SCPI, D/COM <sup>5</sup>	SCPI, D/COM <sup>5</sup>	no	SCPI, COM/DCOM
<b>I/O</b>	LAN, USB <sup>6</sup> , GPIB, VGA, parallel, RS-232	LAN, USB <sup>6</sup> , GPIB, VGA, parallel, RS-232	GPIB, VGA	LAN, USB <sup>6</sup> , GPIB, VGA, parallel, RS-232
<b>ADS linkage</b>	Software driver supported	Software driver supported	no	Software driver supported
<b>Built-in source attenuator</b>	yes (with Option x25)	yes (with Option UNL)	no	yes
<b>DC bias input</b>	no	yes (with Option UNL)	no	yes
<b>Time domain</b>	yes (with Option 010)	yes (with Option 010)	no	yes (with Option 010)
<b>Corrected<sup>7</sup></b>	(2-port cal, 3.5 mm), 20 GHz models only 44 to 48 31 to 40 44 to 48 ±.003 to .006 ±.010 to .104	(2-port cal, 2.4 mm) Dir 36 to 42 dB SM 31 to 41 dB LM 35 to 42 dB Refl trk ± 0.001 to 0.027 dB Trans trk ± 0.014 to 0.200 dB	(coaxial) Dir 40 dB SM source dependent LM 20 dB	--
<b>Trace noise</b>	0.006 dB rms, 1 kHz BW (at 20 GHz) 0.004 dB rms, 100 kHz BW (at 6 GHz)	0.006 dB rms (1 kHz BW)	unspecified	--
<b>Measurement speed (1 sweep, 201 points correction off)</b>	9 ms (250 kHz BW) 6 ms (600 kHz BW)	12 ms (35 kHz BW)	--	--

1. Specified to 67 GHz, with operation to 70 GHz.

2. 4-port available in 20 GHz model.

3. Only on 4-port model.

4. Functions up to 67 GHz.

5. Open Windows environment. You can load any software on the instrument, such as Visual Basic.

6. Keyboard and mouse can be attached using USB ports.

7. Dir = directivity; SM = source match; LM = load match; Refl trk= reflection tracking; Trans trk = transmission tracking

## Literature

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Our product and application literature is available for viewing and download from our product Web sites listed under "Web Resources" on the back page of this selection guide.

### Brochures

*Test Solutions for Multiport and Balanced Devices*  
literature number 5988-2461EN

*E5100A Network Analyzer (10 kHz to 180/300 MHz)*  
literature number 5968-1873E

*Combination Analyzers  
(Network/Spectrum/Impedance Analyzers)*  
literature number 5965-9374E

*ENA-L RF Network Analyzers (300 kHz to 1.5 or 3 GHz)*  
literature number 5989-0167EN

*ENA RF Network Analyzers (300 kHz to 3 or 8.5 GHz)*  
literature number 5988-3765EN

*PNA-L MW Network Analyzers  
(10 MHz to 20, 40, 50 or 67 GHz)*  
literature number 5989-0168EN

*MW & RF PNA Network Analyzers  
(300 kHz to 20, 40, 50, or 67 GHz)*  
literature number 5968-8472E

*N5250A Millimeter-Wave PNA Network Analyzers  
(10 MHz to 110 GHz)*  
literature number 5988-9620EN.pdf

*Signal Integrity Solutions*  
literature number 5988-5405EN

### Application Notes

**Amplifiers -**  
*How to Characterize CATV amplifiers effectively*  
literature number 5965-9434E

*Amplifier Linear and Gain Measurements*  
literature number 5988-8644EN

*Amplifier Swept-Harmonic Measurements*  
literature number 5988-9473EN

*Amplifier Intermodulation-Distortion Measurements*  
literature number 5988-9474EN

*Characterizing Differential Amplifiers with True  
Differential Signals*  
literature number 5988-9463EN

**Mixers/Converters -**  
*Mixer Conversion-Loss and Group Delay  
Measurement Techniques and Comparisons*  
literature number 5988-9619EN

*Measuring Absolute Group Delay of Multistage  
Converters using PNA Network Analyzers*  
literature number 5989-0219EN

*Mixer Transmission Measurements  
Using The Frequency Converter*  
literature number 5988-8642EN

*Novel Method for Vector Mixer Characterization  
and Mixer Test System Vector Error Correction*  
literature number 5988-7826EN

**Pulsed Measurements -**  
*Accurate Pulsed Measurements*  
literature number 5989-0563EN

*Pulsed Antenna Measurements  
Using PNA Network Analyzer*  
literature number 5989-0221EN

*Antenna and RCS Measurement Configurations*  
literature number 5989-0220EN

*Triggering the PNA Series Network Analyzer  
for Antenna Measurements*  
literature number 5988-9518EN

### Additional ENA Application Notes

*On-Wafer Impedance Measurements Using the ENA  
and Impedance Parameter Display Software*  
literature number 5989-0033EN

*Differential S-parameter Measurements of PCI Express  
Connectors using the ENA Series Network Analyzer*  
literature number 5988-9848EN

*High Speed  $f_T$  vs.  $I_c$  characterization of  
Bipolar transistor Using an ENA Network Analyzer*  
literature number 5988-9994EN

*In-Fixture Characterization Using the ENA Series  
RF Network Analyzer with Cascade Microtech  
Probing System*  
literature number 5988-6552EN

*Evolution of Test Automation Using the Built-In VBA  
with the ENA Series RF Network Analyzers*  
literature number 5988-6192EN

*ADSL Copper Loop Measurements*  
literature number 5968-1196E

## Web Resources

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Visit our Web sites for additional product information and literature.

Microwave and RF network analyzers:

[www.agilent.com/find/na](http://www.agilent.com/find/na)

ENA RF series network analyzers:

[www.agilent.com/find/ena](http://www.agilent.com/find/ena)

PNA Microwave series network analyzers:

[www.agilent.com/find/pna](http://www.agilent.com/find/pna)

Combination analyzers:

[www.agilent.com/find/combo](http://www.agilent.com/find/combo)

Electronic calibration (ECal):

[www.agilent.com/find/ecal](http://www.agilent.com/find/ecal)

Materials measurement solutions:

[www.agilent.com/find/materials](http://www.agilent.com/find/materials)

Physical layer test systems  
and signal integrity solutions:

[www.agilent.com/find/plts](http://www.agilent.com/find/plts)

Test and measurement accessories:

[www.agilent.com/find/accessories](http://www.agilent.com/find/accessories)

Mixers and converters:

[www.agilent.com/find/fca](http://www.agilent.com/find/fca)



### Agilent Email Updates

[www.agilent.com/find/emailupdates](http://www.agilent.com/find/emailupdates)

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### Agilent Technologies' Test and Measurement Support, Services, and Assistance

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#### Our Promise

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