170 GHz / 220 GHz Broadband Vector Network Analysis Solution

For on-wafer millimeter-wave component characterization

- 900 Hz / 10 MHz to 170 GHz / 220 GHz
- +5 dBm output power at 220 GHz at Probe Tip
- 90 dB dynamic range at 220 GHz at Probe Tip

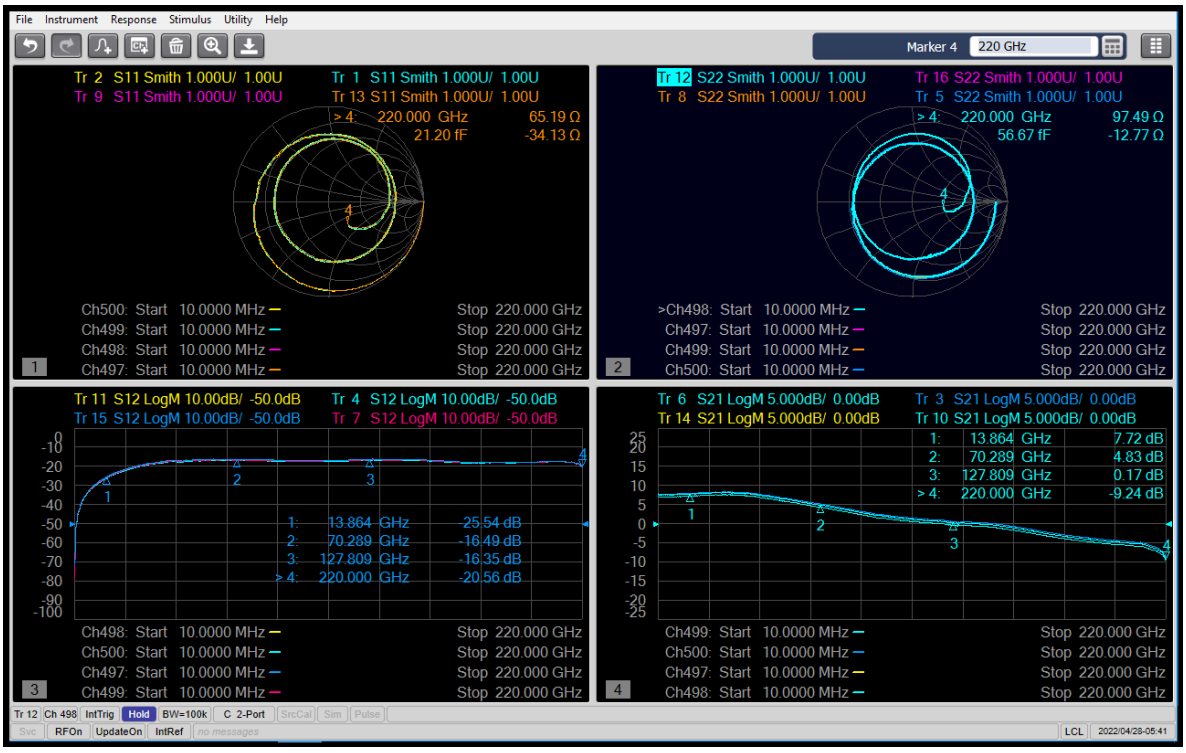
KEYSIGHT

New 170 GHz / 220 GHz Broadband Vector Network Analysis

Enabling Insights into Broadband device performance

Keysight together with world-leading millimeter-wave solution partners offer a single-sweep VNA on-wafer solution operating from 900 Hz / 10 MHz – 170 / 220 GHz. This innovative solution has the best dynamic range, highest output power, and greatest stability over time in the industry. Designers can use these advantages to efficiently characterize on-wafer devices and circuits, enabling the creation of highly accurate PDK models that will shorten the design and verification cycle and allow faster deployment of devices for the emerging 5G and 6G MMICs. The solution comprises Keysight's N5291A industry-leading 125 GHz broadband VNA together with VDI's specially designed sub-THz frequency extenders and FormFactor T-Wave GSG Dual band probes with 50-to-100-um-pitch 1. This fully integrated solution using FormFactor's WinCal calibration software and standards enables accurate calibration to achieve the best measurement performance in the market. All of this has been carefully integrated onto FormFactor's industry leading Probing Systems insure ease of use.

Since it's based on the N5291A and uses VDI's sub-THz modules, it makes very simple to upgrade to this broadband VNA configuration.



S-parameter measurement of an amplifier biased through N5295AX03 frequency extender bias tees.
(2x15 µm CS pHEMT at Vg = -0.2 V and Vd = 3.5 V)

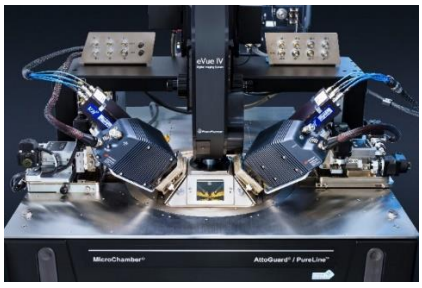
1. The FormFactor T-Wave probe is designed and Manufactured by DMPI.

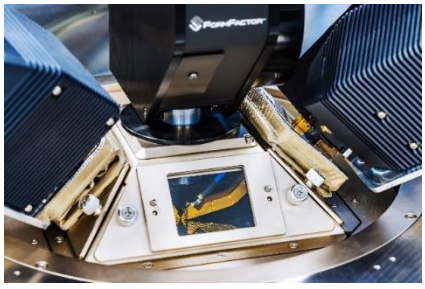
Solution architecture

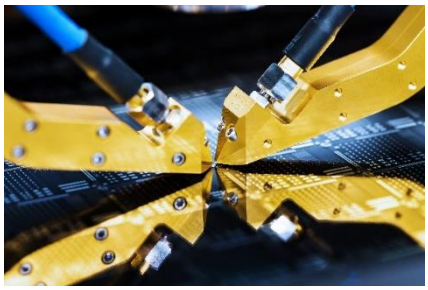
As mentioned above, the solution leverages Keysight N5291A broadband VNA, and it includes Keysight's N52xxB PNA network analyzer, N5292A 4-port test set controller and N5295AX frequency extenders. In addition, it uses VDI's 110 GHz to 170 GHz or 130 GHz to 220 GHz frequency extender module. The on-wafer device characterization is realized by the FormFactor T-Wave Dual Band Probe with its replaceable integrated probe chip technology.

170 GHz/220 GHz VNA solution

FormFactor T-Wave Dual band probe with integrated diplexer







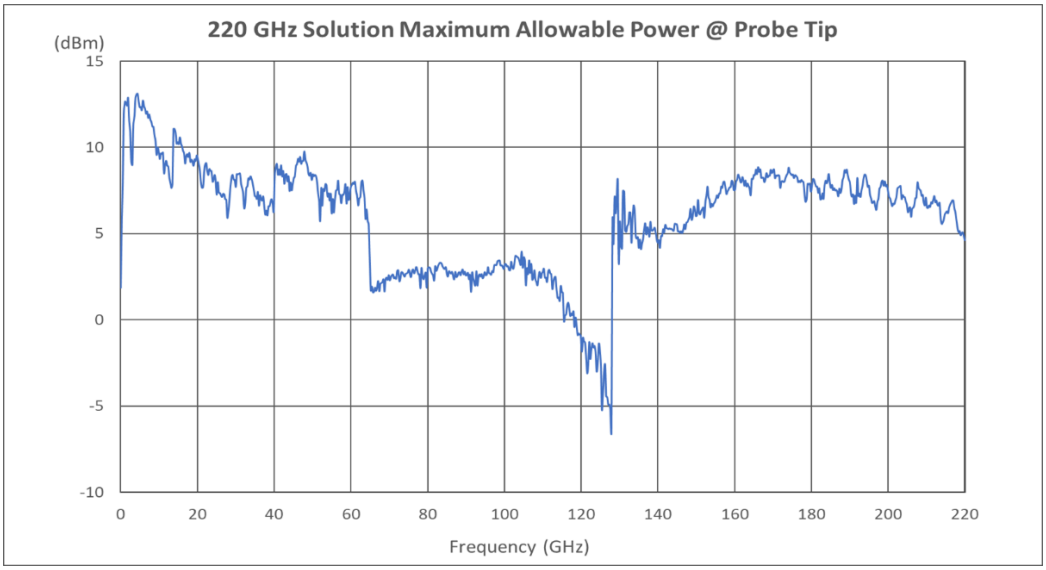
DMPI T-Wave Dual Probe, offered by Form Factor Inc.

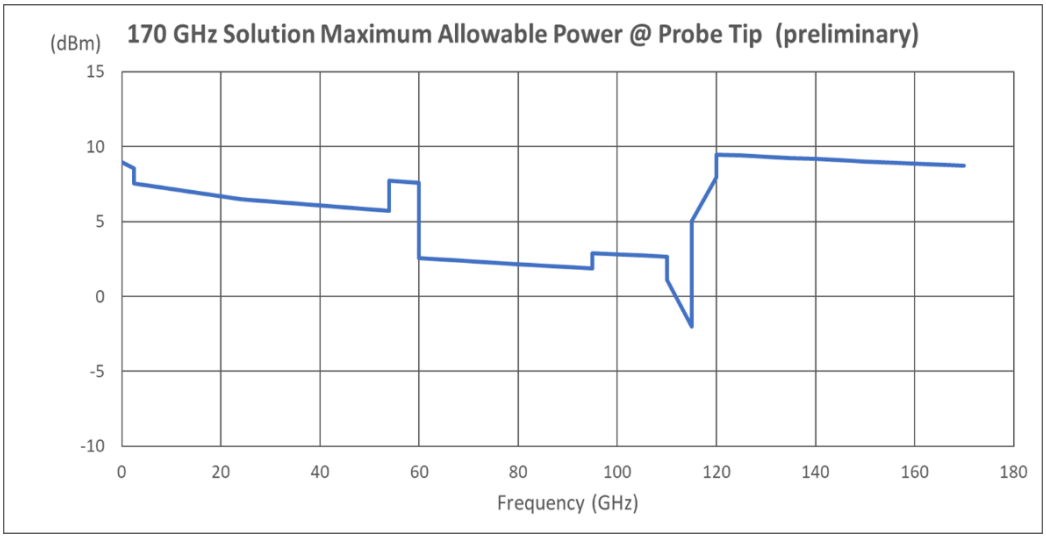
Excellent Measurement performance

This 170 GHz / 220 GHz broadband VNA solutions provide great dynamic range and maximum allowable output power, broadband leveled power flatness. (The performance data for the 220 GHz configuration is Supplemental Performance Data (SPD). The performance data for the 170 GHz VNA configuration is estimated preliminary data.)

Highest output power

This solution achieves the maximum allowable output power of +5 dBm at the probe tip at 220 GHz and help you to evaluate your DUT like an amplifier at a high-power input.



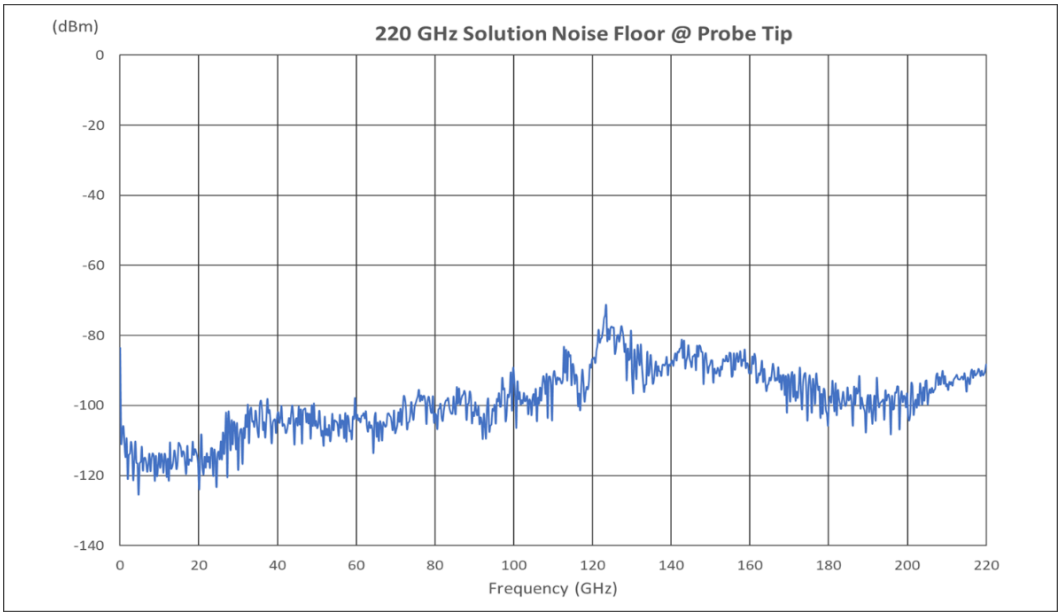


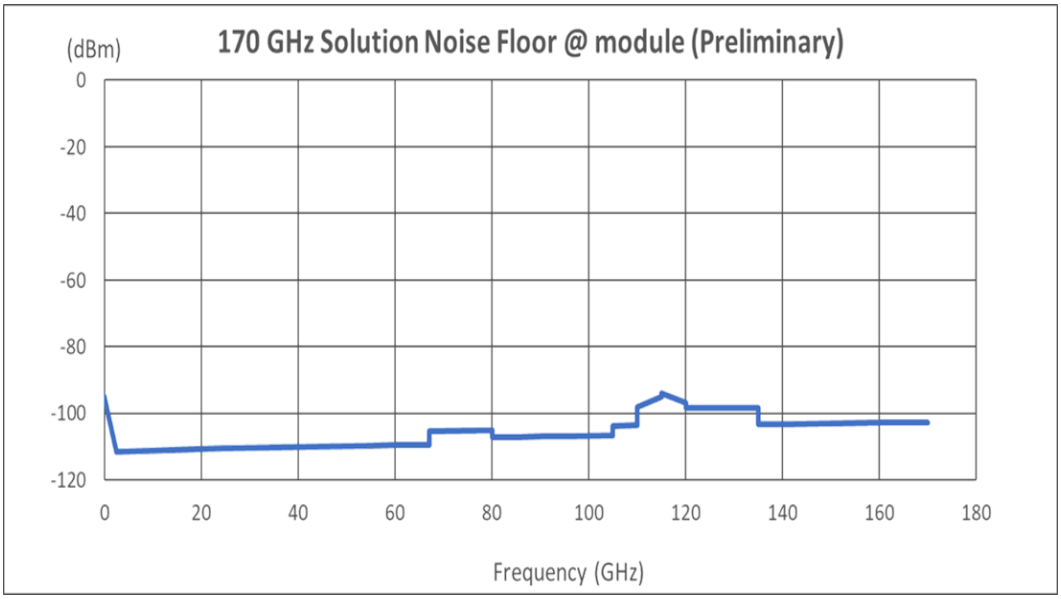
Broadband leveled power (10 MHz to 220 GHz)

- Maximum leveled power: - 6 dBm
- Leveled power flatness: ± 0.25 dB

Noise floor

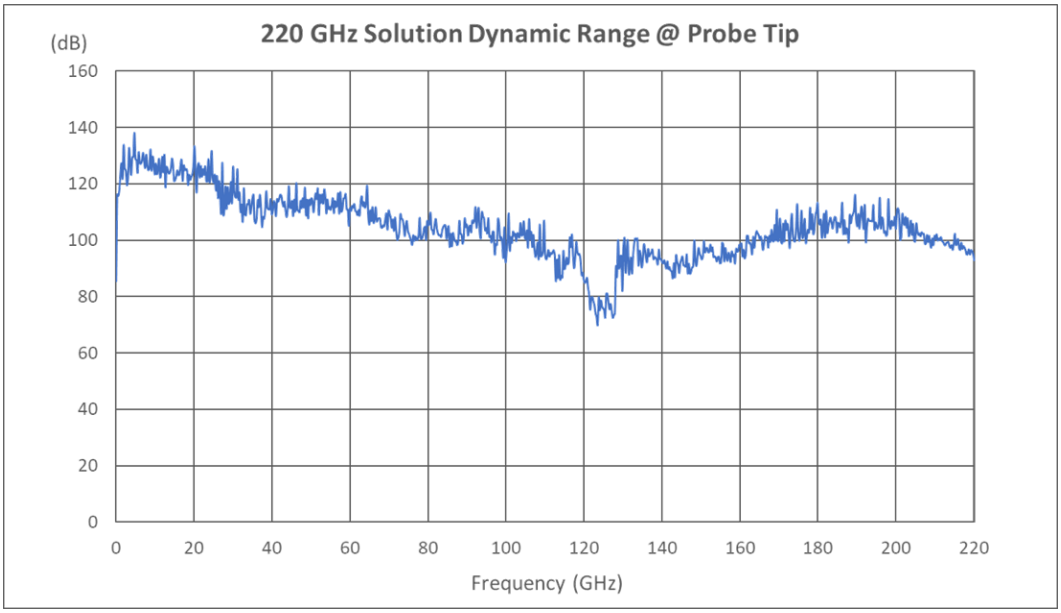
The noise floor of the 170 GHz / 220 GHz broadband VNA solutions is given here.

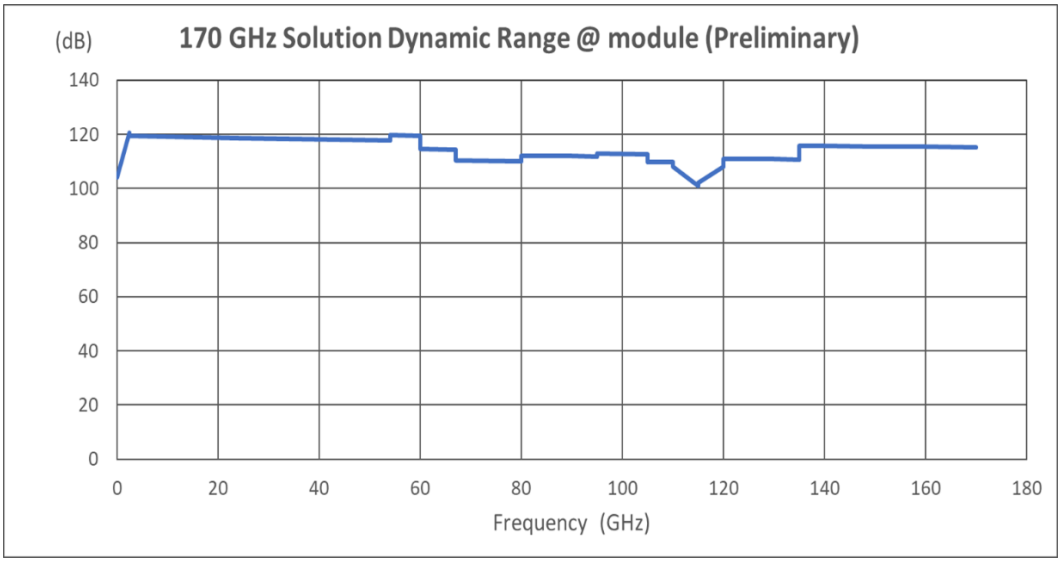




Excellent dynamic range

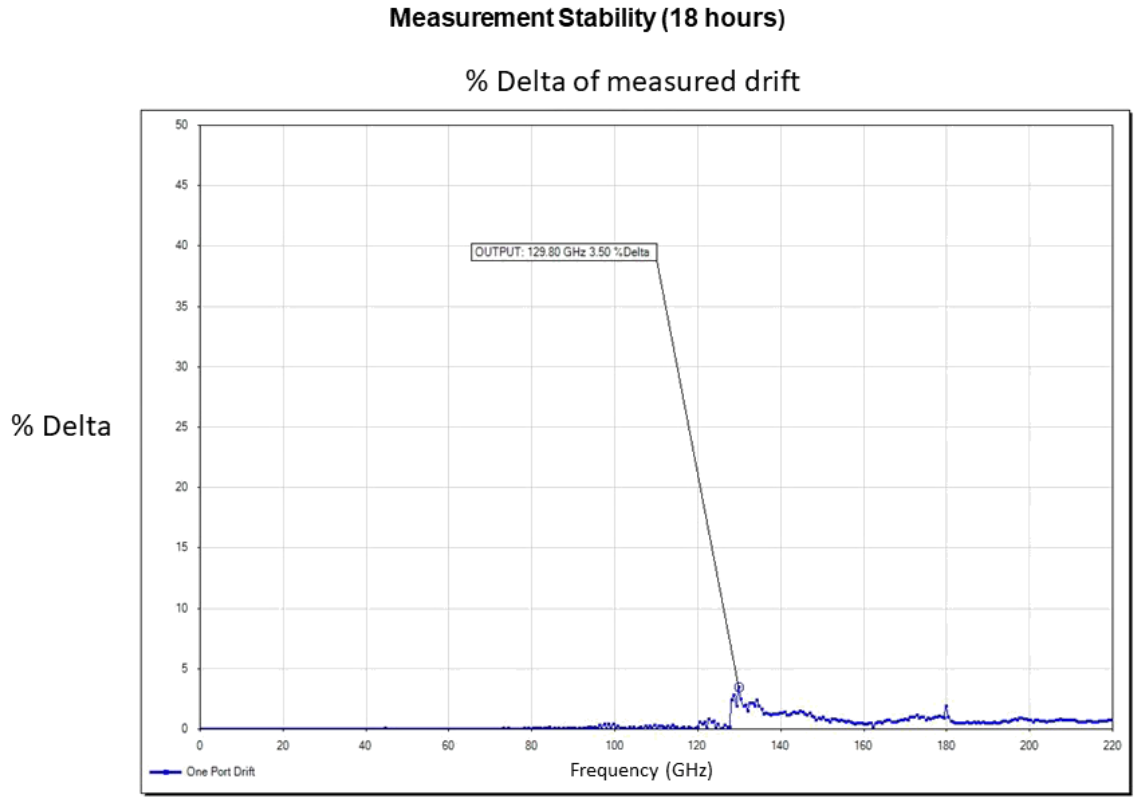
The 170 and 220 GHz broadband VNA solutions have excellent dynamic range (calculated from the maximum allowable power and the noise floor.)





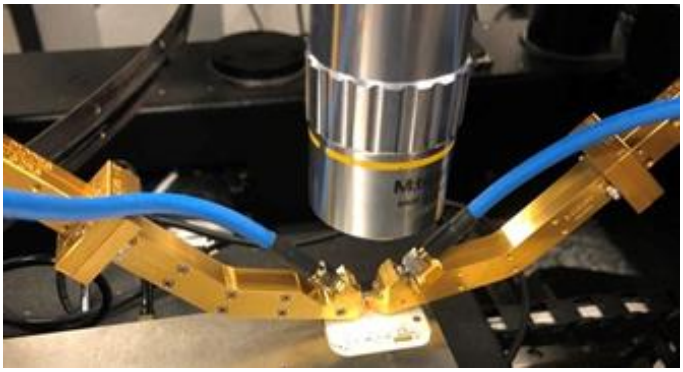
Stability over time

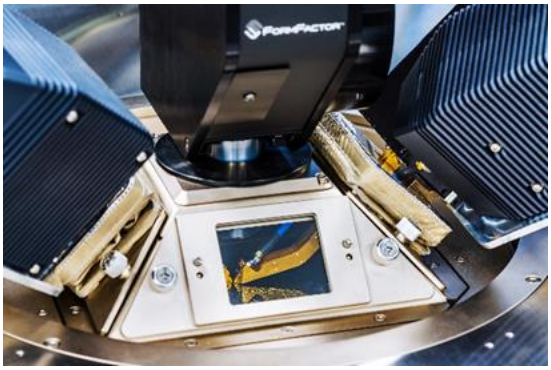
This graph provides relative 1-port measurement stability of the 220 GHz broadband VNA configuration over 18 hours.



FormFactor T-Wave probe and system

- A New highly initiative FormFactor T-Wave™ Dual Band probe with fully integrated diplexer provides a true single sweep broadband up to 220 GHz in a single probe when combined with the Keysight N5291A and VDI frequency extender head. (FormFactor T-Wave probes Designed and Manufacture by DMPI Inc.)
- No tedious swapping between coaxial and WG setups
- Achieves excellent return loss / insertion loss performance, designed for high stability and match performance
- Supports probe GSG probe pitches of 50, 75 and 100 µm
- Probe tip material options for either Ni or NbTi
- Compatible with our latest System hardware and software, including Autonomous RF capable of fully unattended over temperature automated measurement. Compatible with System equipped with either Top Hat or Ice Shield setups.
- Compatible with manual FormFactor RPP404 and programmable RPP504 positioners
- Easy access to connect to the N5291A 110 GHz 1 mm connector interface, as well as to the WG port on the VDI mini 170 / 220 GHz extenders





New FormFactor T-Wave™ Combiner Probe

170 GHz / 220 GHz Broadband VNA Configurations

The items on this list are required for configuring the 170 GHz or 220 GHz broadband VNA.

	170 GHz	220 GHz
	Qty	Qty
N522x/4xB 4-port PNA/PNA-X network analyzer	1	1
N5292A 4-port test set controller	1	1
N5295AXxx 120 GHz frequency extender	2	2
11500I 1.0 mm cable, 8.8 cm	1	1
U8489A power sensor (optional)	1	1
N5290A304 adapter cables	2	2
N5262BW06 VDI frequency extender, 110-170 GHz	2	
N5262BW05 with option EB0 or EB1 VDI frequency extender, 130-220 GHz • EB0: no adjustable attenuator • EB1: with adjustable 0-30 dB attenuator		2
N5262AC06 VDI waveguide calibration kit (optional)	1	
N5262AC05 VDI waveguide calibration kit (optional)		1
S93300B Software license - Broadband, 170 GHz	1	
S93301B Software license - Broadband, 220 GHz		1

Supported PNA and PNA-X configurations [1]

- N5222B-4xx and 020 26.5 GHz 4-port PNA with configurable test set option
- N5224B-4xx and 020 43.5 GHz 4-port PNA with configurable test set option
- N5225B-4xx and 020 50 GHz 4-port PNA with configurable test set option
- N5227B-4xx and 020 70 GHz 4-port PNA with configurable test set option
- N5242B-4xx and 020 26.5 GHz 4-port PNA-X with configurable test set option
- N5244B-4xx and 020 43.5 GHz 4-port PNA-X with configurable test set option
- N5245B-4xx and 020 50 GHz 4-port PNA-X with configurable test set option
- N5247B-4xx and 020 70 GHz 4-port PNA-X with configurable test set option

Available application software

- S93010B Time domain analysis
- S93080B Frequency offset measurements

For details or to add other PNA or PNA-X options to the above listed minimum configuration please refer to the “PNA Family Microwave Network Analyzers (N522x/3x/4xB) - Configuration Guide”, literature number 5992-1465EN.

[1] N522xB with option either 400 or 410 is not supported due to no configurable test set.

N5292A Millimeter-wave 4-port test set controller

- When PNA/PNA-X are 4-port N5222B or N5242B
  - Options 400 and 442 Interconnect kit for 4-port test set and 4-port VNA with 3.5 mm ports
- When PNA/PNA-X are 4-port N5224/5/7B or N5244/5/7B
  - Options 400 and 444 Interconnect kit for 4-port test set and 4-port VNA with 2.4 mm or 1.85 mm ports

Supported frequency extenders

- N5295AX01 Frequency extender, 120 GHz, 1.2 m cable, no bias tee
- N5295AX02 Frequency extender, 120 GHz, 1.2 m cable, pulsed bias tee
- N5295AX03 Frequency extender, 120 GHz, 1.2 m cable, LFE with bias tee

U8489A power sensor

N5290A304 adapter cable

Probe accessories

For Probe or Probe Station accessories, please visit https://www.formfactor.com or contact your Local FormFactor sales office.

Upgradeability

If you have a 4-port N52xxB PNA and an N5292A with option 4xx test set controller, you can configure the 170 / 220 GHz VNA solution by adding the VDI frequency extenders and some accessories from FormFactor. Contact Keysight or FormFactor for more information.

Summary

The 170 / 220 GHz single-sweep VNA on-wafer solution with the best dynamic range, highest output power, and greatest stability over time in the industry enables faster deployment of millimeter-wave components for the emerging 5G and 6G applications.

Related Literature

Literature	Publication number
PNA Family Microwave Network Analyzers (N522x/3x/4xB) – Configuration Guide	5992-1465EN
PNA/PNA-X Series Microwave Network Analyzers – Brochure	5990-4592EN
Millimeter Wave Network Analyzers (N5290A/N5291A) – Configuration Guide	5992-2179EN
Banded Millimeter Wave Network Analysis to 1.5 THz – Technical Overview	5992-2177EN
Keysight 2-Port and 4-Port PNA Network Analyzer: N5221B – 900 Hz to 13.5 GHz, N5222B – 900 Hz to 26.5 GHz – Data Sheet	N5221-90003
Keysight 2-Port and 4-Port PNA Network Analyzer: N5224B – 900 Hz to 43.5 GHz, N5225B – 900 Hz to 50 GHz – Data Sheet	N5224-90003
Keysight 2-Port and 4-Port PNA Network Analyzer: N5227B – 900 Hz to 67 GHz – Data Sheet	N5227-90005
Keysight 2-Port and 4-Port PNA-X Network Analyzer: N5249B – 900 Hz to 8.5 GHz, N5241B – 900 Hz to 13.5 GHz, N5242B – 900 Hz to 26.5 GHz – Data Sheet	N5242-90027
Keysight 2-Port and 4-Port PNA-X Network Analyzer: N5244B – 900 Hz to 43.5 GHz, N5245B – 900 Hz to 50.0 GHz – Data Sheet	N5245-90028
Keysight 2-Port and 4-Port PNA-X Network Analyzer: N5247B – 900 Hz to 67 GHz – Data Sheet	N5247-90029