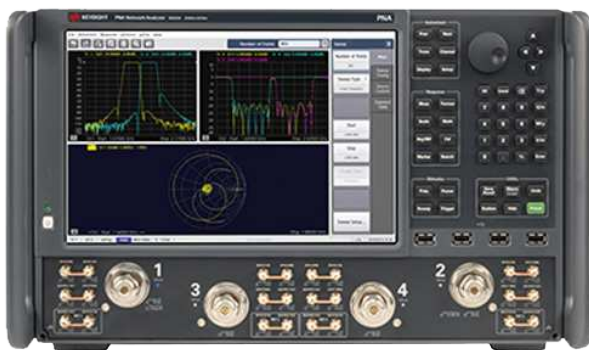


# Vector Network Analyzer




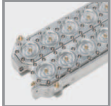
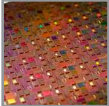





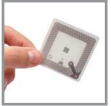
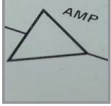



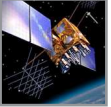






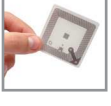











## Table of Contents

|   |    |
|---|----|
| Gain Deeper Confidence                            | 3  |
| Keysight VNA Solutions                            | 4  |
| Active Component Evaluation and Test              | 6  |
| Passive Component Evaluation and Test             | 8  |
| General Purpose, Education                        | 10 |
| Manufacturing                                     | 13 |
| High-Speed Serial Interconnect Analysis           | 15 |
| Installation and Maintenance                      | 16 |
| Related Network Analyzer Products and Accessories | 17 |
| Key Performances and Functions Comparison         | 19 |
| Migration and Upgrades                            | 23 |
| Related Literature                                | 24 |
| Web Resources                                     | 25 |

# Gain Deeper Confidence

Whether you're testing active or passive components, the right mix of speed and performance gives you an edge. In R&D, our vector network analyzers (VNAs) provide a level of measurement integrity that helps you transform deeper understanding into better designs. On the production line, our cost-effective VNAs provide the throughput and repeatability you need to transform parts into competitive components. Every Keysight Technologies, Inc. VNA is the ultimate expression of our expertise in linear and nonlinear device characterization. On the bench, in a rack or in the field, we can help you gain deeper confidence.









## Physical measurement ecosystem

|                                | Manufacturer  |   |   |   |   |  | Operator   |
|--------------------------------|---|---|---|---|---|--|--|
|                                | Device/Material   | Component   | Module/Sub-System   | Set/System  |   |  |  |
| Wireless                       | Capacitors<br>Inductors<br>Ferrite beads<br>Registers<br>PCB<br>Material                        | Antenna<br>Cable<br>Connector<br>Adapter<br>Oscillator  | Filter<br>BTS Filter<br><br>        | Front End<br>Module<br>  | BTS<br>   | Handset<br>     | BTS<br>Backhaul Comm.<br>   |
|                                |               | <br> | Amplifiers<br>PA<br>LNA<br><br> | Mixer<br>Frequency<br>Converter<br><br>   | Satellite Ground Station<br><br>P2P Comm.<br><br>Radar<br> |  | Ground Station<br><br>Radar<br><br>Military Comm.<br> |
| Aerospace and Defense          |              |    |    |    |   |               |  |
| Industry<br>Science<br>Medical | Research<br> | Teaching<br>   | HSD Comm.<br>Component<br><br>  | Diagnosis System & Component<br><br><br>Medical & Industrial Process<br> |   | Diagnosis<br> |  |





# Keysight VNA Solutions

Keysight offers a variety of vector network analyzers with frequency, performance, and versatility to meet your measurement needs.

To help you determine which solution 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 typical network analyzer applications, the measurement needs for those applications, and how Keysight's network analyzers meet those needs.

| Model   | Typical application  | Frequency range  |  |
|---|--|--|--|
| <b>PNA Family</b><br>Reach for unrivaled excellence |  <b>N524xB PNA-X Series</b><br>Most advanced and flexible VNA                         | <ul style="list-style-type: none"> <li>– Replace an entire rack of equipment with one instrument</li> <li>– Complete linear and nonlinear active device characterization</li> </ul>    | <ul style="list-style-type: none"> <li>– 10 MHz to 8.5/13.5/26.5/43.5/50/67 GHz</li> <li>– Up to 1.5 THz with extenders</li> <li>– 900 Hz start frequency available on N5242B/45B/47B</li> </ul> |
|   |  <b>N522xB PNA Series</b><br>High performance microwave VNA                           | <ul style="list-style-type: none"> <li>– Highest performance passive component analysis</li> <li>– Active components characterization</li> <li>– Metrology and cal lab</li> </ul>      | <ul style="list-style-type: none"> <li>– 10 MHz to 13.5/26.5/43.5/50/67 GHz</li> <li>– Up to 1.5 THz with extenders</li> <li>– 900 Hz start frequency available on N5222B/27B</li> </ul>         |
|   |  <b>N523xB PNA-L Series</b><br>Economy microwave VNA                                  | <ul style="list-style-type: none"> <li>– Microwave S-parameter test</li> <li>– Signal integrity</li> <li>– Material measurements</li> </ul>  | <ul style="list-style-type: none"> <li>– 300 kHz to 8.5/13.5/ 20 GHz</li> <li>– 10 MHz to 43.5/50 GHz</li> </ul>   |
| <b>ENA</b><br>Drive down the cost of test           |  <b>E5080A ENA</b><br>High performance RF VNA with modern GUI                        | <ul style="list-style-type: none"> <li>– RF component test</li> <li>– High-rejection filter test</li> <li>– Multiport module test</li> </ul>   | <ul style="list-style-type: none"> <li>– 9 kHz to 4.5/6.5/9 GHz</li> </ul>   |
|   |  <b>E5072A ENA</b><br>High performance RF VNA with configurable test set            | <ul style="list-style-type: none"> <li>– RF amplifier test</li> <li>– High-power RF component test</li> <li>– PIM measurements</li> </ul>  | <ul style="list-style-type: none"> <li>– 30 kHz to 4.5/8.5 GHz</li> </ul>  |
|   |  <b>E5071C ENA</b><br>High performance RF VNA                                       | <ul style="list-style-type: none"> <li>– RF component test</li> <li>– Multiport module test</li> <li>– Material measurements</li> <li>– Signal integrity</li> </ul>                    | <ul style="list-style-type: none"> <li>– 9 kHz to 4.5/6.5/8.5 GHz</li> <li>– 300 kHz to 14/20 GHz</li> </ul>   |
|   |  <b>E5061B ENA</b><br>LF-RF VNA with impedance analysis function<br>Low cost RF VNA | <ul style="list-style-type: none"> <li>– LF component/circuit test</li> <li>– Component Z evaluation</li> <li>– RF component test</li> <li>– CATV component test</li> </ul>            | <ul style="list-style-type: none"> <li>– 5 Hz to 0.5/1.5/3 GHz</li> <li>– 100 kHz to 1.5/3 GHz</li> </ul>  |
|   |  <b>E5063A ENA</b><br>Low-cost RF VNA for passive component test                    | <ul style="list-style-type: none"> <li>– Antenna manufacturing test</li> <li>– RF passive component test</li> <li>– Material measurements</li> <li>– PCB manufacturing test</li> </ul> | <ul style="list-style-type: none"> <li>– 100 kHz to 0.5/1.5/3/4.5/6.5/8.5/14/18 GHz</li> </ul>   |

## Keysight VNA Solutions (continued)

| Model   |  | Typical application   | Frequency range   |
|---|--|---|---|
| <b>PXI VNA</b><br>Drive down the size of test   | <br><b>M937xA</b><br>Full 2-port VNA that fits in just one-slot     | <ul style="list-style-type: none"> <li>– Multiport module test</li> <li>– Multi-site (parallel) manufacturing test</li> </ul>       | <ul style="list-style-type: none"> <li>– 300 kHz to 4/6.5/9/14/20/26.5 GHz</li> </ul>                                   |
|   | <br><b>M9485A</b><br>High-performance multiport VNA                 | <ul style="list-style-type: none"> <li>– Multiport module test</li> </ul>   | <ul style="list-style-type: none"> <li>– 1 MHz to 9 GHz</li> </ul>  |
| <b>USB VNA</b><br>Compact Form. Zero Compromise | <br><b>P937xA</b><br>Compact 2-port USB VNA                         | <ul style="list-style-type: none"> <li>– Manual test of passive components</li> <li>– General purpose manufacturing test</li> </ul> | <ul style="list-style-type: none"> <li>– 300 kHz to 4.5/6.5/9/14/20/26.5 GHz</li> </ul>                                 |
| <b>FieldFox</b><br>Carry precision with you     | <br><b>Handheld RF and Microwave Analyzers</b><br>Handheld analyzer | <ul style="list-style-type: none"> <li>– Wireless installation and maintenance</li> <li>– Interference detection</li> </ul>         | <ul style="list-style-type: none"> <li>– 30 kHz to 4/6.5/9/14/18/26.5 GHz</li> <li>– 300 kHz to 32/44/50 GHz</li> </ul> |

# Active Component Evaluation and Test

## Measurement challenges

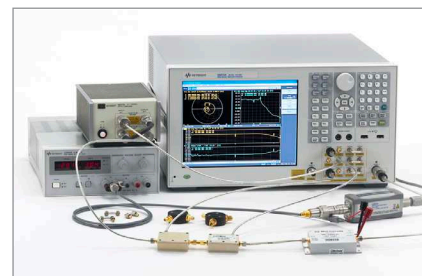
Keysight vector network analyzers can be used to characterize and test active components, such as amplifiers, mixers, and frequency converters. They can easily measure commonly specified amplifier parameters such as gain, gain and phase compression, isolation, return loss, and group delay. Harmonic distortion is often used to understand an amplifier's nonlinear behavior, and requires the receiver to be tuned at a different frequency from the source. Frequency-translating devices, such as mixers and frequency converters 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 (FOM) to detect output frequencies different from the input. Additional instruments and signal conditioning devices may be required for testing with two-tone, higher input and output power, or for other types of measurements including noise figure, ACP, and EVM. As a result, the test system becomes complicated or requires multiple stations.

## Our solutions

Keysight offers a wide range of flexible and affordable test solutions for vector network analysis of active components. Keysight's VNAs are designed for linear and nonlinear characterization with the highest accuracy. In addition to high performance, a variety of measurement applications simplifies setup, reduce test time, and improve measurement accuracy.

## Key features

- Amplifier gain, match and isolation: S-parameter measurements
- AM-AM and AM-PM conversion: power sweep, source and receiver calibration
- High power/pulse configurability: configurable test set, high output power, source and receiver attenuators, internal pulse generators, external pulse generator control, internal pulse modulators
- Frequency-converter conversion gain/loss: FOM, source and receiver calibration, scalar mixer calibration
- Frequency-converter conversion phase/group delay: FOM, magnitude and phase calibration, vector mixer calibration
- LO drive/measurements: second internal source, external RF source control, 3-port calibration and measurements, LO power calibration
- Mixer topology: swept-RF, swept/fixed- LO (fixed-IF/swept-IF), dual-stage converter, converter with embedded LO
- Accurate source power output and absolute power measurements: source and receiver calibration, power-sensor mismatch correction, receiver leveling
- Harmonic distortion: FOM, source and receiver calibration, low source harmonics, receiver attenuator
- Intermodulation-distortion (IMD): FOM, second internal source, external source control, internal combining network, swept-IMD
- Noise figure measurements
- Hot-S22 measurements: FOM, second internal source, internal combining network
- Power-added efficiency: DC inputs and/or DC meter control
- DC bias: internal DC bias source/DC source control/internal bias-tee
- Active hot parameters: removal of system-to-system correlation problem
- Nonlinear vector network analysis (NVNA): waveform analysis, X-parameters



## Active Component Evaluation and Test (continued)

| Models    | Features                         |                                   |  |                |                  |   |                          |  |                   |                      |                                 |      |
|-----------|----------------------------------|-----------------------------------|--|----------------|------------------|---|--------------------------|--|-------------------|----------------------|---------------------------------|------|
|           | Amplifier gain, match, isolation | Amplifier AM-AM, AM-PM conversion | High-power config-ure-ability <sup>1</sup> | Pulse          | DC bias/DC input | FOM, conversion gain/loss/phase/group delay | Setup wizard/Quick start | Active measurement applications <sup>2</sup> | Spectrum Analysis | Two internal sources | Internal combiner/path switches | NVNA |
| PNA-X     | ●                                | ●                                 | ●  | ●              | ●                | ●   | ●                        | ●  | ●                 | ●                    | ●                               | ●    |
| PNA       | ●                                | ●                                 | ●  | ●              | ●                | ●   | ●                        | ●  | ●                 | ● <sup>7</sup>       |                                 |      |
| PNA-L     | ●                                | ●                                 | ● <sup>3</sup>                             | ● <sup>4</sup> |                  | ● <sup>6</sup>                              | ●                        |  | ●                 |                      |                                 |      |
| E5080A    | ●                                | ●                                 |  | ● <sup>4</sup> | ●                | ●   | ●                        |  |                   |                      |                                 |      |
| E5072A    | ●                                | ●                                 | ● <sup>3</sup>                             | ● <sup>4</sup> | ●                | ●   | ●                        |  |                   |                      |                                 |      |
| E5071C    | ●                                | ●                                 |  | ● <sup>4</sup> | ●                | ●   | ●                        |  |                   |                      |                                 |      |
| E5061B LF | ●                                | ●                                 |  | ● <sup>4</sup> | ● <sup>5</sup>   |   |                          |  |                   |                      |                                 |      |
| E5061B RF | ●                                | ●                                 |  | ● <sup>4</sup> |                  |   |                          |  |                   |                      |                                 |      |
| M9485A    | ●                                | ●                                 | ●  | ●              | ●                | ●   | ●                        | ●  |                   |                      |                                 |      |
| FieldFox  | ●                                |                                   |  |                | ● <sup>5</sup>   | ● <sup>8</sup>                              |                          |  |                   |                      |                                 |      |

1. Includes configurable test set, high-output power, source attenuator, and receiver attenuator
2. Includes swept-frequency gain compression, two-tone IMD, pulse, noise figure measurements for amplifiers and frequency converters
3. Receiver attenuator not available
4. Requires external pulse generators and modulators

5. Built-in DC bias source, no bias tee
6. Conversion phase/group delay not available
7. Requires 4-port PNA
8. Scalar FOM using USB power sensor or spectrum analyzer functionality

## Typical solutions

### Most integrated and flexible

#### N524xB PNA-X Series microwave network analyzer

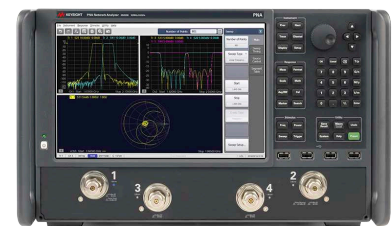
- 10 MHz to 8.5/13.5/26.5/43.5/50/67 GHz, 2- or 4-ports (900 Hz start frequency available on N5242B/45B/47B)
- Two internal sources with low harmonics, combining network, pulse generators/modulators, and low-noise receiver
- Internal path configuration switches for multiple measurements with a single connection
- Amplifier and converter applications for simple setup, faster measurements and improved accuracy



### Highest performance

#### N522xB PNA Series microwave network analyzer

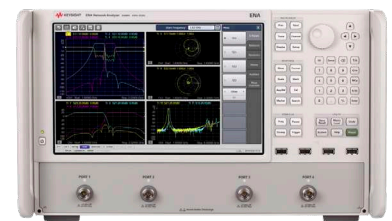
- 10 MHz to 13.5/26.5/43.5/50/67 GHz, 2- or 4-ports (900 Hz start frequency available on N5222B/27B)
- Two internal sources (4-port only) and pulse generators/modulators
- Highest RF performance and accuracy
- Amplifier and converter applications for simple setup, faster measurements and improved accuracy



### RF standard with flexibility

#### E5080A ENA vector network analyzer

- 9 kHz to 4.5/6.5/9 GHz, 2- or 4-port
- Wide power sweep range (-90 to +15 dBm)
- Frequency Offset Mode, Scalar Mixer measurement, and Vector Mixer Characterization



# Passive Component Evaluation and Test

## Measurement challenges

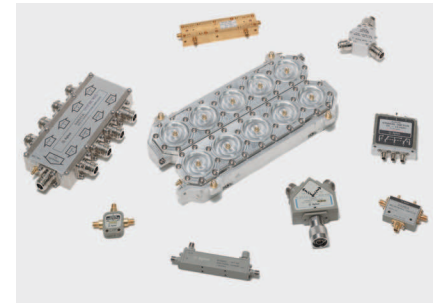
For quality communications systems, high performance passive devices such as filters, combiners, switches, and transmission lines often require low ripple and low insertion loss in the pass band, and high rejection ratios in the stop band. Devices are sometimes used in balanced circuits and therefore have multiple input and output ports that complicate measurement-system configurations. For these devices, the key measurement challenge is to easily get accurate data, as fast as possible. Wide measurement-frequency range is required to characterize multi-band operation.

## Our solutions

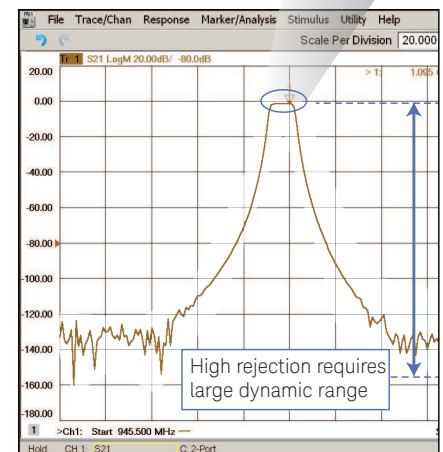
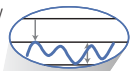
Keysight VNAs have a broad frequency range; from 5 Hz to 1.5 THz. Low trace noise, advanced calibration techniques, and good stability help evaluate your passive components with the required accuracy. VNAs with a configurable test set allow direct receiver access, improving system dynamic range for more accurate and faster device measurements. Multiple traces can be displayed in different formats, and various marker searches including filter parameters and trace-math functions are available for easy analysis.

## Key features

- Wide dynamic range: fast and accurate filter measurements
- Wide frequency range: covers in- and out-of-band characteristics
- Direct receiver access: obtain widest possible dynamic range
- Low-cost solution: just enough performance and function for your test
- Low trace noise and high stability: high quality device measurements
- Unknown-thru calibration: easy and accurate non-insertable device measurements
- Adapter removal/characterization: accurate mixed-connector device measurements
- Balanced S-parameter measurements: accurate measurements without balun
- Multiport/Multi-site solutions: easy multiport or multiple DUT evaluation
- Full N-port calibration: mismatch-corrected accurate multiport measurements
- Metrology option: highest accuracy and stability for metrology-grade component evaluation
- Time domain analysis/gating function: troubleshooting and simple simulation
- Trace analysis functions using marker and trace math



Accurate measurements of low insertion loss and low ripple require a VNA with low trace noise and high stability.





## Passive Component Evaluation and Test (continued)

| Models    | Features                        |                         |  |                 |   |                          |  |                       |                     |                        |                  |
|-----------|---------------------------------|-------------------------|--|-----------------|---|--------------------------|--|-----------------------|---------------------|------------------------|------------------|
|           | MIN/MAX frequency in the series | Wide dynamic range (dB) | Extended dynamic range by direct receiver access | Affordable cost | Trace noise at 1 kHz IFBW (dB rms) <sup>1</sup> | Unknown thru calibration | Adapter removal/ characterize function | Balanced S-parameters | Multiport solutions | Max # of full-port cal | Metrology option |
| PNA-X     | 10 MHz/67 GHz                   | > 130                   | ●  |                 | 0.002   | ●                        | ●                                      | ●                     | ●                   | > 4                    |                  |
| PNA       | 10 MHz/67 GHz                   | > 130                   | ●  |                 | 0.002   | ●                        | ●                                      | ●                     | ●                   | > 4                    | ●                |
| PNA-L     | 300 kHz/50 GHz                  | > 130                   | ●  | ●               | 0.004   | ●                        | ●                                      | ●                     | ●                   | > 4                    |                  |
| E5080A    | 9 kHz/9 GHz                     | > 135                   |  | ●               | 0.0005  | ●                        | ●                                      | ●                     | ●                   | 4                      |                  |
| E5072A    | 30 kHz/8.5 GHz                  | > 120                   | ●  |                 | 0.0005  | ●                        | ●                                      |                       |                     | 2                      |                  |
| E5071C    | 9 kHz/20 GHz                    | > 120                   |  | ●               | 0.0004  | ●                        | ●                                      | ●                     | ●                   | 4                      |                  |
| E5061B LF | 5 Hz/3 GHz                      | > 120                   |  |                 | 0.003   |                          | ●                                      |                       |                     | 2                      |                  |
| E5061B RF | 100 kHz/3 GHz                   | > 120                   |  | ●               | 0.003   |                          | ●                                      |                       |                     | 2                      |                  |
| E5063A    | 100 kHz/18 GHz                  | > 115                   |  | ●               | 0.0006  | ●                        | ●                                      |                       |                     | 2                      |                  |
| M937xA    | 300 kHz/26.5 GHz                | > 115                   |  | ●               | 0.003   | ●                        | ●                                      | ●                     | ●                   | Up to 32               |                  |
| M9485A    | 1 MHz/9 GHz                     | > 130                   | ●  | ●               | 0.003   | ●                        | ●                                      | ●                     | ●                   | Up to 24               |                  |
| P937xA    | 300 kHz/26.5 GHz                | > 115                   |  | ●               | 0.003   | ●                        | ●                                      | ●                     | ●                   | 2 / 4 <sup>3</sup>     |                  |
| FieldFox  | 30 kHz/50 GHz                   | > 95                    |  | ●               | 0.004 <sup>4</sup>                              | ●                        |  | ●                     |                     | 2                      |                  |

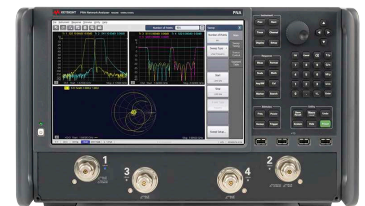
1. Calculated based on the specification at different IFBW settings
2. 1-port differential measurements
3. A 4-port network analyzer can be configured with two P937xA USB VNAs.
4. Trace noise at 1 GHz with 300 kHz IFBW

### Typical solutions

#### Best accuracy up to microwave frequencies

##### N522xB PNA Series network analyzer

- 10 MHz to 13.5/26.5/43.5/50/67 GHz, 2- or 4-ports
- Wide dynamic range (> 128 dB at 26.5 GHz, > 112 dB at 67 GHz)
- World's highest accuracy. Metrology option for ultimate S-parameter measurements.
- Full N-port calibration support
- Up to 1.5 THz by using millimeter-wave frequency extenders



#### Best accuracy for RF passive component test

##### E5080A ENA vector network analyzer

- 9 kHz to 4.5/6.5/9 GHz, 2- or 4-ports
- Wide dynamic range (135 dB spec, 147 dB typical)
- Excellent trace noise (0.0015 dBrms with IFBW=10 kHz) and stability (0.005 dB/°C)



#### Best balance between price and performance

##### E5063A ENA vector network analyzer

- Wide frequency coverage up to 18 GHz, 2-ports
- Lowest-cost Keysight benchtop VNA



#### Easy to reconfigure based on test needs

##### PXI vector network analyzer (M937xA & M9485A)

- Full N-port calibration support
- 300 kHz to 4/6.5/9/14/20/26.5 GHz (M937xA)
- Best PXI VNA performance on key specifications such as dynamic range, measurement speed, and trace noise (M9485A)



# General Purpose, Education

## Measurement challenges

General-purpose vector network analyzers are essential in education institutions and many other RF labs. Users typically require measurements of S-parameters, power, and sometimes material parameters, for a broad range of passive and active components, with both single-ended and differential inputs and outputs. Devices typically have 2-, 3- and sometimes 4-ports, and must be measured in coaxial, in-fixture, or on-wafer environments. Active devices like amplifiers, mixers, and frequency-converters often require considerable time to measure all necessary parameters. Test equipment is not used every day and is often shared with other groups.

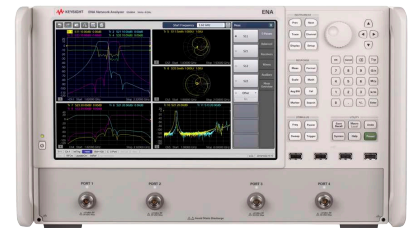
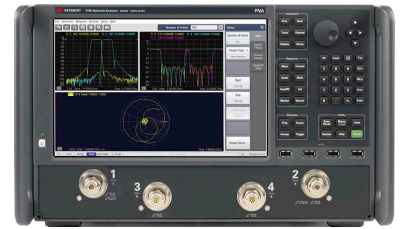
## Our solutions

Keysight has a wide range of general-purpose VNAs, from powerful yet economical bench-top models covering the frequency range of a few GHz up to 100's of GHz, to compact USB VNA models that are easily shared and give results on par with their benchtop equivalent.

- ENA and PNA-L benchtop models offer excellent speed and accuracy at affordable prices
- PNA offers the highest S-parameter accuracy and can be used with millimeter-wave extenders up to 1.5 THz
- PXI VNA offers best PXI performance using only a single slot in modular test solutions
- Guided calibration wizards and ECal modules make calibration easy
- USB VNA's portability makes it easy to share among different groups

## Key features

- 4-port models make it easy to test couplers, circulators, splitters, and other 3- and 4-port devices, as well as balanced/differential components
- ECal modules replace mechanical calibration kits making calibration fast and easy to perform, and much less prone to operator errors
- Power-meter-based calibration yields accurate measurements of DUT input and output power over a very broad range of powers
- Built-in support for port extensions, port matching, de-embedding, and impedance transformations extends coaxial accuracy to on-wafer and in-fixture measurements
- Offsetting the frequency of the source and receivers allows measurements of mixers and frequency converters
- External millimeter-wave modules extend the frequency of operation up to 1.5 THz
- Materials measurement software offers full characterization of dielectric properties using a variety of measurement methods



## General Purpose, Education (continued)

| Models    | Features      |                |              |                 |                       |                         |                             |  |
|-----------|---------------|----------------|--------------|-----------------|-----------------------|-------------------------|-----------------------------|--|
|           | 2-port models | 4-port models  | ECal support | Power meter cal | Frequency offset mode | Probe, fixture features | Support for mm-wave modules | Spectrum analysis and independent source |
| PNA-X     | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| PNA       | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| PNA-L     | ●             | ● <sup>1</sup> | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| E5080A    | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| E5072A    | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| E5071C    | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| E5061B LF | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| E5061B RF | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| E5063A    | ●             | ●              | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| M937xA    | ●             | ● <sup>2</sup> | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| P937xA    | ●             | ● <sup>3</sup> | ●            | ●               | ●                     | ●                       | ●                           | ●  |
| FieldFox  | ●             | ●              | ●            | ●               | ● <sup>4</sup>        | ●                       | ●                           | ●  |

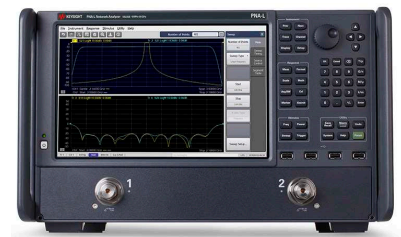
1. 13.5 and 20 GHz models only
2. Add additional modules to achieve up to 32-port in a single PXI chassis.
3. Add additional module to achieve a 4-port network analyzer.
4. Scalar FOM using USB power sensor or spectrum analyzer functionality

### Typical solutions

#### Best value for microwave S-parameter measurements

N523xB PNA-L Series microwave network analyzer

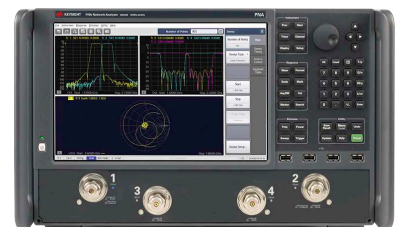
- 300 kHz to 8.5/13.5/20 GHz, 10 MHz to 43.5/50 GHz, 2-ports
- 300 kHz to 13.5/20 GHz 4-ports
- Basic S-parameters and materials measurements



#### Unsurpassed accuracy in S-parameter measurements

N522xB PNA Series microwave network analyzer

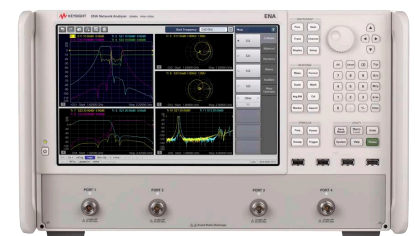
- 10 MHz to 13.5/26.5/43.5/50/67 GHz, 2- or 4-ports
- Wide dynamic range (> 128 dB at 26.5 GHz, > 112 dB at 67 GHz)
- Linear and non-linear measurement options
- Up to 1.5 THz using millimeter-wave frequency extenders



#### The best-in-class performance and advanced usability

E5080A ENA vector network analyzer

- 9 kHz to 4.5/6.5/9 GHz, 2- or 4-port
- Wide dynamic range (135 dB spec, 147 dB typical)
- Modern GUI



## General Purpose, Education (continued)

### Easy to reconfigure based on test needs

#### M937xA PXIe vector network analyzer

- 300 kHz to 4/ 6.5/ 9/ 14/ 20/ 26.5 GHz
- Competent performance on key specifications such as dynamic range, measurement speed, and trace noise
- RF and microwave balanced devices
- Full N-port calibration support (up to 32-port)



### Easily shared tool for quick evaluations

#### P937xA USB vector network analyzer

- Full 2-port VNA that fits in just one hand
- Light weight of 1.9 kg
- 300 kHz to 4.5/6.5/9/14/20/ 26.5 GHz
- Plug & play USB connector to host PC for fast setup
- Same GUI and measurement science with Keysight benchtop and PXI VNAs.



# Manufacturing

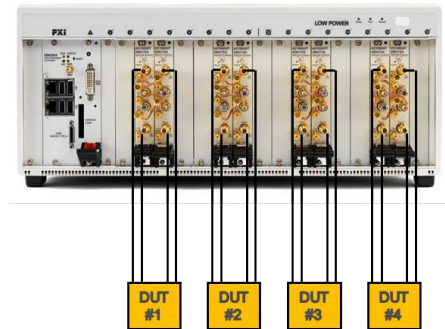
## Measurement challenges

Driving down the cost of test is the key challenge in manufacturing, and there are multiple factors that influence this. One key factor is throughput. The measurement time of a VNA can be divided into several different contributions such as sweep speed, data analysis, display processing, and data transfer. In many cases, the analyzer must send pass/fail results to an automated system. The sweep speed and data-analysis speed are critical for high-volume manufacturing. Being able to minimize the amount of operator intervention, as well as connection and calibration times will also affect measurement throughput. Initial procurement cost, system uptime, maintenance costs, and future performance upgrade costs for test stations also affect total cost of ownership.



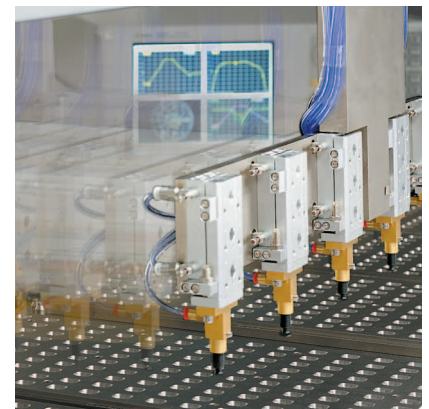
## Our solutions

Keysight offers a broad range of VNAs with very fast data-acquisition speeds and excellent repeatability due to low trace noise and high temperature stability – essential elements to optimize manufacturing test. Many VNAs are equipped with a parts-handler interface to achieve fast throughput on an automated production line. You can find the optimum VNA for your manufacturing environment, and only pay for the capabilities you need to minimize your initial procurement costs.



## Key features

- Fast processors and wide bandwidths: very fast data acquisition speeds
- Fast data-transfer speeds for maximum throughput
- Segment sweeps: faster testing by tailored stimulus conditions
- Pass/fail limit testing: easy and fast data analysis on the VNA
- Test fixture de-embedding: measure device's true performance
- Internal programming capability: customize VNA operation and data analysis
- ECal modules: simple and fast calibration
- Parts-handler interface: fast handshaking with an ATE system
- Multiport/Multi-site solutions: multiple and multiport device test with minimal connections
- Direct-receiver access: obtain widest possible dynamic range
- Upgradable processors: keep your instrument up-to-date
- Hardware upgrade paths: support your evolving measurement needs



## Manufacturing (continued)

| Models    | Features                     |                |                         |                           |                                 |              |                         |                                |                        |                  |                   |
|-----------|------------------------------|----------------|-------------------------|---------------------------|---------------------------------|--------------|-------------------------|--------------------------------|------------------------|------------------|-------------------|
|           | Fast data process & transfer | Segment sweeps | Pass/fail limit testing | Test fixture de-embedding | Built-in programming capability | ECal support | Parts handler interface | Multiport/Multi-site solutions | Direct receiver access | Hardware upgrade | Processor upgrade |
| PNA-X     | ●                            | ●              | ●                       | ●                         |                                 | ●            | ●                       | ●                              | ●                      | ●                | ●                 |
| PNA       | ●                            | ●              | ●                       | ●                         |                                 | ●            | ●                       | ●                              | ●                      | ●                | ●                 |
| PNA-L     | ●                            | ●              | ●                       | ●                         |                                 | ●            | ●                       | ●                              | ●                      | ●                | ●                 |
| E5080A    | ●                            | ●              | ●                       | ●                         |                                 | ●            | ●                       | ●                              |                        | ●                |                   |
| E5072A    | ●                            | ●              | ●                       | ●                         | ●                               | ●            | ●                       |                                | ●                      | ●                |                   |
| E5071C    | ●                            | ●              | ●                       | ●                         | ●                               | ●            | ●                       | ●                              | ●                      | ●                | ●                 |
| E5061B LF | ●                            | ●              | ●                       |                           | ●                               | ●            | ●                       |                                | ●                      | ●                | ●                 |
| E5061B RF | ●                            | ●              | ●                       |                           | ●                               | ●            | ●                       |                                | ●                      | ●                | ●                 |
| E5063A    | ●                            | ●              | ●                       | ●                         |                                 | ●            | ●                       |                                | ●                      | ●                | ●                 |
| M937xA    | ●                            | ●              | ●                       | ●                         | ● <sup>1</sup>                  | ●            | ● <sup>2</sup>          | ●                              |                        | ●                | ● <sup>3</sup>    |
| M9485A    | ●                            | ●              | ●                       | ●                         | ● <sup>1</sup>                  | ●            | ● <sup>2</sup>          | ●                              | ●                      | ●                | ● <sup>3</sup>    |
| P937xA    | ●                            | ●              | ●                       | ●                         | ● <sup>1</sup>                  | ●            |                         |                                |                        | ●                | ● <sup>3</sup>    |
| FieldFox  |                              | ●              |                         |                           |                                 | ●            |                         |                                |                        |                  |                   |

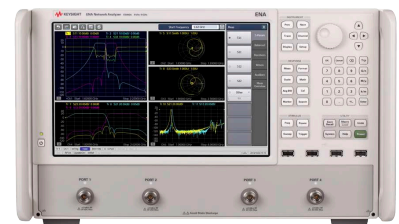
1. Programming capability is available in the controller used to control the VNA.
2. The M9341A/B PXIe I/O module is required.
3. The central processor for this instrument is the controller, which is upgradable.

## Typical solutions

### The standard in RF manufacturing test

#### E5080A ENA vector network analyzer

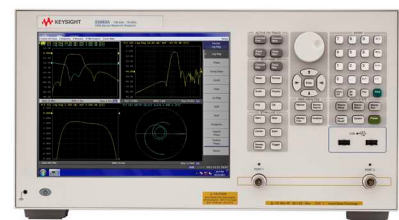
- 9 kHz to 4.5/6.5/9 GHz, 2- or 4-ports
- Fast measurement speed
- Wide dynamic range (135 dB spec, 147 dB typical)
- Excellent trace noise (0.0015 dBBrms with IFBW=10 kHz) and stability (0.005 dB/°C)



### Best balance between price and performance

#### E5063A ENA vector network analyzer

- 100 kHz to 4.5/8.5/18 GHz
- > 117 dB dynamic range
- 0.006 dB rms trace noise
- PCB test function



### Best value for microwave manufacturing

#### N523xB PNA-L Series microwave network analyzer

- 300 kHz to 8.5/13.5/20 GHz, 10 MHz to 43.5/50 Hz, 2-ports
- 300 kHz to 13.5/20 GHz, 4-ports
- Wide frequency range up to 50 GHz



### Easy to reconfigure based on test needs

#### PXI vector network analyzer (M937xA & M9485A)

- True multipoint VNA for full calibrated measurements
- Up to 32-port VNA configuration in a single chassis (M937xA)
- Best performance on key specifications such as dynamic range, measurement speed, and trace noise (M9485A)
- Multi-site parallel measurement capability



# High-Speed Serial Interconnect Analysis

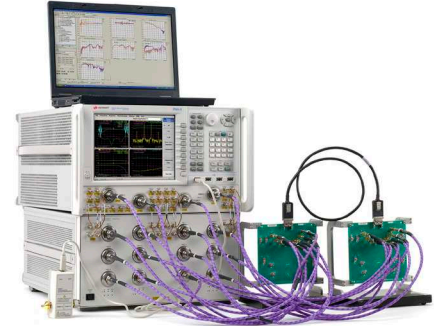
## Measurement challenges

As data rates of digital systems increase, signal integrity of interconnects drastically affects system performance. The effects of physical layer components such as printed circuit board traces, connectors, cables, and IC packages can no longer be ignored. Fast and accurate analysis of interconnect performance in both time and frequency domains become critical to ensure reliable system performance. Because managing multiple test systems becomes difficult, a single test system that can fully characterize differential high-speed digital devices is a very powerful tool.

## Our solutions

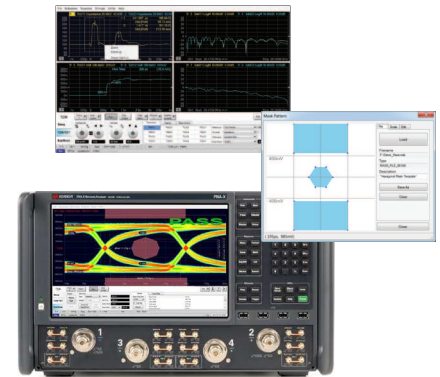
### N1930B Physical Layer Test System (PLTS)

- Automatic Fixture Removal (AFR) for accurate, yet simple error correction and de-embedding of unwanted structures inside channel path
- Channel simulator provides user-defined pre-emphasis and equalization settings for real-world channel analysis
- MATLAB interface allows many aspects of testing to be customized and automated which typically cuts test-plan development in half
- Characterization report details all critical DUT performance parameters along with specific test-system information to archive important technical test-plan data



### Enhanced Time Domain Analysis (ENA option TDR, S93011A for PNA)

- Similar look-and-feel to traditional TDR oscilloscopes, for simple and intuitive operation
- Easily locate source of loss, reflections and crosstalk by simultaneous analysis of both time and frequency domains
- Internal protection circuits inside the instrument provide high robustness against electrostatic discharge (ESD)
- Determine optimal emphasis and equalization settings for your link
- Simulate real-world signals through jitter insertion
- Analyze impedance of active devices under actual operating conditions (Hot TDR) to quantify the multiple reflection effect



## High-speed serial interconnect analysis

| Models                        | Features                               |                    |                  |             |             |                               |         |                                    |                    |  |
|-------------------------------|--|--------------------|------------------|-------------|-------------|-------------------------------|---------|------------------------------------|--------------------|--|
|                               | Maximum bandwidth                      | Maximum # of ports | Frequency domain | Time domain | Eye diagram | Stressed eye diagram analysis | Hot TDR | Compliance test (MOI) <sup>1</sup> | Real-time analysis | Advanced error correction methods <sup>2</sup> |
| PLTS                          | Up to 67 GHz                           | Up to 16           | ●                | ●           | ●           | ●                             | ●       |                                    |                    | ●  |
| Enhanced time domain analysis | ENA: Up to 20 GHz<br>PNA: Up to 67 GHz | Up to 4            | ●                | ●           | ●           | ●                             | ●       | ●                                  | ●                  |  |

1. PLTS has automated test suite templates that assist R&D engineers with compliance-type testing  
 2. Advanced features: automatic fixture removal (AFR), differential TRL, multiport crosstalk

# Installation and Maintenance

## Measurement challenges

Network analyzer measurements made in the field are fundamentally similar to measurements in the lab users need to test S-parameters of devices such as cables and filters to determine their performance. The main difference is the requirements placed on the network analyzer hardware. Portability is a big challenge in the field. Carrying benchtop instruments on a cart or trying to fit a benchtop instrument in a tight space like an aircraft is difficult. Locating AC power can also be difficult, so a portable and battery-operated analyzer is often vital for field test. In addition, while indoor temperatures may be fairly stable, the weather conditions outdoors are quite variable, so the equipment has to be designed to handle these changes. Any VNA used outdoors also has to be rugged, as it is moved around often. Finally, the measurements made in the field need to match the measurements made in the lab, and have similar accuracy.

## Our solutions

### FieldFox analyzer family

- Designed for field use, battery operated, portable, display viewable in sunlight
- Completely sealed enclosure compliant with MIL-PRF-28800F Class 2 and type tested; meets IEC/EN 60529 requirements for ingress protection
- Large buttons are easy to operate even while wearing gloves
- Network analyzer—measure all four S-parameters, and perform calibrations such as full 2-port Cal and TRL; unique QuickCal for field calibration
- Optional spectrum analyzer and GPS receiver for interference analysis



### M937xA PXIe vector network analyzer

- Best PXI VNA performance on key specifications such as dynamic range, measurement speed, and trace noise
- Full two-port VNA that fits in just one slot
- Full N-port calibration support



### E5061B RF ENA vector network analyzer

- Benchtop light weight model up to 3 GHz
- Suitable for measurements that require higher analog performance such as wide dynamic range or fast sweep speed



## Installation and maintenance

| Models    | Features       |              |              |   |                        |                         |             |                   |                   |  |
|-----------|----------------|--------------|--------------|---|------------------------|-------------------------|-------------|-------------------|-------------------|--|
|           | Portability    | Battery life | S-parameters | Frequency range                               | Dynamic range at 3 GHz | Full 2-port calibration | Time domain | Spectrum analyzer | SCPI programmable |  |
| FieldFox  | 6.6 lb/3 kg    | 3.5 hours    | ●            | 30/300 kHz to 4/6.5/9/14/18/26.5/32/44/50 GHz | 95 dB                  | ●                       | ●           | ●                 | ●                 |  |
| M937xA    | 1.3 lb/0.59 kg | N/A          | ●            | 300 kHz to 4/6.5/9/14/20/26.5 GHz             | 115 dB                 | ●                       | ●           |                   | ●                 |  |
| P937xA    | 4.5 lb/2.04 kg | N/A          | ●            | 300 kHz 4.5/6.5/9/14/20/26.5 GHz              | 115 dB                 | ●                       | ●           |                   | ●                 |  |
| E5061B RF | 30 lb/14 kg    | N/A          | ●            | 100 kHz to 1.5/3 GHz                          | 120 dB                 | ●                       | ●           |                   | ●                 |  |



## Related Network Analyzer Products and Accessories

### Electronic calibration (ECal) modules

PNA ENA PXI VNA USB VNA FieldFox

Keysight ECal modules bring calibration to your vector network analyzers with just a single connection from DC up to 67 GHz. The ECal modules are state-of-the-art, solid-state devices with programmable and highly repeatable impedance states which are traceable via National Metrology Institute. ECal modules are controlled directly from the Keysight network analyzers; no external PC is required. Electronic calibration replaces traditional mechanical standard calibration, and provides consistent calibration and eliminating operator error while bringing convenience and simplicity to your calibration routine.



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

### Microwave test accessories

PNA ENA PXI VNA USB VNA FieldFox

Keysight provides a complete series of coaxial and waveguide RF and microwave test accessories – everything from adapters, power limiters, DC blocks, attenuators, and couplers, to switches and system amplifiers. These test accessories complete your test solutions by simplifying test setups and maximizing the equipment's full potential to ensure the best possible measurement results.



Two U1810B USB coaxial switches, DC to 18 GHz, SPDT at the ENA test port

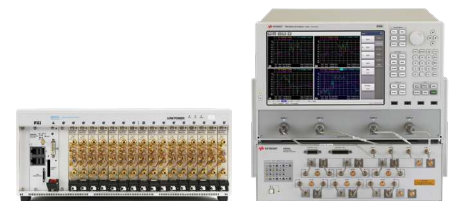
[www.keysight.com/find/mtacatalog](http://www.keysight.com/find/mtacatalog)

### Multiport/multi-site solutions

PNA ENA PXI VNA

Whether you're measuring differential devices, highly integrated multiport components, or testing many 1-port devices, Keysight offers a variety of multiport/multi-site solutions to suit your measurement needs and dramatically reduce test times.

[www.keysight.com/find/multiport](http://www.keysight.com/find/multiport)



PXI VNA up to 32-ports, multiport test set

E5080A ENA with E5092A configurable multiport test set

### Broadband and millimeter wave

PNA

The N5290A/91A millimeter-wave system is a single-sweep solution from 900 Hz to 110/120 GHz with built-in Kelvin bias tees and 2- and 4-port S-parameter measurements. This is a direct replacement for the N5251A with improved performance with smaller size frequency extender heads. In particular, a new receiver-leveling function lets you set the source power accurately at the 1.0 mm test port. Keysight also offers a variety of banded millimeter-wave solutions that enable the PNA and PNA-X network analyzers to make S-parameter measurements up to 1.5 THz.



N5290A/91A single sweep solution

[www.keysight.com/find/N5291A](http://www.keysight.com/find/N5291A)

## Related Network Analyzer Products and Accessories (continued)

### Materials measurement

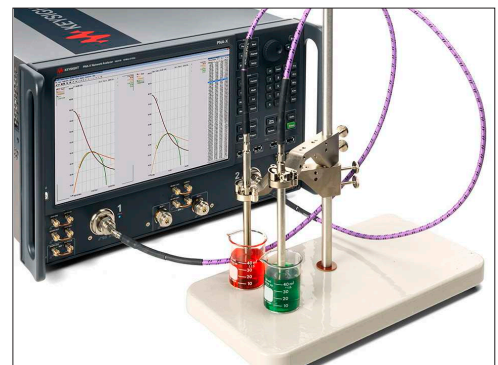
PNA

ENA

FieldFox

Trust Keysight to deliver leading-edge techniques for measuring dielectric and magnetic properties of materials. The N1501A dielectric probe kit offers hardware for measuring complex permittivity of liquids and conformable solids from 200 MHz to 50 GHz. The N1500A materials measurement suite automates a variety of techniques across a wide frequency span, including transmission-line, free-space and resonant-cavity methods. The 85072A 10 GHz split-cylinder resonator measures complex permittivity and loss tangent of thin films, un-clad substrates, and other low-loss sheet materials as part of a turnkey solution for IPC standard TM 650 2.5.5.13. Measuring electromagnetic properties of materials is critical in all stages of a products lifecycle: design, incoming inspection, process monitoring and quality assurance. Keysight sets the measurement standard with more than 20 years of experience and innovative new products.

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

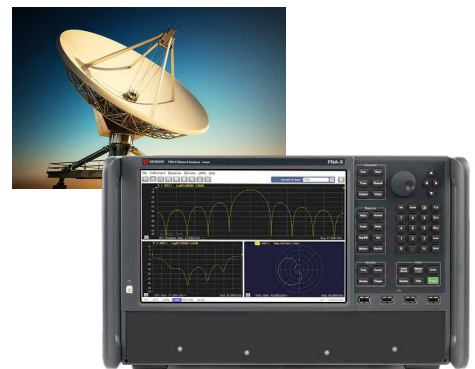


### Antenna receiver

PNA

Keysight Technologies provides many of the components you need to make accurate antenna and radar cross-section (RCS) measurements. The N5264B PNA-X measurement receiver is a dedicated antenna receiver with 400,000 point-per-second data acquisition on all five measurement channels. The N5264B provides twice as many receivers compared to any other antenna receiver on the market. The N5264B is compatible with MXG or PSG signal generators, the 85309B distributed frequency converter, and 85320A/B mixers. The receiver and an MXG source can completely replace the 8530A and 8360B sources for existing antenna ranges and typically results in a system-speed improvement that is 10 times faster. Additionally, the built-in 8510x/8530A code-emulation software provides a drop-in replacement for existing antenna ranges utilizing an 8530A. The N5264B is supported by major antenna-system integrators such as Microwave Vision Group, Nearfield Systems Inc., ETS-Lindgren, and the System Planning Corporation.

[www.keysight.com/find/antenna](http://www.keysight.com/find/antenna)



N5264B PNA-X measurement receiver

### CalPod calibration-refresh modules

PNA

Keysight provides a new and unique way to quickly and easily refresh a calibration at the push of a button, without removing the DUT and without the physical connection of standards. CalPods are particularly useful in thermal or thermal-vacuum chambers for removing environmental effects from your measurement results due to temperature changes of cables, connectors, and adaptors, or for removing variations due to cable movements or variations in switch matrices.

[www.keysight.com/find/calpods](http://www.keysight.com/find/calpods)



85541A 40 GHz temperature characterized CalPod

# Key Performances and Functions Comparison

| Models | Performances   |  |                           |   |                                   |   |   | Dimension<br>H (mm) x<br>W (mm)<br>x D (mm),<br>weight (kg) |                              |
|--------|--|--|---------------------------|---|-----------------------------------|---|---|---|------------------------------|
|        | Frequency  | Dynamic range (dB)<br>at 3/20 GHz at<br>10 Hz IFBW   |                           | Noise floor<br>(dBm) at<br>3/20 GHz<br>at 10 Hz<br>IFBW | Max power<br>at 3/20 GHz<br>(dBm) | Best trace noise<br>at 10 kHz <sup>1</sup> IFBW<br>Mag (dBrms)/<br>Phase (degrms) | Best speed<br>at 201 point<br>1sweep,<br>correction off |   |                              |
|        |  | System   | Direct receiver<br>access |   |                                   |   |   |   |                              |
| PNA-X  | N5249B   | 10 MHz to 8.5 GHz  | 124-128/<br>124-129       | 136-140/<br>133-141                                     | -114/-114                         | +8-13/<br>+5-10   | 0.0063/0.047  | 5 ms<br>(600 kHz IFBW)                                      | 267 x 426 x 533,<br>27-37 kg |
|        | N5241B   | 10 MHz to 13.5 GHz   | 124-128/<br>124-129       | 136-140/<br>133-141                                     | -114/-114                         | +8-13/<br>+5-10   | 0.0063/0.047  | 5 ms<br>(600 kHz IFBW)                                      | 267 x 426 x<br>533, 27-37 kg |
|        | N5244B   | 10 MHz to 43.5 GHz   | 118-123/<br>121-125       | 130-135/<br>133-137                                     | -110/-111                         | +8-13/<br>+10-14  | 0.0063/0.094  | 6 ms<br>(600 kHz IFBW)                                      | 267 x 426 x<br>583, 47-49 kg |
|        | N5245B   | 10 MHz (900 Hz <sup>2</sup> ) to 50 GHz  | 124-130/<br>125-130       | 136-142/<br>136-140                                     | -115/-118                         | +9-15/<br>+7-12   | 0.0063/0.063  | 9.7 ms<br>(600 kHz IFBW)                                    | 267 x 426 x<br>583, 47-49 kg |
|        | N5247B   | 10 MHz (900 Hz <sup>2</sup> ) to 67 GHz  | 127/<br>124-127           | 138/<br>135-138   | -114/-116                         | +9-13/<br>+8-11   | 0.0063/0.063  | 6.3 ms<br>(600 kHz IFBW)                                    | 267 x 426 x<br>583, 43-45 kg |
| PNA    | N5221B   | 10 MHz to 13.5 GHz   | 127/<br>124-127           | 139/<br>136-139   | -114/-114                         | +13/<br>+10-13  | 0.0063/0.047  | 5.6 ms<br>(600 kHz IFBW)                                    | 267 x 426 x<br>533, 27-37 kg |
|        | N5222B   | 10 MHz (900 Hz <sup>2</sup> ) to 26.5 GHz  | 125-127/<br>124-127       | 137-139/<br>136-139                                     | -114/-114                         | +11-13/<br>+10-13   | 0.0095/0.063  | 4.7 ms<br>(600 kHz IFBW)                                    | 267 x 426 x<br>582, 40-42 kg |
|        | N5224B   | 10 MHz to 43.5 GHz   | 127/<br>124-127           | 138/<br>135-138   | -114/-116                         | +9-13/<br>+8-11   | 0.0063/0.063  | 6.3 ms<br>(600 kHz IFBW)                                    | 267 x 426 x<br>583, 43-45 kg |
|        | N5225B   | 10 MHz to 50 GHz   | 131-133/<br>111-114       | 144/124   | -120/-106                         | +11-13/<br>+5-8   | 0.012/0.19  | 5.75 ms<br>(600 kHz IFBW)                                   | 267 x 426 x<br>446, 24 kg    |
|        | N5227B   | 10 MHz (900 Hz <sup>2</sup> ) to 67 GHz  | 128/<br>101-105           | 141/114   | -120/-107                         | +8/<br>-6 -2  | 0.0063/0.063  | 5.75 ms<br>(600 kHz IFBW)                                   | 267 x 426 x<br>446, 24 kg    |
| PNA-L  | N5239B   | 300 kHz to 8.5 GHz   | 131-133/<br>111-114       | 144/124   | -120/-106                         | +11-13/<br>+5-8   | 0.012/0.19  | 5.75 ms<br>(600 kHz IFBW)                                   | 267 x 426 x<br>446, 24 kg    |
|        | N5231B   | 300 kHz to 13.5 GHz<br>(N5231B Option 2xx)   | 128/<br>101-105           | 141/114   | -120/-107                         | +8/<br>-6 -2  | 0.0063/0.063  | 5.75 ms<br>(600 kHz IFBW)                                   | 267 x 426 x<br>446, 24 kg    |
|        | N5232B   | 300 kHz to 20 GHz<br>(N5232B Option 2xx)   | 110/100                   | 128/117   | -110/-100                         | 0/0   | 0.019/0.19  | 6 ms<br>(600 kHz IFBW)                                      | 267 x 426 x<br>446, 25 kg    |
|        | N5231B   | 300 kHz to 13.5 GHz<br>(N5231B Option 4xx)   | 123/<br>123/96            | 151/<br>NA  | -117/<br>-123/-106                | +16/<br>+10/0   | 0.0015/0.013  | 3 ms<br>(500 kHz IFBW)                                      | 222 x 426 x<br>496, 20 kg    |
|        | N5232B   | 300 kHz to 20 GHz<br>(N5232B Option 4xx)   | 123/96                    | NA  | -123/-106                         | +10/0   | 0.0015/0.013  | 3 ms<br>(500 kHz IFBW)                                      | 222 x 426 x<br>486, 20-22 kg |
| ENA    | E5080A   | 9 kHz to 4.5 GHz (Option 245/445)<br>9 kHz to 6.5 GHz (Option 265/465)<br>9 kHz to 9 GHz (Option 295/495)  | 135/<br>123/<br>123/      | 151/<br>NA  | -130/<br>-117/<br>-123/           | +15/<br>+16/<br>+10/  | 0.0015/0.01   | 2 ms<br>(500 kHz IFBW)                                      | 267 x 426 x 488,<br>21-23 kg |
|        | E5072A   | 30 kHz to 4.5 GHz (Option 245)<br>30 kHz to 8.5 GHz (Option 285)   | 123/<br>123/96            | 151/<br>NA  | -117/<br>-123/-106                | +16/<br>+10/0   | 0.0015/0.013  | 3 ms<br>(500 kHz IFBW)                                      | 222 x 426 x<br>496, 20 kg    |
|        | E5071C   | 9 kHz to 4.5 GHz<br>(Option 240, 440)<br>100 kHz to 4.5 GHz<br>(Option 245, 445)<br>9 kHz to 6.5 GHz<br>(Option 260, 460)<br>100 kHz to 6.5 GHz<br>(Option 265, 465)<br>9 kHz to 8.5 GHz<br>(Option 280, 480)<br>100 kHz to 8.5 GHz<br>(Option 285, 485) | 123/<br>123/96            | NA  | -123/<br>-123/-106                | +10/<br>+10/0   | 0.0011/0.013  | 3 ms<br>(500 kHz IFBW)                                      | 222 x 426 x<br>487, 19-20 kg |
|        | E5061B   | 300 kHz to 14 GHz<br>(Option 2D5, 4D5)<br>300 kHz to 20 GHz<br>(Option 2K5, 4K5)   | 123/96                    | NA  | -123/-106                         | +10/0   | 0.0015/0.013  | 3 ms<br>(500 kHz IFBW)                                      | 222 x 426 x<br>486, 20-22 kg |
|        | E5061B   | 5 Hz to 3 GHz (LF-RF Option 3L5,<br>S-parameter, port)<br>100 kHz to 3 GHz<br>(RF Option 135, 235, 137, 237)<br>100 kHz to 1.5 GHz<br>(RF Option 115, 215, 117, 217)   | 120/<br>117/              | NA  | -120/<br>-127/                    | +10/<br>0/  | 0.0091/0.055  | 9 ms<br>(300 kHz IFBW)                                      | 215 x 426 x<br>296, 14 kg    |
| E5063A | 100 kHz to 4.5 GHz (Option 245)<br>100 kHz to 8.5 GHz (Option 285)<br>100 kHz to 18 GHz (Option 2H5) | 117/<br>117/   | NA                        | -127/<br>-127/  | 0/<br>0/                          | 0.0019/0.014  | 9 ms<br>(300 kHz IFBW)                                  | 215 x 426 x<br>296, 11 kg                                   |                              |

- Option 425
- Option 205

## Key Performances and Functions Comparison (continued)

| Models   |                            | Performances  |  |                           |  |  |  | Dimension                                      |                                  |
|----------|----------------------------|---|--|---------------------------|--|--|--|--|----------------------------------|
|          |                            | Frequency   | Dynamic range (dB)<br>at 3/20 GHz at<br>10 Hz IFBW |                           | Noise floor<br>(dBm) at<br>3/20 GHz at<br>10 Hz IFBW | Max power<br>at 3/20 GHz<br>(dBm)                      | Best trace noise<br>at 10 kHz <sup>1</sup> IFBW<br>Mag (dBrms)/<br>Phase (degms) |  |                                  |
|          |                            |   | System   | Direct receiver<br>access |  |  |  | H (mm) x<br>W (mm) x<br>D (mm),<br>weight (kg) |                                  |
| PXI VNA  | M9370A                     | 300 kHz to 4 GHz  | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 6 ms<br>(600 kHz IFBW)                         | 128.4 x 19.9 x<br>212.6, 0.59 kg |
|          | M9371A                     | 300 kHz to 6.5 GHz  | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 6 ms<br>(600 kHz IFBW)                         | 128.4 x 19.9 x<br>212.6, 0.59 kg |
|          | M9372A                     | 300 kHz to 9 GHz  | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 6 ms<br>(600 kHz IFBW)                         | 128.4 x 19.9 x<br>212.6, 0.59 kg |
|          | M9373A                     | 300 kHz to 14 GHz   | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 6 ms<br>(600 kHz IFBW)                         | 128.4 x 19.9 x<br>212.6, 0.59 kg |
|          | M9374A                     | 300 kHz to 20 GHz   | 115/ 110   | - / -                     | -108/-108  | +7/+2  | 0.003/0.030  | 6 ms<br>(600 kHz IFBW)                         | 128.4 x 19.9 x<br>212.6, 0.59 kg |
|          | M9375A                     | 300 kHz to 26.5 GHz   | 115/ 110   | - / -                     | -108/-108  | +7/+2  | 0.003/0.030  | 6 ms<br>(600 kHz IFBW)                         | 128.4 x 19.9 x<br>212.6, 0.59 kg |
|          | M9485A                     | 1 MHz to 9 GHz  | 140 (typical) / -                                  | 162 (typical)/-           | -125 / -   | +13 / -  | 0.003 / 0.02   | 2.8 ms<br>(1 MHz IFBW)                         | n/a                              |
| USB VNA  | P9370A                     | 300 kHz to 4.5 GHz  | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 14 ms<br>(600 kHz IFBW)                        | 48 x 176 x 333,<br>1.90 kg       |
|          | P9371A                     | 300 kHz to 6.5 GHz  | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 14 ms<br>(600 kHz IFBW)                        | 48 x 176 x 333,<br>1.90 kg       |
|          | P9372A                     | 300 kHz to 9 GHz  | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 14 ms<br>(600 kHz IFBW)                        | 48 x 176 x 333,<br>1.90 kg       |
|          | P9373A                     | 300 kHz to 14 GHz   | 115/-  | - / -                     | -108/-   | +7/-   | 0.003/0.030  | 14 ms<br>(600 kHz IFBW)                        | 48 x 176 x 333,<br>1.90 kg       |
|          | P9374A                     | 300 kHz to 20 GHz   | 115/-  | - / -                     | -108/-108  | +7/+2  | 0.003/0.030  | 14 ms<br>(600 kHz IFBW)                        | 48 x 176 x 333,<br>1.90 kg       |
|          | P9375A                     | 300 kHz to 26.5 GHz   | 115/-  | - / -                     | -108/-105  | +7/+2  | 0.003/0.030  | 14 ms<br>(600 kHz IFBW)                        | 48 x 176 x 333,<br>1.90 kg       |
| FieldFox | N9913A                     | 30 kHz to 4 GHz   | 95/74  | - / -                     | - / -  | -1/-10   | 0.004/0.070  | 300 ms<br>(10 kHz IFBW)                        | 292 x 188 x<br>72, 3 kg          |
|          | N9914A                     | 30 kHz to 6.5 GHz   | (300 Hz IFBW)                                      |                           |  |  | (300 Hz IFBW)  |  |                                  |
|          | N9915A                     | 30 kHz to 9 GHz   |  |                           |  |  |  |  |                                  |
|          | N9916A                     | 30 kHz to 14 GHz  |  |                           |  |  |  |  |                                  |
|          | N9917A                     | 30 kHz to 18 GHz  |  |                           |  |  |  |  |                                  |
|          | N9918A                     | 30 kHz to 26.5 GHz  |  |                           |  |  |  |  |                                  |
|          | N9950A<br>N9951A<br>N9952A | 300 kHz to 32 GHz<br>300 kHz to 44 GHz<br>300 kHz to 50 GHz | 100/102 (300<br>Hz IFBW)                           | - / -                     | - / -  | Port 1: +2,<br>port 2: 0/<br>Port 1: +1,<br>port 2: -2 | 0.004/0.070<br>(300 Hz IFBW)   | 180 ms<br>(10 kHz IFBW)                        | 292 x 188 x<br>72, 3.2 kg        |

1. Calculated to normalize 10 kHz IFBW equivalent noise

## Key Performances and Functions Comparison (continued)

| Models  |  | Features and functions                            |                        |                        |   |                            |                             |                    |                       |  |                                  | Unique function/<br>feature  |   |
|---------|--|---|------------------------|------------------------|---|----------------------------|-----------------------------|--------------------|-----------------------|--|----------------------------------|--|---|
|         |  | Sweep type  | 4-port test set option | Full N port cal option | Front jumpers for direct receiver access or high power handling | Built-in 2nd source option | Receiver attenuators option | Built-in bias tees | Frequency offset mode | Internal pulse modulator and generator | Built-in programming environment |  | Noise figure measurement option   |
| PNA-X   | N5241B<br>N5242B<br>N5244B<br>N5245B<br>N5247B<br>N5249B | Linear, Log, Segment, CW, Power, DC source, Phase | ●                      | ●                      | ●   | ●                          | ●                           | ● (Option)         | ●                     | ●                                      | ●                                | ● (Standard and low-noise receiver)  | Nonlinear vector network analyzer option<br>Built-in combiner<br>LFE (900 Hz - )<br>Enhanced time domain analysis<br>Up to 24-port external test set<br>mm-wave support<br>Spectrum analysis option |
| PNA     | N5221B<br>N5222B<br>N5224B<br>N5225B<br>N5227B           |   | ●                      | ●                      | ● (Option)  | ●                          | ●                           | ● (Option)         | ●                     | ●                                      | ●                                | ● (Standard receiver)  | Metrology option<br>LFE (900 Hz - )<br>Enhanced time domain analysis<br>Up to 24-port external test set<br>mm-wave support<br>Spectrum analysis option  |
| PNA-L   | N5234B<br>N5235B   | Linear, Log, Segment, CW, Power, DC source        | ●                      | ●                      | ● (Option)  |                            |                             |                    | ●                     |  |                                  |  | Up to 24 port external test set<br>Enhanced time domain analysis  |
|         | N5239B<br>N5231B<br>N5232B                               |   | ● <sup>1</sup>         | ●                      | ● (Option)  |                            |                             |                    | ●                     |  |                                  |  | Spectrum analysis option  |
| ENA     | E5080A   | Linear, Log, Segment, Power                       | ●                      |                        |   |                            |                             | ●                  | ●                     |  |                                  |  | Modern GUI<br>Up to 22 port external test set   |
|         | E5072A   |   |                        | ●                      |   |                            | ●                           | ●                  |                       | ●                                      |                                  | Deep extended dynamic range as 151 dB (SPD)  |   |
|         | E5071C   |   | ●                      |                        |   |                            |                             | ● (Option)         | ●                     |  | ●                                | Enhanced time domain analysis<br>Up to 22 port external test set                               |   |
|         | E5061B<br>LF-RF option                                   | Linear, Log, Segment, Power, DC bias              |                        |                        |   |                            |                             |                    |                       |  | ●                                | Gain-phase port (5 Hz to 30 MHz)<br>Impedance analysis (Option 005)<br>Built-in DC bias source |   |
|         | E5061B<br>RF option                                      | Linear, Log, Segment, Power                       |                        |                        |   |                            |                             |                    |                       |  | ●                                | 75 Ω test set option<br>T/R test set option  |   |
|         | E5063A   | Linear, Log, Segment                              |                        |                        |   |                            |                             |                    |                       |  |                                  |  | PCB manufacturing test  |
| PXI VNA | M9370A<br>M9371A<br>M9372A<br>M9373A<br>M9374A<br>M9375A | Linear, Log, Segment, CW, Power                   | ● <sup>2</sup>         | ●                      |   |                            |                             |                    |                       | ●                                      |                                  | ● <sup>3</sup>   | Multiport up to 32 ports, multi-site, modular   |
|         | M9485A   |   | ●                      | ●                      | ● (Option)  | ● (M9377A)                 | ● (Option)                  | ● (Option)         | ●                     | ●                                      | ● <sup>3</sup>                   | ● (Standard receiver)  | Multiport up to 24 ports, modular   |
| USB VNA | P9370A<br>P9371A<br>P9372A<br>P9373A<br>P9374A<br>P9375A | Linear, Log, Segment, CW, Power                   | ● <sup>2</sup>         |                        |   |                            |                             |                    | ●                     |  |                                  | ● <sup>3</sup>   |   |

1. N5231B and N5232B only.
2. Add additional modules to increase number of ports.
3. Programming capability is available in the controller.

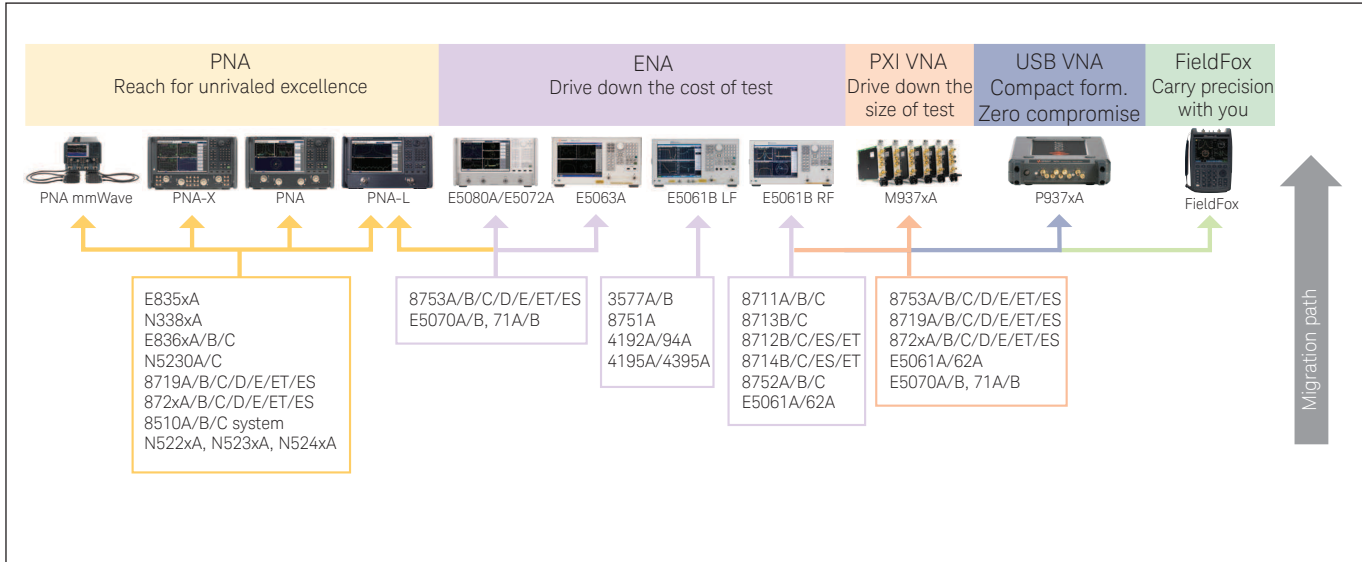
## Key Performances and Functions Comparison (continued)

| Models   | Features and functions |                        |                        |   |                            |                             |                    |                       |  |                                  |                                 |  |
|--|------------------------|------------------------|------------------------|---|----------------------------|-----------------------------|--------------------|-----------------------|--|----------------------------------|---------------------------------|--|
|  | Sweep type             | 4-port test set option | Full N port cal option | Front jumpers for direct receiver access or high power handling | Built-in 2nd source option | Receiver attenuators option | Built-in bias tees | Frequency offset mode | Internal pulse modulator and generator | Built-in programming environment | Noise figure measurement option | Unique function/feature  |
| FieldFox<br>N9913A<br>N9914A<br>N9915A<br>N9916A<br>N9917A<br>N9918A<br>N9950A<br>N9951A<br>N9952A<br><br>Microwave (combination) analyzers <sup>1</sup> | Linear                 |                        |                        |   |                            |                             |                    |                       |  |                                  |                                 | Handheld<br>Spectrum analysis option<br>T/R test set (Option 210)<br>Full 2-port S-parameters (Option 211)<br>Mixed mode S-parameters (Option 212) |

1. Combination analyzer = Cable and antenna tester (CAT) + Vector network analyzer (VNA) + Spectrum analyzer (SA)

# Migration and Upgrades

Carefully planned instrument migration and modernization can maximize your test-system efficiency, performance, and readiness, while minimizing risk and potential disruptions, keeping you at the leading edge in the competitive marketplace. Keysight PNA, ENA, PXI VNA, USB VNA, and FieldFox are perfect replacements to their predecessors. Take advantage of the latest VNAs' advanced performance and modern functions when replacing the legacy network analyzers.



## Premium trade-in solutions

In many countries, Keysight offers a variety of trade-in solutions to give you advanced measurement capabilities, increased throughput and greater reliability—for less than list price. Please contact an Keysight sales representative or visit [www.keysight.com/find/savings](http://www.keysight.com/find/savings).

- Trade-in your legacy network analyzer
- Receive credit toward the purchase of a new VNA

## Protect your VNA investment

Keysight offers various VNA hardware and software upgrades to meet your future measurement needs. Keysight's cXL code-translation software can also help you run your legacy 8753, 8720, and 8510 remote programs while controlling the latest VNAs. Contact Keysight or visit [www.keysight.com/find/nadisco](http://www.keysight.com/find/nadisco) for more information.

## Related Literature

| Literature   | Number      |
|--|-------------|
| <i>Keysight PNA and PNA-L Series Microwave Network Analyzers – Brochure</i>                        | 5990-8290EN |
| <i>Keysight PNA-X Series Microwave Network Analyzers – Brochure</i>                                | 5990-4592EN |
| <i>PNA Family Microwave Network Analyzers – Configuration Guide</i>                                | 5992-1465EN |
| <i>E5080A ENA Vector Network Analyzer – Brochure</i>   | 5992-0290EN |
| <i>E5072A ENA Vector Network Analyzer – Technical Overview</i>                                     | 5990-8004EN |
| <i>E5071C ENA Vector Network Analyzer – Brochure</i>   | 5989-5478EN |
| <i>S93011A Enhanced Time Domain Analysis with TDR - Technical Overview</i>                         | 5992-2715EN |
| <i>E5061B ENA Vector Network Analyzer – Brochure</i>   | 5990-6794EN |
| <i>E5071C ENA Option TDR Enhanced Time Domain Analysis – Technical Overview</i>                    | 5990-5237EN |
| <i>E5061B-3L5 LF-RF Network Analyzer with Option 005 Impedance Analysis Function – Data Sheet</i>  | 5990-7033EN |
| <i>E5063A ENA Vector Network Analyzer – Brochure</i>   | 5991-3614EN |
| <i>M937xA PXIe Vector Network Analyzer – Data Sheet</i>  | M9370-90002 |
| <i>M937xA PXIe Vector Network Analyzer – Startup Guide</i>   | M9370-90001 |
| <i>M937xA PXIe Vector Network Analyzer – Configuration Guide</i>                                   | 5991-4885EN |
| <i>M937xA PXIe Vector Network Analyzer – Brochure</i>  | 5992-0098EN |
| <i>M937xA PXIe Vector Network Analyzer – Flyer</i>   | 5991-4883EN |
| <i>M9485A PXIe Multiport Vector Network Analyzer - Configuration Guide</i>                         | 5992-0758EN |
| <i>P937xA USB Vector Network Analyzer - Data Sheet</i>   | 5992-2765EN |
| <i>P937xA USB Vector Network Analyzer - Configuration Guide</i>                                    | 5992-2663EN |
| <i>FieldFox Handheld Analyzers – Technical Overview</i>  | 5992-0772EN |
| <i>FieldFox Handheld Analyzers – Data Sheet</i>  | 5990-9783EN |
| <i>FieldFox Handheld Analyzers – Configuration Guide</i>   | 5990-9836EN |
| <i>Physical Layer Test System (PLTS) – Technical Overview</i>                                      | 5989-6841EN |
| <i>Millimeter Wave Network Analyzer (N5290A/N5291A) – Configuration Guide</i>                      | 5992-2179EN |
| <i>Banded Millimeter Wave Network Analysis to 1.5 THz – Technical Overview</i>                     | 5992-2177EN |
| <i>Measuring Dielectric Properties Using Keysight's Materials Measurement Solutions – Brochure</i> | 5991-2171EN |
| <i>Keysight 855xxA Series Calibration Refresh Modules – Product Fact Sheet</i>                     | 5991-2450EN |



## Web Resources

|  |  |
|--|--|
| Keysight Network Analyzer Family                 | <a href="http://www.keysight.com/find/na">www.keysight.com/find/na</a>               |
| PNA Series Network Analyzers                     | <a href="http://www.keysight.com/find/pna">www.keysight.com/find/pna</a>             |
| ENA Series Network Analyzers                     | <a href="http://www.keysight.com/find/ena">www.keysight.com/find/ena</a>             |
| PXI Vector Network Analyzers                     | <a href="http://www.keysight.com/find/pxivna">www.keysight.com/find/pxivna</a>       |
| Keysight Streamline Series USB Network Analyzers | <a href="http://www.keysight.com/find/usb-vna">www.keysight.com/find/usb-vna</a>     |
| FieldFox Handheld RF and Microwave Analyzers     | <a href="http://www.keysight.com/find/fieldfox">www.keysight.com/find/fieldfox</a>   |
| Millimeter-Wave Controllers                      | <a href="http://www.keysight.com/find/mmwave">www.keysight.com/find/mmwave</a>       |
| Material Test Equipment                          | <a href="http://www.keysight.com/find/materials">www.keysight.com/find/materials</a> |
| Physical Layer Test System (PLTS) software       | <a href="http://www.keysight.com/find/plts">www.keysight.com/find/plts</a>           |
| RF & Microwave Test Accessories                  | <a href="http://www.keysight.com/find/mta">www.keysight.com/find/mta</a>             |
| Antenna Measurements                             | <a href="http://www.keysight.com/find/antenna">www.keysight.com/find/antenna</a>     |
| Multiport/Multi-site Solutions                   | <a href="http://www.keysight.com/find/multiport">www.keysight.com/find/multiport</a> |
| CalPod Calibration Refresh Module                | <a href="http://www.keysight.com/find/calpods">www.keysight.com/find/calpods</a>     |
| Mechanical and Electronic Calibration Kits       | <a href="http://www.keysight.com/find/ecal">www.keysight.com/find/ecal</a>           |
| PNA-X Nonlinear Vector Network Analyzer          | <a href="http://www.keysight.com/find/nvna">www.keysight.com/find/nvna</a>           |

Learn more at: [www.keysight.com](http://www.keysight.com)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

Find us at [www.keysight.com](http://www.keysight.com)

This information is subject to change without notice. © Keysight Technologies, 2014-2018, Published in USA, August 2, 2018, 5989-7603EN



**KEYSIGHT**  
TECHNOLOGIES

**НАУЧНОЕ  
ОБОРУДОВАНИЕ**  
ГРУППА КОМПАНИЙ