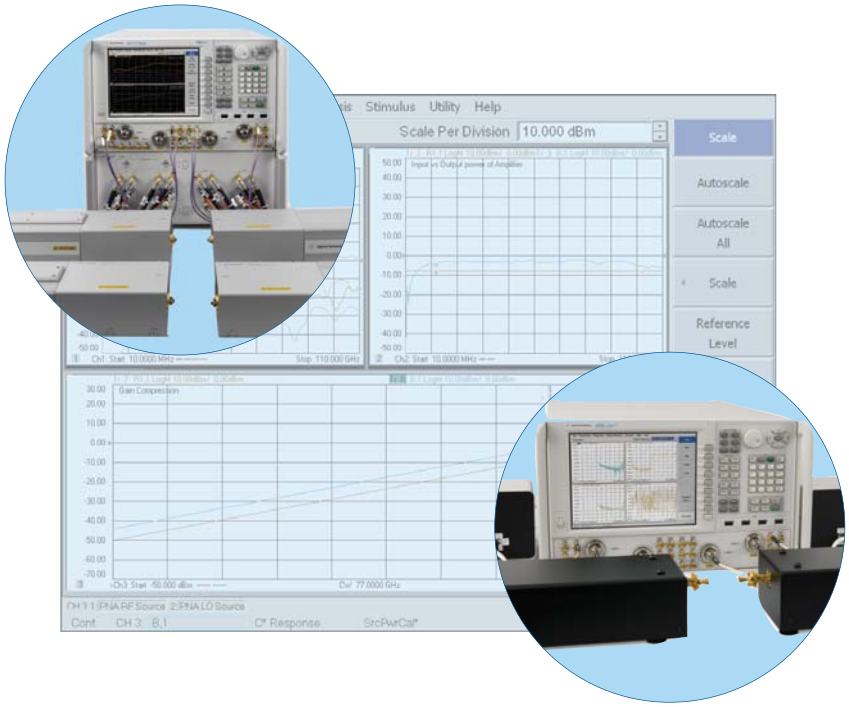
Agilent
Millimeter-Wave Network Analyzers 10 MHz to 110 GHz, with Extensions to 1.1 THz

Technical Overview



High Performance Bench-Top Millimeter-wave Network Analyzers

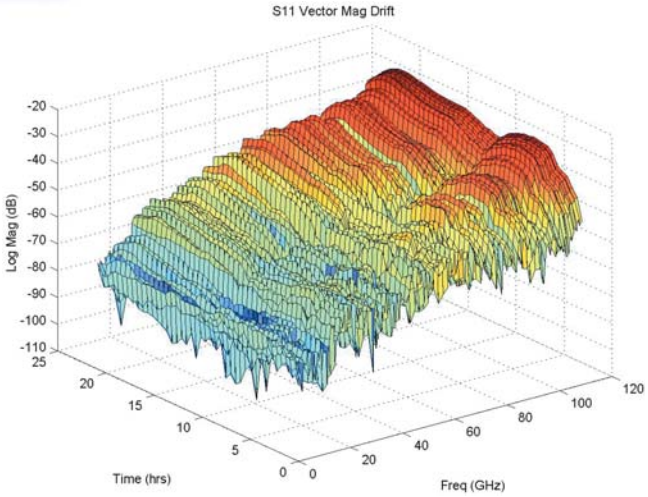
- Widest frequency coverage in the industry; with single sweep from 10 MHz to 110 GHz and banded waveguide measurements to 1.1 THz
- Minimize space and maintenance costs with compact frequency extender designs and eliminate the need for an additional source for 4-port configurations
- Industry leading application suite at millimeter-wave frequencies; scalar mixer, pulse, true differential, and leveled power control features
- Highest accuracy measurements through patented calibration techniques for both banded waveguide and single sweep 110 GHz measurements
- Excellent source performance ensures the best measurement dynamic range without external sources

Agilent Technologies

Single Sweep 10 MHz to 110 GHz Measurement Solutions

Currently there are two solutions that offer 10 MHz to 110 GHz measurement capability; one is the existing N5250C based on Agilent's E8361C PNA and the other is based on Agilent's latest N5247A PNA-X configuration. The N5247A solution is currently available as a configured set of components, while the E8361C solution is available as a system N5250C or can be configured with separate components. Both solutions use a millimeter-wave test controller and use a combination of frequency converters with combiners that provide a male 1.0 mm test port connector.

These two solutions are the only bench-top broadband systems with integrated tri-axial bias tees that provide accurate control of device bias through its force/sense ability. These solutions are ideal for device characterization, modeling and parameter extraction in coaxial or on-wafer due to accurate biasing leads to precise characterization, and broad frequency coverage down to 10 MHz offers superb time domain resolution. With the introduction of the PNA-X based solution accurate leveled power can now be applied to the device being measured including the ability to sweep the power at the 1.0 mm port.



N5250C Single Sweep Solution (10 MHz to 110 GHz)

This solution is based on the E8361C PNA with a N5260A millimeter-wave controller and set of Agilent millimeter-wave modules that include a frequency combiner with a bias tees as well as attenuator options.

Key features

- Frequency Range: 10MHz to 110 GHz
- Dynamic Range > 110 dB, without the need for external RF and LO sources
- Built in Kelvin bias tee on combiners which brings the bias signal close to the device being measured
- Industry leading stability less the 1% drift over a 24 hour period
- Mechanical attenuation of 25 to 30 dB available for above 67 GHz on either port 1 or 2 for high-power device measurements
- Removing the combiners converts the system to extend W-Band waveguide system for measurements from 67 GHz to 110 GHz
- Modules fully compatible with Cascade® probe stations and Agilent accessories to easily connect to probes
- Utilizes Agilent's patented weight least squares calibration method in 1.0 mm for industry leading accuracy

Performance

The N5250C offers unsurpassed performance for broadband, mm-wave measurements. Figure 1 demonstrates the superb dynamic range of the N5250C system compared to Agilent's previous 8510XF system when measuring a connectorized bandpass filter at 94 GHz.

The N5250C also offers superb speed with measurements up to 42 times faster than the 8510XF. All of this performance comes in a compact package that requires no external synthesizers. The port 1 millimeter-wave test head has a 25 dB attenuator to control power using a continuously adjustable micrometer.

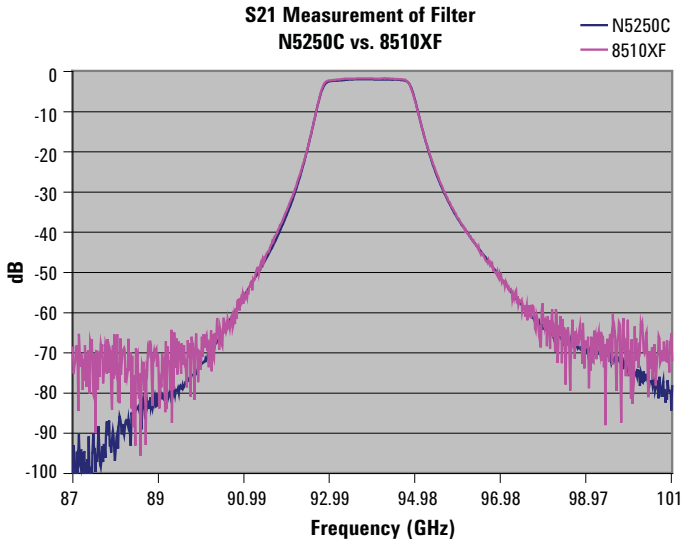


Figure 1. S_{21} filter measurement comparisons with Agilent's N5250C and 8510XF systems.

The N5250C offers excellent performance for on-wafer measurements as well. Options 017 and 018 add 67 GHz bias-tees to the combiner assembly, between the input to the combiner and the 67 GHz coupler. The bias-tees have tri-axial connectors force, sense, and ground. Positioning the bias-tees close to the DUT greatly improves stability for on-wafer and in-fixture devices.

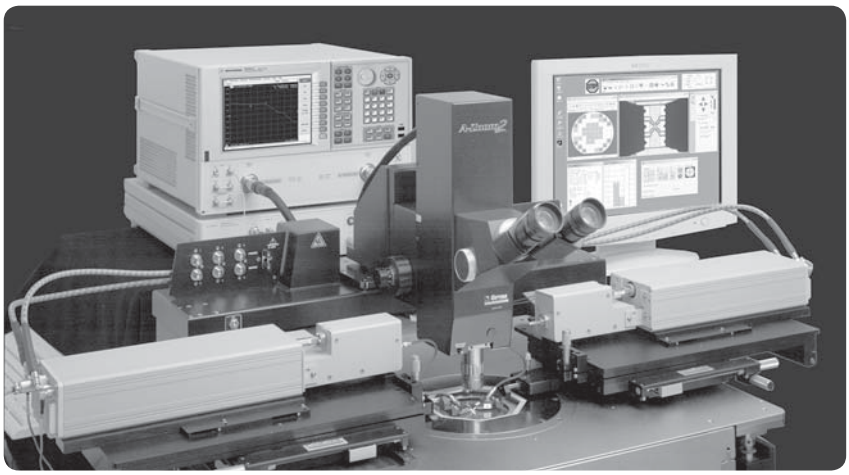


Figure 2. 110 GHz millimeter-wave system with Cascade Microtech's probe station.

Figure 3 shows an S_{21} measurement of a 40 ps transmission line made on a Cascade Microtech[1] Summit probe station with Infinity probes. The N5250C is fully compatible with the Wavevue Measurement Studio Software from Cascade.

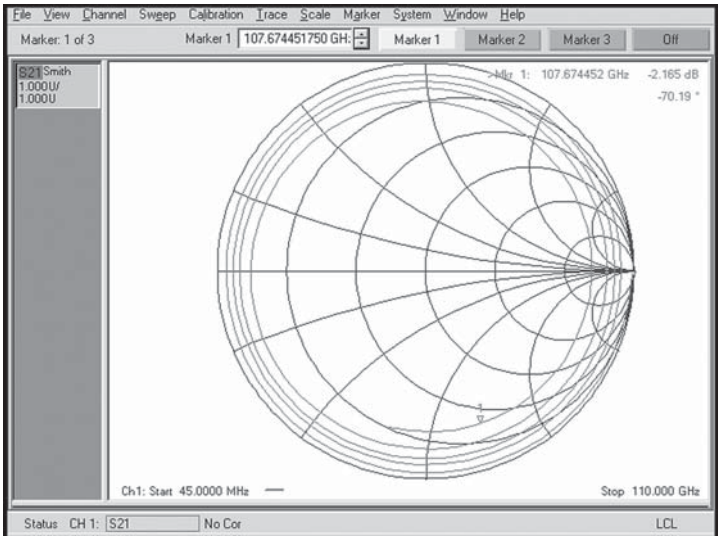


Figure 3. S_{21} measurement of a 40 ps transmission line made on a Cascade Microtech Summit probe station with Infinity probes.

Flexibility

The N5250C builds on the flexibility and performance of Agilent's PNA series of network analyzers. Purchase the full N5250C system, and have the flexibility of both a 10 MHz to 67 GHz PNA and mm-wave heads covering 67 GHz to 110 GHz, which combine to create a broadband, high performance 110 GHz system.

Alternatively, purchase an E8361C PNA with Option H11 (covering 10 MHz to 67 GHz) now, and you can easily upgrade in the future to the 110 GHz system by simply adding the N5260A mm-wave controller with test heads.

Ease-of-use

The N5250C uses the standard PNA firmware, allowing you to: leverage software between PNA Series network analyzers, regardless of the frequency range of your measurement; manually control the instrument, using either the front panel or a mouse to access the simple pull-down menus; and utilize the Cal Wizard, which will guide you step-by-step through the most complicated of calibrations.

Also, an extensive, context-sensitive Help system thoroughly explains all of the PNA's features. In any dialogue box, simply click **Help** to see a detailed explanation of the feature you are using. Programming examples in both SCPI and COM are also included.

1. *Cascade Microtech is an Agilent channel partner.* ***www.cascademicrotech.com***

Connectivity

Windows® built-in operating system and familiar user interface provides both ease-of-use and connectivity.

- Capture images quickly, easily and in .jpg, .bmp, and .png formats for easy data analysis, archiving, and printing.
- Control the analyzer using SCPI commands or gain the speed and connectivity advantage of COM/DCOM.
- Develop code in programming environments such as Visual Basic, Visual Basic.NET, Visual C++, Visual C++.NET, Agilent-VEE, or LabView.
- Execute code directly from the analyzer or remotely with an external PC through LAN or GPIB, or multiple USB ports.
- Use multiple USB ports to control a variety of peripherals.

The N5250C PNA and the entire series of microwave PNA instruments are based on the Windows XP operating system, which makes operation and programming simple, and provides a powerful environment in which easy-to-use measurement functions and PC capabilities are seamlessly linked. In addition, the new millimeter-wave PNA has linkages to Agilent's Advanced Design System (ADS) and IC-CAP modeling software.

For parameter extraction and device modeling, the N5250C is compatible and fully supported by the Agilent IC-CAP modeling software, the platform of choice for high frequency device modeling. IC-CAP is an open platform that offers flexibility for RF engineers to modify and customize their own models and thus, enhancing model accuracy.

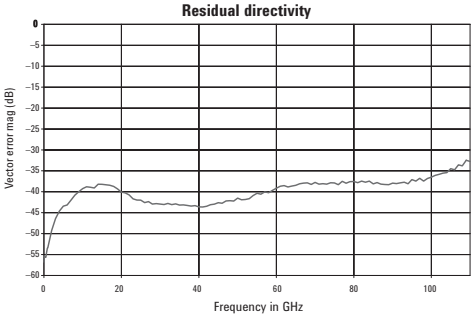
Typical performance[1]

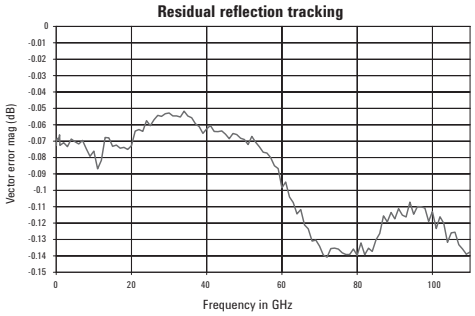
Test port power (dBm)	1.0 mm test port (standard configuration[2] or Option 017[3])	1.85 mm PNA port
10 to 45 MHz	–8	–7
45 to 500 MHz	–3	–1
500 MHz to 2 GHz	0	+2
2 to 10 GHz	–2	+2
10 to 24 GHz	–5	0
24 to 30 GHz	–7	0
30 to 40 GHz	–10	–1
40 to 45 GHz	–15	–5
45 to 50 GHz	–12	–1
50 to 60 GHz	–17	–4
60 to 67 GHz	–19	–8
67 to 70 GHz	–9	n/a
70 to 75 GHz	–7	n/a
75 to 80 GHz	–6	n/a
80 to 100 GHz	–5	n/a
100 to 110 GHz	–8	n/a

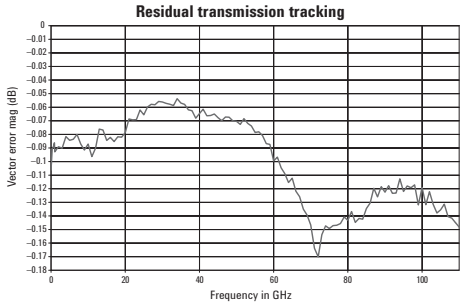
Noise floor[4] (dBm)	1.0 mm test port	1.85 mm PNA port
10 to 45 MHz	–71	–72
45 to 500 MHz	–97	–98
500 MHz to 2 GHz	–120	–121
2 to 10 GHz	–118	–121
10 to 24 GHz	–116	–121
24 to 30 GHz	–107	–112
30 to 40 GHz	–102	–108
40 to 45 GHz	–99	–106
45 to 50 GHz	–97	–104
50 to 60 GHz	–95	–104
60 to 67 GHz	–92	–103
67 to 70 GHz	–92	n/a
70 to 75 GHz	–96	n/a
75 to 80 GHz	–95	n/a
80 to 100 GHz	–94	n/a
100 to 110 GHz	–95	n/a

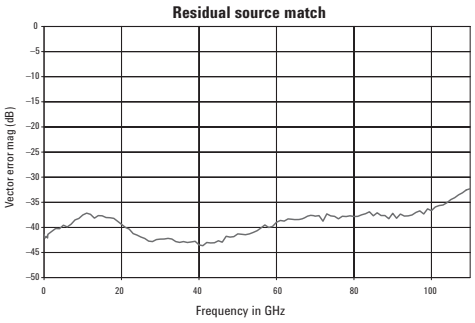
System dynamic range[4] (dB)	1.0 mm test port	1.85 mm PNA port
10 to 45 MHz	63	65
45 to 500 MHz	94	97
500 MHz to 2 GHz	120	123
2 to 10 GHz	116	123
10 to 24 GHz	111	121
24 to 30 GHz	100	112
30 to 40 GHz	92	107
40 to 45 GHz	84	101
45 to 50 GHz	85	103
50 to 60 GHz	78	100
60 to 67 GHz	75	95
67 to 70 GHz	83	n/a
70 to 75 GHz	89	n/a
75 to 80 GHz	89	n/a
80 to 100 GHz	89	n/a
100 to 110 GHz	87	n/a

1. *Typical performance is expected performance of an average unit which does not include guardbands. It is not covered by the product warranty.*
2. *Assumes a 30 inch cable from PNA 1.85 mm Test Port Out is used to provide the 10 MHz to 67 GHz source signal. The standard configuration does not have a bias tee in the 1.0 mm head.*
3. *Assumes a 30 inch cable from PNA Source Out bulkhead connector is used to provide the 10 MHz to 67 GHz source signal. Option 017 includes a bias tee in the 1.0 mm head.*
4. *Measured at test port in a 10 Hz bandwidth.*









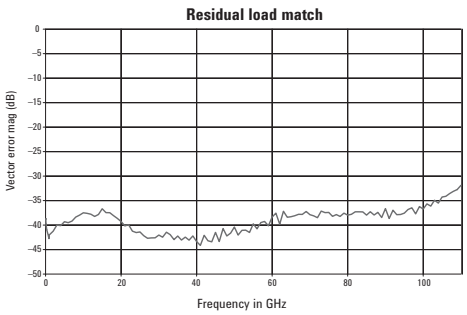


Figure 4. Plots showing residual calibration errors based on a coverage factor of 2 (2 sigma).

Measurement cycle time[1] (ms) *Forward sweep, uncorrected*

	Number of points					
	51	101	201	401	801	1601
10 MHz to 110 GHz 10 kHz IFBW	300	400	500	600	700	1000
58 to 62 GHz 10 kHz IFBW			111			
75 to 79 GHz 10 kHz IFBW			93			

Cycle time versus IF bandwidth *Forward sweep, uncorrected, 201 points*

IF bandwidth (Hz)	45 MHz to 100 GHz cycle time (ms)	75 to 79 GHz cycle time (ms)
10000	500	93
1000	800	267
100	3500	2000
10	20900	18200

1. *"Cycle time" includes sweep time, retrace time, and band-crossing time. For a full 2-port corrected measurement with forward and reverse sweeps, the cycle times above should be approximately doubled.*

Test port damage level

Frequency	1.0 mm test port	1.85 mm test port	Waveguide port
10 MHz to 110 GHz	27 dBm	27 dBm	27 dBm

Option H08 and H11 rear panel connectors (typical)

IF connectors	A, R1, R2, B (BNC Connectors)
IF connector input frequency	8.333 MHz
Nominal input impedance at IF inputs	50 Ω
RF damage level to IF connector inputs	–20.0 dBm
DC damage level to IF connector inputs	25 volts
0.1 dB compression point at IF inputs	–27.0 dBm
Pulse input connectors[1]	A, R1, R2, B (BNC Connectors)
Nominal input impedance at pulse inputs	1 Kohm
Minimum IF gate width	20 ns for less than 1 dB deviation from theoretical performance[2]
DC damage level to pulse connector inputs	5.5 volts
Drive voltage	TTL (0, +5.0) volts
Rear panel LO power – test port frequency (see 836x H11 specs for test port frequencies up to 67 GHz)	
67 GHz to 110 GHz[3]	–7 to –13 dBm
Rear panel RF power – test port frequencies (see 836x H11 specs for test port frequencies up to 67 GHz)	
67 GHz to 76 GHz[4]	–4 to –10 dBm
76 GHz to 96 GHz[4]	+1 to –5 dBm
96 GHz to 110 GHz[4]	+5 to –1 dBm

1. *Pulse input connectors are operational only with Option H08 (Pulse Measurement Capability) enabled.*
2. *Based on deviation from signal reduction equation: Signal Reduction (dB) = $20\log_{10}$(Duty_cycle) = $20\log_{10}$(pulse_width/period). Measured at Pulse Repetition Frequency (PFR) of 1 MHz.*
3. *For rear panel LO port frequency, divide by 8.*
4. *For rear panel RF port frequency, divide by 6.*

Note: Typical system performance for front panel jumpers is not provided for the N5250C.

N5250C system block diagram

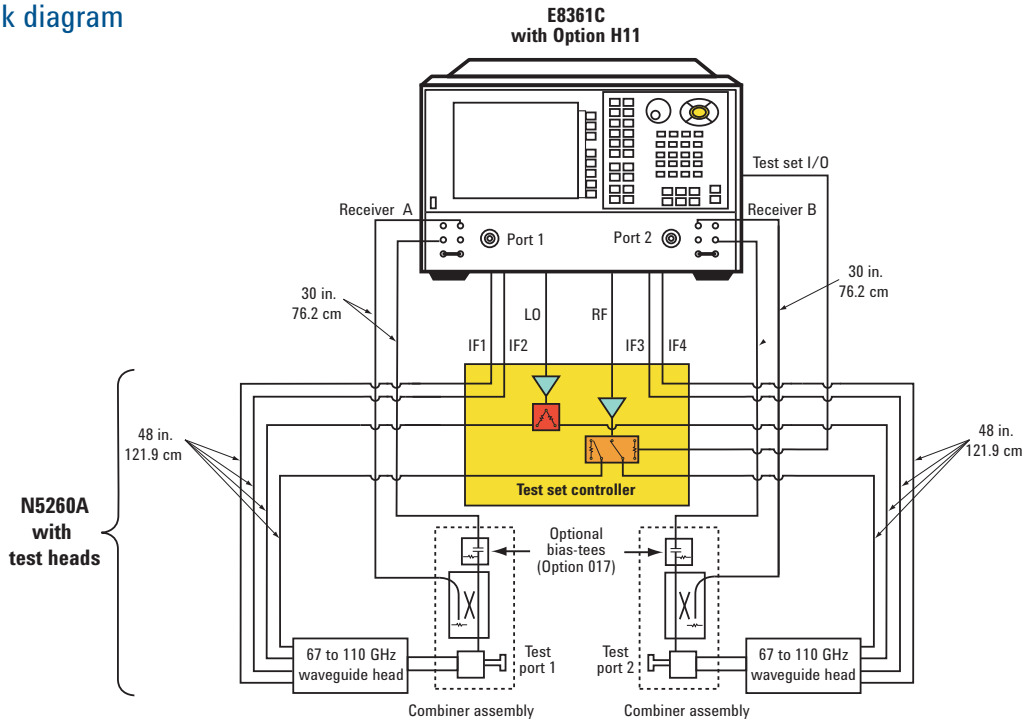


Figure 5. With Option 017, the signal is routed out of PNA from the front panel jumpers rather than the ports. Without Option 017, the signal is routed from the front panel ports to the combiner assembly, allowing access to the PNA's internal bias-tees.

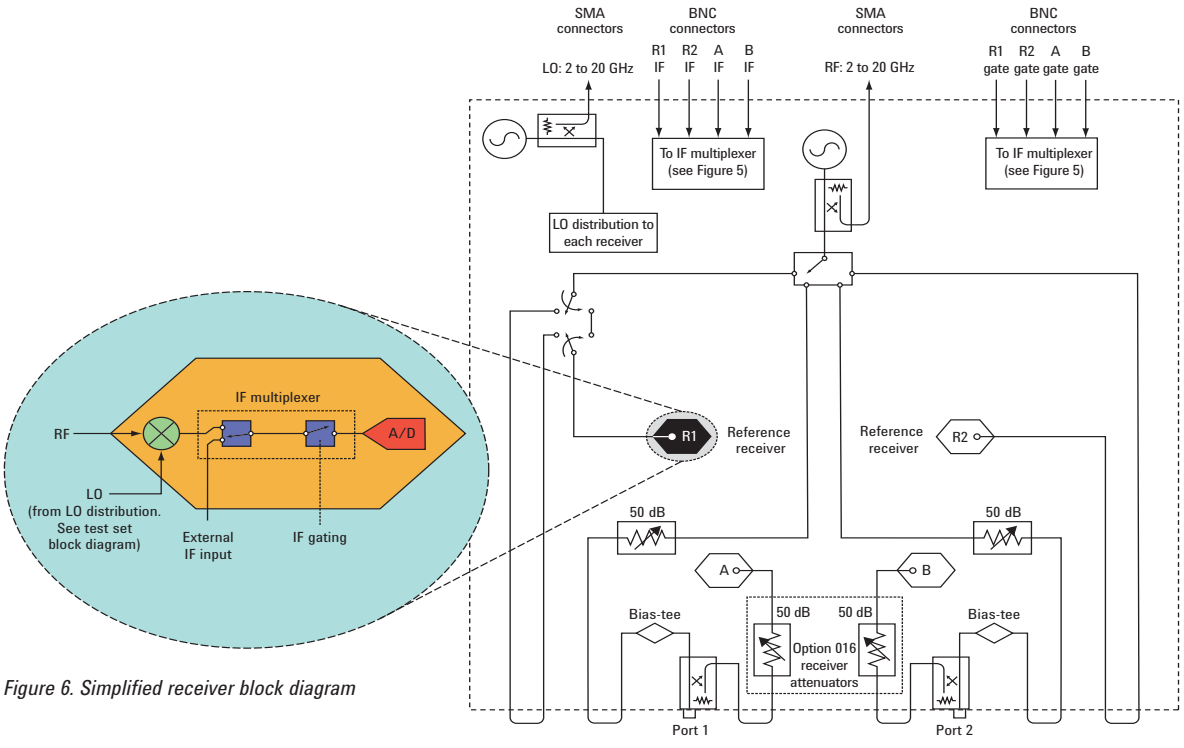


Figure 6. Simplified receiver block diagram

Figure 7. PNA test set block diagram

N5247A PNA-X Based Single Sweep Solution (10 MHz to 110 GHz)

This configuration of the millimeter network analyzer is based on the N5247A PNA-X network analyzer. It allows both a single sweep measurement solution that starts at 10 MHz up to 110 GHz and full port power level control. This solution is a direct replacement for the 8510XF with improved performance, in particular an added capability to control and use receiver leveling to set the power accurately at the 1.0 mm test port. Architecturally very similar to the existing N5250C system but is configurable as a set of separate components that include the N5247A PNA-X, either a 2- or 4-port millimeter-wave test set controller and the appropriate broadband frequency extenders as needed. Refer to the configuration information at the end of this section.

Key features

This solution includes all the key features of the N5250C solution plus the following:

- Provides 2- and 4-port S-parameter measurements from 10 MHz to 110 GHz in a single sweep
- Full power control over the entire frequency range down to at least 50 dBm
- Receiver leveling to maintain accurate power across the entire frequency range
- Broad power sweeps across the entire frequency range
- Supports true differential measurements across frequency range
- Support for scalar mixer measurements
- Integrated pulse measurement capability

Performance

This solution provides the most complete and highest performance network analysis capability for frequencies from 10 MHz to 110 GHz. Figure 8 below illustrates just one of the most significant features of this system, leveled port power to within less than 0.2 dB a factor of 5 times better than the 8510XF solution.

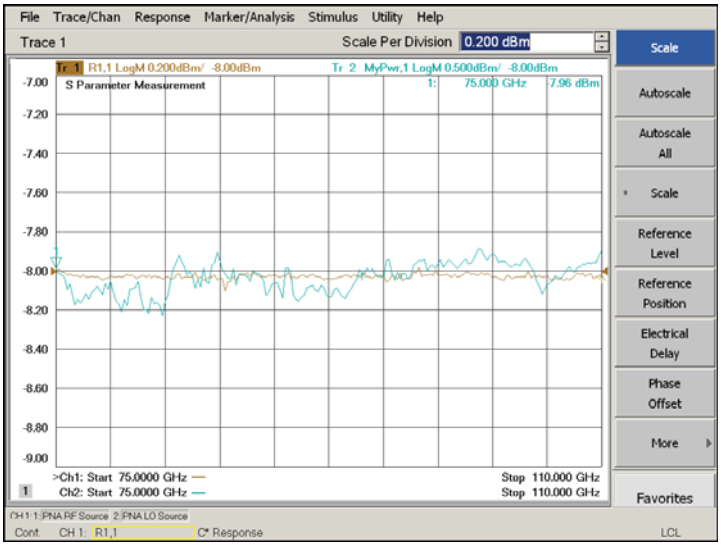


Figure 8. A demonstration of power accuracy; power sensor measurement vs. N5247A PNA-X R1 receiver < 0.1 dBm

Another key performance characteristic is the ability to produce very low level signals for 110 GHz device measurements. Figure 9 below shows the typical performance of the power output across the 10 MHz to 110 GHz frequency range.

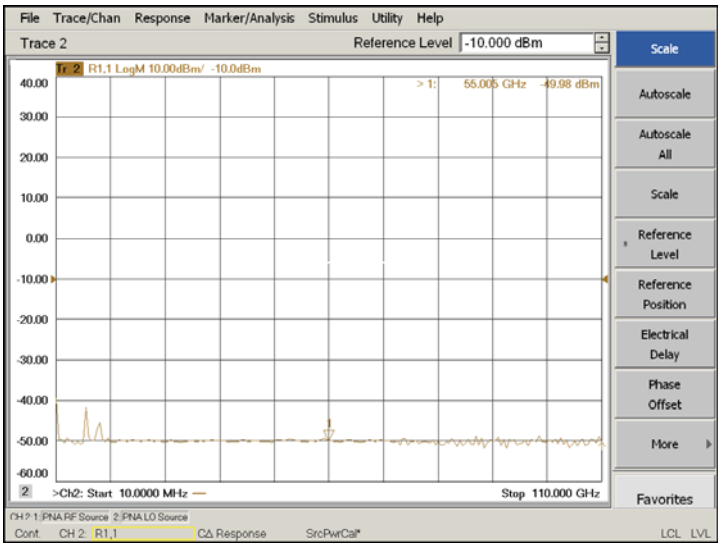


Figure 9. The lowest output power of -50 dBm from 10 MHz to 110 GHz

Application support

Since the architecture is based on the N5247A PNA-X platform it enables several new measurement applications which include a true differential, pulse, and scalar measurements. The flexibility of the system measurement capabilities enables a single touchdown for on-wafer components that will completely characterize the behavior of the device being measured.

The ability to accurately control power allows for simple gain compression measurements at millimeter-wave frequencies. Figure 10 is an example of power sweep being used to do a measurement of a 110 GHz buffer amplifier while also doing a traditional S-parameter.

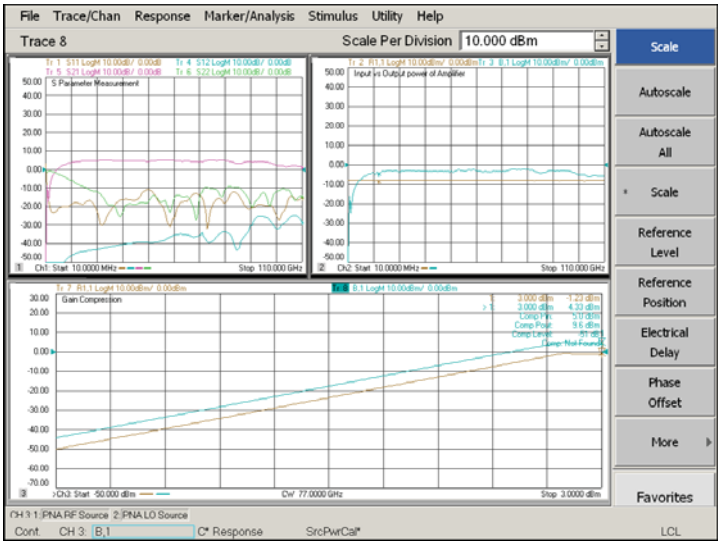


Figure 10. Application of power sweep used to make a gain compression measurement at 77 GHz

With integrated pulse modulators and receivers of the N5247A PNA-X, pulse measurements can be easily achieved. Below is an example of a pulse profile at a CW of 98 GHz.

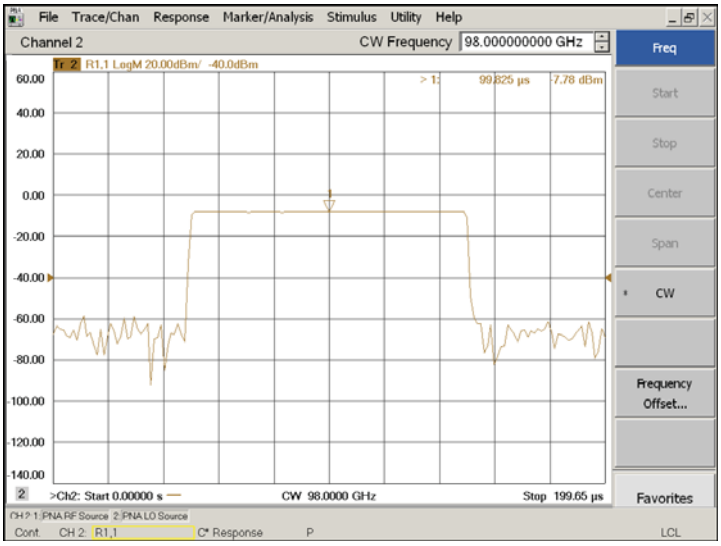


Figure 11. Application of the integrated pulse capability which shows a pulse profile of the calibrated R1 receiver input to an amplifier at 98 GHz

With the integrated true differential application, true mode signals can now be applied to devices up to 110 GHz. The following is an example of a measurement that shows the differential phase of a WR-10 Magic-Tee sum and difference port phase.

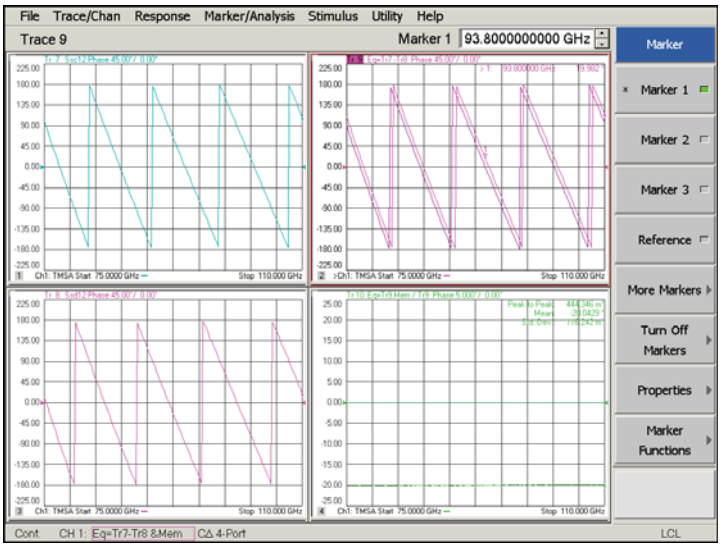


Figure 12. Illustration of the difference in phase between the sum and difference ports of a Magic Tee and the adjustment of phase using the true differential application

In addition to the above application measurements for millimeter wave this solution also offers the capability to easily make mixer measurements. Here is an example using the N5247A solution performing a LO power sweep of a 75 to 110 GHz down converter mixer at a CW of 75 GHz. It shows the SC21 plot while sweeping the LO from –20 to +11 dBm.

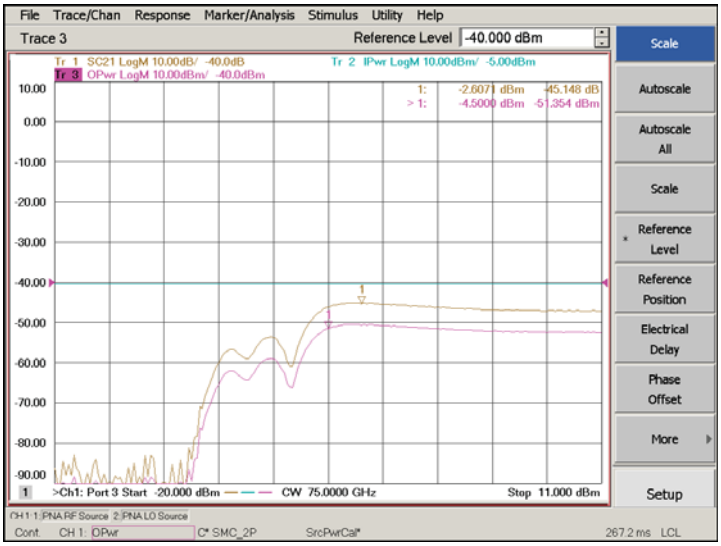


Figure 13. Swept LO at a millimeter wave frequency of 75 GHz

Typical performance (PNA-X Based 110 GHz Solution)

Maximum Output Test Port Power (dBm)		
Frequency (GHz)	1.0 mm test Port	1.85 mm PNA-X Port
0.01 – 0.45	11	12
0.045 – 0.5	11	13
0.5 – 2	12	14
2 – 10	13	15
10 – 24	10	15
24 – 30	7	14
30 – 40	0	9
40 – 45	3	13
45 – 50	2	13
50 – 60	0	13
60 – 67	2	13
67 – 70	–6	n/a
70 – 75	–4	n/a
75 – 80	–4	n/a
80 – 100	–4	n/a
100 – 110	–4	n/a

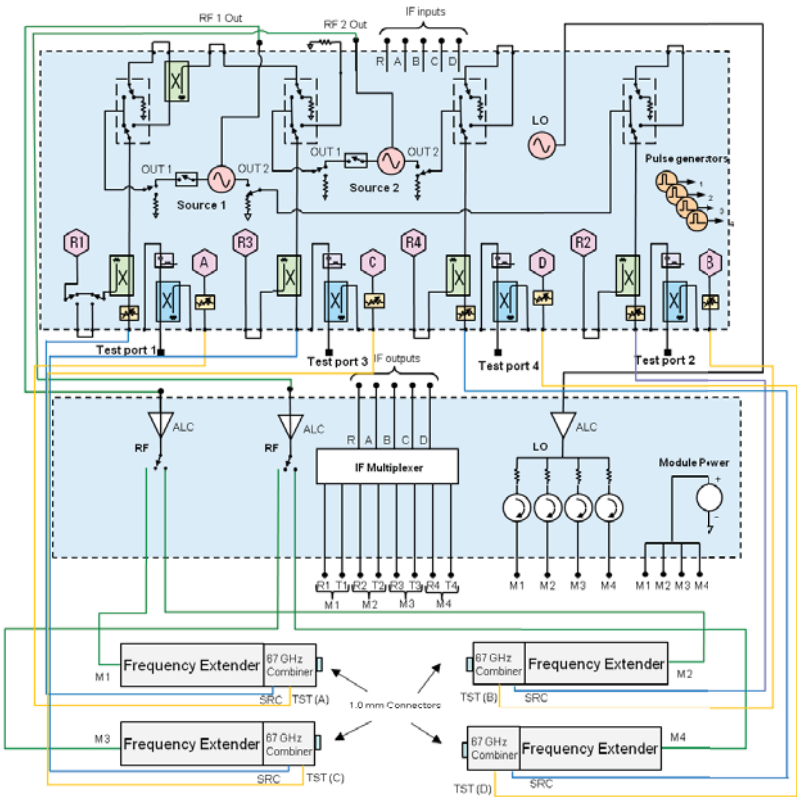
Noise Floor (dBm)		
Frequency (GHz)	1.0 mm test Port	1.85 mm Test Port
0.01 – 0.45	–75	-76
0.45 – 0.5	–106	-107
0.5 – 2	–115	-116
2 – 10	–116	-119
10 – 24	–116	-121
24 – 30	–105	-110
30 – 40	–104	-110
40 – 45	–103	-110
45 – 50	–101	-108
50 – 60	–98	-107
60 – 67	–96	-107
67 – 70	–89	n/a
70 – 75	–93	n/a
75 – 80	–93	n/a
80 – 100	–93	n/a
100 – 110	–91	n/a

Dynamic Range (dB)		
Frequency (GHz)	1.0 mm Test Port	1.85 mm Test Port
0.01 – 0.45	86	88
0.45 – 0.5	117	120
0.5 – 2	127	130
2 – 10	129	134
10 – 24	126	136
24 – 30	112	124
30 – 40	104	119
40 – 45	106	123
45 – 50	103	121
50 – 60	98	120
60 – 67	98	120
67 – 70	83	n/a
70 – 75	89	n/a
75 – 80	89	n/a
80 – 100	89	n/a
100 – 110	87	n/a

Notes:

1. *Typical performance is expected performance of an average unit which does include guardbands.*
2. *All data presented is based on performance of existing N5250C for frequencies above 67 GHz.*
3. *For Frequencies up to 67 GHz these are computed using the combiner loss and noise contribution as per the N5250C system and taking into account the PNA-X performance to 67 GHz.*
4. *Note actual performance is expected to be better these are worse case typical performance.*

N5247A based single sweep solution configuration



Banded Millimeter-Wave Solutions to 1.1 THz

Agilent offers a variety of banded millimeter-wave solutions that enable the PNA and PNA-X network analyzers to make S-Parameter measurements up 1.1 THz. These solutions are easily configurable and the frequency extenders used are from OML Inc. and Virginia Diodes Inc. as well as Farran Microwave, allowing the flexibility of price performance solution to meet the measurement need.

The currently supported solutions through Agilent may be configured with or without a test set depending on the measurements required and the frequency extenders being used.

These solutions are easily configured using a simple on-screen dialog box that allows you to easily select different frequency bands while maintaining the hardware configuration.

Test Set Controller Based Solutions

Figure 14. Two port banded millimeter-wave solution

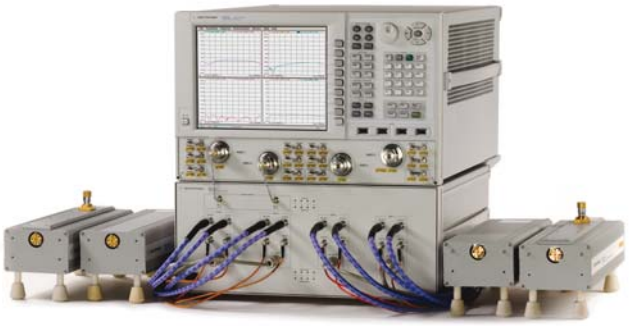


Figure 15. Four port test set based banded PNA-X millimeter-wave solution

Key features

- Frequency extenders from OML Inc. cover a frequency range of 50 GHz to 500 GHz while extenders from Virginia Diodes Inc. allow solutions up to 1.1 THz
- These configurations allow for special modules to be configured that extend the frequency of a particular waveguide band, such as 56 GHz to 94 GHz frequency to address the 60 GHz wireless HDMI applications
- These solutions allow for 2- and 4-port configurations and have integrated power supplies and signal condition with the test set controller
- Multiple waveguide bands can be configured and using the firmware interface it is easy to switch between frequencies for different measurements
- The four port configurations are ideally suited for mixer applications, no need for an additional external LO for the device being tested
- These solutions take advantage of the PNA-X features to enable power level control, scalar mixer measurements, and pulse measurements.

Performance

The test set based solutions offer not only the highest frequency coverage up to 1.1 THz, they have also shown the best dynamic range in the industry. Figure 16 is an example of a WR2.2 frequency extender dynamic range using a PNA-X network analyzer and a N5262A test set controller; with a typical performance of –60 dB in a 10 Hz IFBW.

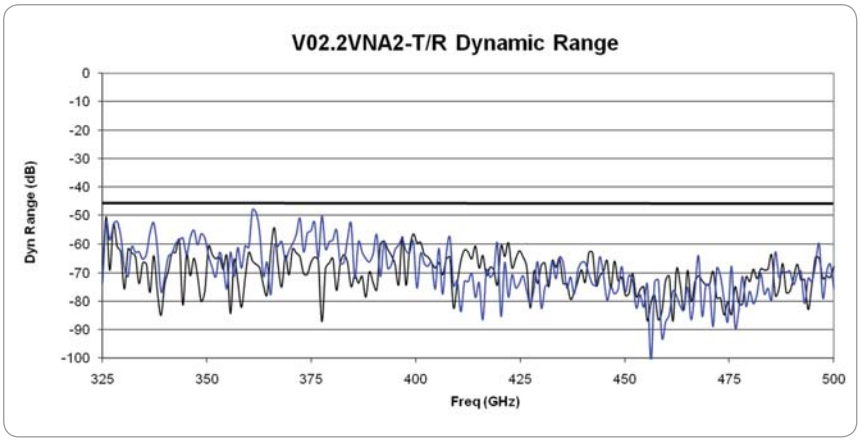


Figure 16. Dynamic range of a 325 to 500 GHz WR-2.2OML Inc. Frequency Extender

For detailed specifications and performance of the different frequency extenders, please contact your local Agilent Field Sales Representative. The banded millimeter-wave system can also be configured for on-wafer applications. Waveguide probing accessories are available from Cascade Microtech, including Impedance Standard Substrates (ISS) for waveguide probes. Figure 17 shows the waveguide version of Cascade's Infinity probe to 500 GHz.

Figure 17. Cascade Infinity Probe (GSG 150), waveguide versions to 500 GHz.

Flexibility

The PNA banded millimeter-wave systems offer exceptional performance with ultimate system flexibility. A banded millimeter-wave system can be configured from the N5250C 110 GHz system or the PNA-X Based 110 GHz solution by simply replacing the test head modules with the waveguide modules of your choice.

Ease-of-use

The banded millimeter-wave system uses built-in firmware, allowing you to; leverage software between PNA and PNA-X Series network analyzers, regardless of the frequency range of your measurement; manually control the instrument, from the front panel or a mouse to access the simple pull-down menus; and utilize the Cal Wizard, which will guide you step-by-step through the most complicated of calibrations.

The banded millimeter-wave system can easily be configured using the dialogue box shown in Figure 18. Multiple system configurations can be added to the list, but only one is active at a time. Creating a banded configuration is easy, simply enter the start and stop frequencies, and the multipliers for RF and LO frequency ranges (the values are located on the test head modules). Once a configuration has been added to the list, simply highlight the setup of choice and then click Activate Selected Config to apply.

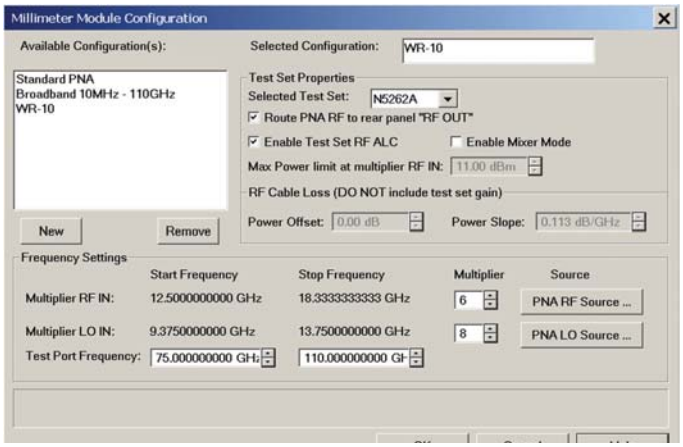


Figure 18. On-screen dialog to configure a banded millimeter-wave setup

A number of different configurations can be setup for different frequency bands. In addition, for the N5261A and N5262A there is the added capability to turn on and off the test set ALC for pulse measurements. Also available, is the ability to enable mixer sweep for scalar mixer measurements. This interface allows for the ease of switching from one configuration to the next without restarting the PNA/PNA-X or reconfiguration of connections.

In addition, an extensive, context-sensitive Help system thoroughly explains all of the PNA and PNA-X features. In any dialog box, simply click **Help** to see a detailed explanation of the feature you are using. Programming examples in both SCPI and COM are also included.

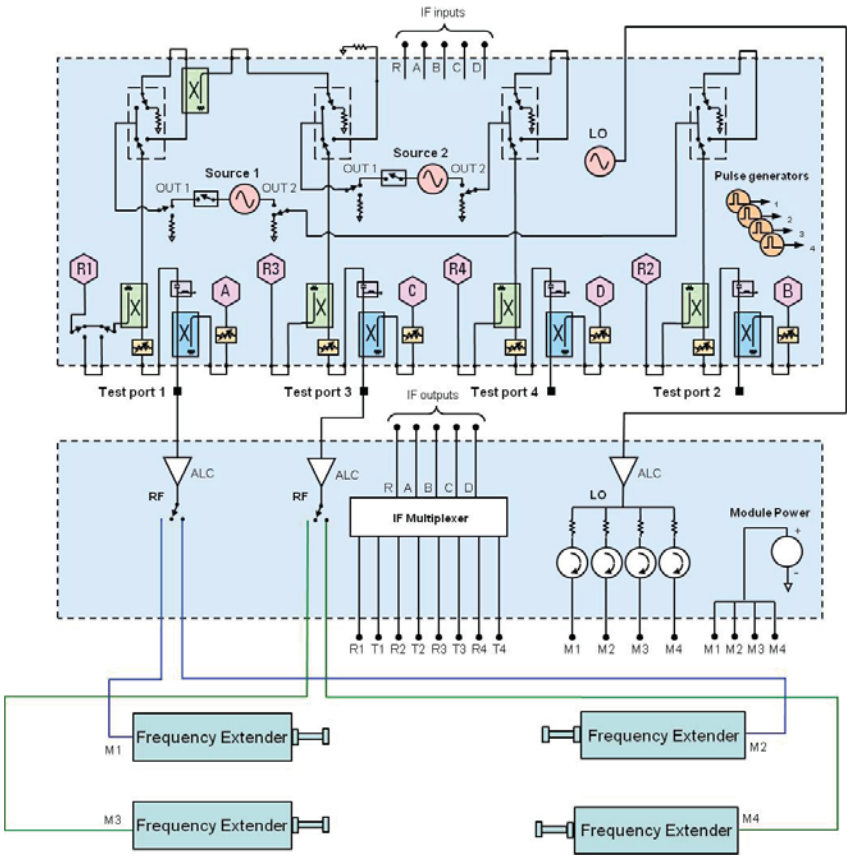
Connectivity

Windows built-in operating system and familiar user interface provides both ease-of-use and connectivity.

- Capture images quickly, easily and in .jpg, .bmp, and .png formats for easy data analysis, archiving, and printing.
- Control the analyzer using SCPI commands or gain the speed and connectivity advantage of COM/DCOM.
- Develop code in programming environments such as Visual Basic, Visual Basic.NET, Visual C++, Visual C++.NET, Agilent-VEE, or LabView.
- Execute code directly from the analyzer or remotely with an external PC through LAN or GPIB, or multiple USB ports.
- Use multiple USB ports to control a variety of peripherals.

The PNA and PNA-X millimeter-wave series instruments are based on the Windows XP operating system, which makes operation and programming simple, and provides a powerful environment in which easy-to-use measurement functions and PC capabilities are seamlessly linked.

Test set controller based solution block diagram



Direct Connect Solutions

These solutions connect directly to the front panel of a dual source PNA-X and do not require a millimeter-wave test set controller. Although, both OML and VDI frequency extenders are supported, this solution is typically configured with the VDI frequency extenders as shown below.

Key features

- Does not use require a test set controller
- Supports full S-parameter measurements within a waveguide band with a dual source PNA-X network analyzer with either 2- or 4-ports
- Uses external power supplies that come with the frequency extenders from Virginia Diodes Inc.
- Frequency offset mode of the PNA-X is utilized to drive the frequency extenders
- Currently supports a power calibration and power sweep with the OML frequency extenders
- Allows use of a higher IF frequency for the test and reference signals and can be driven with either a 26.5, 44, 50 or 67 GHz PNA-X
- A downloadable macro is available from Agilent that simplifies the setup of the frequency offset mode

Performance

The direct connect configuration is currently supported using the frequency offset mode of the PNA-X and requires at least two sources to be able to complete 2-port S-parameter measurements. The RF signal for the frequency extenders are supplied via the PNA-X Port 1 and Port 2 while the LO is supplied with either the second source that drives the PNA-X ports 3 and 4. With this hardware configuration, the frequency offset mode can be used to set the RF source to sweep the frequency range of the waveguide band while the LO sweeps the mixers in the extenders to produce the IF signals required to make a S-parameter measurement. An external power supply is required to allow the frequency extenders to operate, if OML frequency extenders are used an external 12 V, 1.3 A power supply would be required.

Calibration technology built into the PNA-X enables the most accurate measurements. The following is a few of the performance characteristics of the system. Figure 19 demonstrates the achievable stability of this system; it shows the vector magnitude stability of 500 to 750 GHz over a period of 24 hours under typical laboratory conditions of 25 deg C.

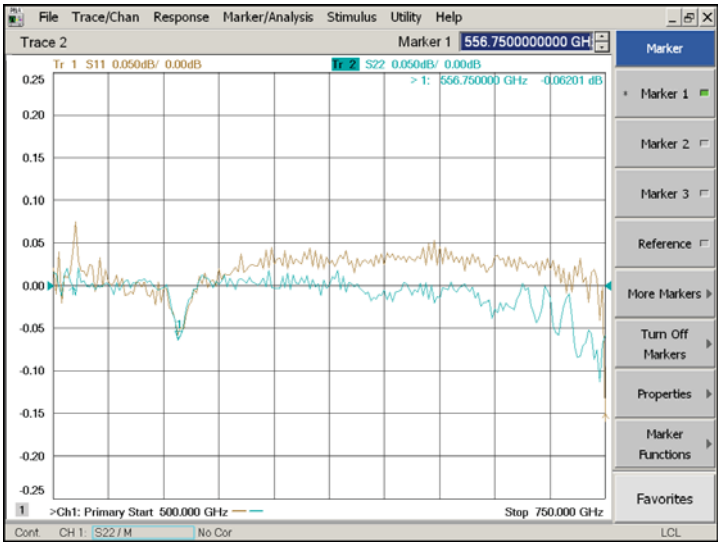


Figure 19. Typical drift performance of the PNA-X solution at 500 to 750 GHz using Virginia Diodes frequency extenders

Notice the excellent performance of less than 0.15 dB of both the short terminated ports relative to memory over a period of 24 hours. Another key performance characteristic is excellent dynamic range as illustrated by the 750 GHz -100 dB dynamic range shown below.

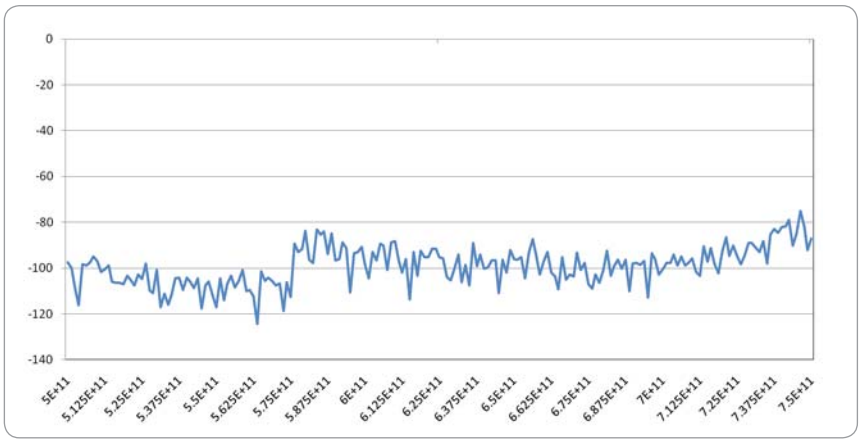
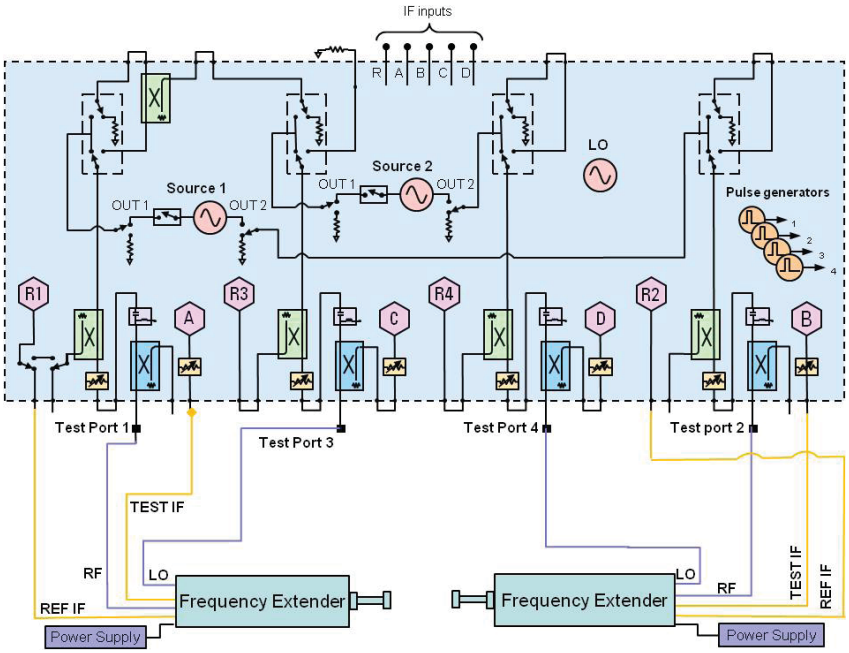


Figure 20. WR1.5 dynamic range measurements with VDI frequency extenders connected to a PNA-X

This configuration of the PNA-X with Virginia Diodes frequency extenders offers the ability to directly connect frequency extenders to a 4-port PNA-X with dual sources enabling vector network analysis measurements up to 1.1 THz. A list of the available frequency extenders that are currently available is in the configuration tables on pages 29 and 30.

Direct Connect solution block diagram



N5250C Ordering Information

With the N5250C, you receive all of the features and flexibility of the PNA platform, including:

- Windows architecture
- LAN, GPIB, and multiple USB ports
- 29 IFBW settings, 32 channels, 64 traces, and 20,001 points per trace
- Frequency converter measurements[1], pulsed-RF measurements[1], and time-domain transform applications

Note: Installation and productivity assistance (requires a completed ISP at order)

N5250C configuration *(block diagram detail shown in Figure 5)*

- E8361C PNA microwave network analyzer which supplies the signal for frequencies up to 67 GHz
- Millimeter-wave test set controller drives the millimeter-wave test heads for performance up to 110 GHz
- The combiner assembly contains a 67 GHz coupler and a combiner that combines the 10 MHz to 67 GHz signal from the PNA with the 67 GHz to 110 GHz signal from the millimeter-wave test heads. Option 017 allows you to add bias-tees to the combiner assembly for added measurement stability for on-wafer and in-fixture devices.
- Millimeter-wave test heads provide the signal from 67 GHz to 110 GHz
- Test set and module cables

1. *Up to 67 GHz.*

N5250C PNA millimeter-wave system, 10 MHz to 110 GHz, includes:

E8361C MW PNA with IF access (Option H11)

- Configurable test set – Option 014
- Extended power range and bias-tees – Option UNL
- Frequency-offset mode – Option 080
- Reference channel switch – Option 081

N5260A millimeter-wave test set controller with test heads

- 67 GHz to 110 GHz test heads, micrometer attenuator on port 1
- 1.0 mm combiner assembly
- Test set and module interconnecting cables

Note: Installation and productivity assistance (requires a completed ISP at order)

Additional options available:

- Millimeter-wave modules with bias-tees – Option 017
- Millimeter-wave modules with bias-tees and port 2 attenuator – Option 018
- Receiver attenuator – Option 016[2]
- Time-domain capability – Option 010
- Pulsed-RF measurement capability – Option H08[2]
- Frequency converter application – Option 083[2]

Factory integration of the N5250C system integrates the E8361C with Option H11 and the N5260A millimeter-wave test set controller with test heads. On-site installation is included, and the entire system carries a full one-year, on-site warranty (where available).

Recommended bias tee connection for N5250C

The following is a list of cables and adapters that are suggested for connection of the bias tee on the N5250C option 017 and option 018 systems to a 4156C Parametric Analyzer. For other power supplies a different combination of cables maybe required.

- Quantity 5 of the Triax to sub-mini-triax Cascade cable part number is 104-330-LC, (these are used to connect to the Bias Tee connectors on the N5250C combiner module).
- Quantity 5 of the Triax Barrel from Trompeter part BJ78 (use to connect the Cascade cable to the Agilent cables on item 3).
- Quantity 4 of the Agilent Triax to Triax cables Agilent product number 16494A (these are used for the FORCE/SENSE connection, 24 inches long).
- Quantity 1 of the Agilent 16493H Triax to Triax cables Agilent product number 16493H (these will be used for the GNDU connection).

Note: A second GNDU connection is not required to prevent any ground currents.

1. *For on-wafer applications, two 11500J/K/L cables are required; one cable for each test port.*
2. *These options apply to the E8361C and arelimited to 67 GHz frequency range.*

N5250C Components Available Separately

E8361C MW PNA with the following options:

- IF access – Option H11 (required)
- Configurable test set – Option 014 (required)
- Extended power range and bias-tees – Option UNL (required)
- Frequency-offset mode – Option 080 (required)
- Reference channel switch – Option 081 (required)

Additional options available:

- Receiver attenuator – Option 016[1]
- Time-domain capability – Option 010
- Pulsed-RF measurement capability – Option H08[1]
- Frequency converter application – Option 083[1]

The N5260A millimeter wave controller with test heads may be purchased separately in the future to add a single sweep 10 MHz to 110 GHz capability.

N5260A millimeter-wave test set controller, includes:

- Millimeter-wave test set controller
- Two sets of 48 inch test head cables for RF, LO, IF and DC for connection to test heads
- A set of IF, RF, LO and test set interface cable for connection to the PNA or PNA-X

Note: PNA-X requires a set of 4 BNC-SMA adapters and a 10 dB pad for use with the N5260A.

Additional options available: (choose one, if applicable)

The following options include installation and productivity assistance – requires a complete ISP at time of order.

- Option 110 adds 67 GHz to 110 GHz test heads with combiner assembly, and port 1 attenuator.
- Option 120 adds 67 GHz to 110 GHz test heads with combiner assembly, port 1 attenuator and bias-tees.
- Option 130 adds 67 GHz to 110 GHz test heads with combiner assembly, bias-tees, ports 1 and 2 attenuators.

Note: Option PS-S20 Productivity assistance recommended when Option 110, 120, or 130 is NOT ordered.

1. *These options apply to the E8361C and are limited to 67 GHz frequency range.*

Configuring a Single Sweep 110 GHz PNA-X Based Network Analyzer

In order to configure a 10 MHz to 110 GHz PNA-X network analyzer the following basic components are required:

1. N5247A PNA-X 10 MHz to 67 GHz with either 2- or 4-ports
2. N5261A or N5262A millimeter-wave test controller
3. A set of N5250CX10 67 GHz to 110 GHz frequency extenders

N5247A based single sweep solution hardware configuration

Product / Options	Description
	N5247A 67 GHz PNA-X Network Analyzer
N5247A-200	2-ports, single source 10 MHz to 67 GHz PNA-X
N5247A-400	4-ports, dual source 10 MHz to 67 GHz PNA-X
N5247A-020	Adds rear panel direct access IF Inputs
	2-Port Millimeter-Wave Test Set Controller
N5261A	2-port millimeter-wave test set controller for PNA-X based configuration
N5261A-112	A set of cables for 1.85 mm connection to a 2-port N5247A
N5261A-501	A single set (1-port) of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 48"
N5261A-502	A single set (1-port) of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 2 meters
N5261A-503	A single set (1-port) of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 3 meters
N5261A-505	A single set (1-port) of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 5 meters
U3021S-045	Lock Link Kit to secure the N5244/45/47A PNA-X to the Test Set
	4-Port Millimeter Wave Test Set Controller
N5262A	4-port millimeter-wave test set controller for PNA-X based configuration
N5262A-114	A set of cables for 1.85 mm connection to a 4-port N5247A
N5262A-501	A single set of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 48"
N5262A-502	A single set of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 2 meters
N5262A-503	A single set of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 3 meters
N5262A-505	A single set of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 5 meters
U3021S-045	Lock Link Kit to secure the N5244/45/47A PNA-X to the Test Set
	Millimeter Wave Frequency Extenders
N5250CX10-L05	67 to 110 GHz, left T/R module and 1.00 mm combiner assembly without adjustable attenuator, or bias tee
N5250CX10-L10	67 to 110 GHz, left T/R module and 1.00 mm combiner assembly with adjustable attenuator , and no bias tee
N5250CX10-L15	67 to 110 GHz, left T/R module and 1.00 mm combiner assembly with bias tee, and no adjustable attenuator
N5250CX10-L20	67 to 110 GHz, left T/R module and 1.00 mm combiner assembly with adjustable attenuator and bias tee
N5250CX10-R10	67 to 110 GHz, right T/R module and 1.00 mm combiner assembly without adjustable attenuator, or bias tee
N5250CX10-R15	67 to 110 GHz, right T/R module and 1.00 mm combiner assembly with adjustable attenuator, and no bias tee
N5250CX10-R20	67 to 110 GHz, right T/R module and 1.00 mm combiner assembly with bias tee and no adjustable attenuator
N5250CX10-R30	67 to 110 GHz, right T/R module and 1.00 mm combiner assembly with adjustable attenuator and bias tee

Notes:

1. *For the N5247A PNA-X, Option 200 is required for a 2-port 110 GHz configuration while Option 400 may be used for both 2- and 4-port 110 GHz solutions.*
2. *Option 020 is required for direct connection of the IF into the back of the PNA-X.*
3. *The millimeter-wave test set controller includes cables to interface with the PNA-X when either Option 112 or 114 is selected.*
4. *The bias-tees added for this option have a voltage rating of 40 volts and a maximum of 0.5 amps.*
5. *Installation and productivity assistance is included with purchase of the above solution. Please ensure that an ISP is completed by your Agilent Sales representative to qualify for these services.*

1.0 mm accessories

The following accessories are available for use with the N5250C system, but are not included in the system.

- 11500I 1.0 mm (f-f) test port cable (8.8 cm)
- 11500J 1.0 mm (m-f) test port cable (16.0 cm)[1]
- 11500K 1.0 mm (m-f) test port cable (20.0 cm)[1]
- 11500L 1.0 mm (m-f) test port cable (24.0 cm)[1]
- 85059A DC to 110 GHz precision calibration/verification kit
- V281C 1.0 mm (f) to V-band waveguide adapter
- V281D 1.0 mm (m) to V-band waveguide adapter
- W281C 1.0 mm (f) to W-band waveguide adapter
- W281D 1.0 mm (m) to W-band waveguide adapter
- 11920A 1.0 mm (m) to 1.0 mm (m) adapter
- 11920B 1.0 mm (f) to 1.0 mm (f) adapter
- 11920C 1.0 mm (m) to 1.0 mm (f) adapter
- 11921E 1.0 mm (m) to 1.852 mm (m) adapter
- 11921F 1.0 mm (f) to 1.852 mm (f) adapter
- 11921G 1.0 mm (m) to 1.852 mm (f) adapter
- 11921H 1.0 mm (f) to 1.852 mm (m) adapter
- 11922A 1.0 mm (m) to 2.4 mm (m) adapter
- 11922B 1.0 mm (f) to 2.4 mm (f) adapter
- 11922C 1.0 mm (m) to 2.4 mm (f) adapter
- 11922D 1.0 mm (f) to 2.4 mm (m) adapter
- 11923A 1.0 mm (f) connector launch assembly

Measurement options

The following is a list of the measurement options that are supported across the 10 MHz to 110 GHz frequency range. These are enabled by ordering the specific options on the PNA-X. For other PNA-X options that are only supported up to 67 GHz, please refer to the *Agilent PNA Family Microwave Network Analyzers Configuration Guide*, literature number 5989-7606EN.

Option	Measurement Capabilities
N5247A-010	Time domain measurement
N5247A-082	Scalar-calibrated converter measurements
N5247A-083	Scalar-calibrated converter measurements with phase
N5247A-460	Integrated true differential stimulus
N5247A-008	Pulse application
N5247A-080	Frequency offset mode
N5247A-021	Add pulse modulator to internal 1st source
N5247A-022	Add pulse modulator to internal 2nd source
N5247A-025	Add internal 4 pulse generators
N5247A-118	Fast CW mode

Accessories

On-wafer applications

For on-wafer applications, Cascade Microtech provides complete probing systems using the N5250C and other PNA configurations. These include both new probing systems and upgrades to existing Cascade Microtech products. Cascade can also provide on-wafer verification and probing system training. Once the N5250C system is verified in coax, Cascade Microtech will verify the system through its wafer probes.

Banded Millimeter Wave System Configuration

To configure a basic banded millimeter wave measurement system, three basic components may be required:

1. A performance network analyzer
2. Millimeter wave test set controller (optional)
3. A waveguide module based on application need and frequency band
4. An optional calibration kit in waveguide unless on-wafer or other media is being used

Performance network analyzer

Product model	Description	Minimum required options
E8362C	20 GHz 2-port performance network analyzer	H11, 080, 081, 014 and UNL
E8363C	40 GHz 2-port performance network analyzer	H11, 080, 081, 014 and UNL
E8364C	50 GHz 2-port performance network analyzer	H11, 080, 081, 014 and UNL
E8361C	67 GHz 2-port performance network analyzer	H11, 080, 081, 014 and UNL
N5242A	Option 2xx 26.5 GHz 2-port PNA-X network analyzer	Option 020
N5242A	Option 4xx 26.5 GHz 4-port PNA-X network analyzer	Option 020
N5244A	Option 2xx 43.5 GHz 2-port PNA-X network analyzer	Option 020
N5244A	Option 4xx 43.5 GHz 4-port PNA-X network analyzer	Option 020
N5245A	Option 2xx 50 GHz 2-port PNA-X network analyzer	Option 020
N5245A	Option 4xx 50 GHz 4-port PNA-X network analyzer	Option 020
N5247A	Option 2xx 67 GHz 2-port PNA-X network analyzer	Option 020
N5247A	Option 4xx 67 GHz 4-port PNA-X network analyzer	Option 020

Note: When configuring a two Port PNA-X with a N5262A 4-port millimeter wave test set controller, also include Option 551 on the PNA-X for 4-port calibration capability. Also note the direct connection of frequency extenders is ONLY supported with a PNA-X that has Option 224 or 4xx and must include Option 080. Option 020 is not required.

Optionally for rear panel connection of the RF source to the N5261A/N5262A test set controller include the switch combiner options to the PNA-X selected above. Use Option 224 for 2- port PNA-X network analyzers and Option 423 for the 4-port PNA-X network analyzers.

For E836x based systems that use frequency extenders above 200 GHz, these systems require a pair of external synthesizers (one for RF and the other for LO) to maintain at least an 80 dB dynamic range the dynamic range. Recommended synthesizers are E8257D with Options 520 and UNX.

Millimeter-wave test set controllers

N5261A 2-Port Millimeter-wave test set controller for PNA-X based configuration	
N5261A-102	A set of cables for 3.5 mm connection to a 2-port PNA-X N5242A
N5261A-104	A set of cables for 3.5 mm connection to a 4-port PNA-X N5242A
N5261A-106	A set of cables for 2.4 mm connection to a 2-port PNA-X N5244A/N5245A
N5261A-108	A set of cables for 2.4 mm connection to a 4-port PNA-X N5244A/N5245A
N5261A-112	A set of cables for 1.85 mm connection to a 2-port PNA-X N5247A
U3021S-042	Lock Link Kit to secure the N5242A PNA-X to the Test Set
U3021S-045	Lock Link Kit to secure the N5244/45/47A PNA-X to the Test Set

N5262A 4-Port Millimeter-wave test set controller for PNA-X based configuration	
N5262A-102	A set of cables for 3.5 mm connection to a 2-port PNA-X N5242A
N5262A-104	A set of cables for 3.5 mm connection to a 4-port PNA-X N5242A
N5262A-106	A set of cables for 2.4 mm connection to a 2-port PNA-X N5244A/N5245A
N5262A-108	A set of cables for 2.4 mm connection to a 4-port PNA-X N5244A/N5245A
N5262A-114	A set of cables for 1.85 mm connection to a 4-port PNA-X N5247A
U3021S-042	Lock Link Kit to secure the N5242A PNA-X to the Test Set
U3021S-045	Lock Link Kit to secure the N5244/45/47A PNA-X to the Test Set

N5260A 2-Port Millimeter-wave test set controller for PNA based configuration
No additional options required for this configuration. All cables required to connect to PNA as well as two sets of 48 inch RF/LO/DC and IF cable for connection to a pair of OML T/R frequency extenders are included.

Notes:

1. *For the N5261A and N5262A several cable options exist for connecting OML Inc. T/R frequency extenders, please refer to the "Option Descriptions" section for details.*
2. *When configuring the PNA-X with a N5260A millimeter wave test set controller, please include a 10 dB 3.5 mm pad for connection to the LO and a set of four BNC to SMA adapters.*
3. *When configuring an OML Inc. frequency extenders without a test set controller, a set of frequency extender cables with support for an external bias supply are required, order N5260AK48 (4ft. RF/LO/IF/DC cable set that supports external bias connections using banana adapters) for each frequency extender used. Also required is a 12 V, 1.3 A power supply (e.g. Agilent U8001A) for each OML Inc. frequency extender.*
4. *Installation and productivity assistance is included with purchase of the above test set controllers. Please ensure that an ISP is completed by your Agilent Sales representative to qualify for these services.*

Millimeter-wave modules

Several modules are available and other special options may be configured on request. Select the appropriate quantity of modules required for the measurement set up. To request a specially configured test module contact your local Agilent sales engineer.

The single and dual channel receiver modules are used for antenna applications or for 1-port single path S-parameter measurements.

Transmission reflection modules (OML Inc.)

Waveguide flange	Frequency GHz	Standard transmission/ reflection modules	Transmission/reflection modules with 25 dB mechanical attenuator	Transmission/ reflection modules with 15 dB LO and RF amplifier[1]
WR22	33 - 50	N5256AW22 - STD	N5256AW22 - 001	N5256AW22 - 002
WR15	50 - 75	N5256AW15 - STD	N5256AW15 - 001	N5256AW15 - 002
WR12	60 - 90	N5256AW12 - STD	N5256AW12 - 001	N5256AW12 - 002
WR10	75 - 110	N5256AW10 - STD	N5256AW10 - 001	N5256AW10 - 002
WR08	90 - 140	N5256AW08 - STD	N5256AW08 - 001	N5256AW08 - 002
WR06	110 - 170	N5256AW06 - STD	N5256AW06 - 001	N5256AW06 - 002
WR05	140 - 220	N5256AW05 - STD	N5256AW05 - 001	N5256AW05 - 002
WR03	220 - 325	N5256AW03 - STD	N5256AW03 - 001	N5256AW03 - 002
WR02.2	325 - 500	N5256AW02 - STD	Not available	N5256AW02 - 002[2]
Extended WR12	56 - 94	N5256AX12 - STD	N5256AX12 - 001	Available on request

1. *Note the modules with the RF/LO amplifiers are for antenna applications that include a cable loss of 15 dBm to the module from the port of the Test set being used. Do not connect these directly to the test set controller port with the standard 48 inch cable, use a 15 dB pad if needed.*
2. *These modules require an external DC power supply (e.g. E3615A) when using them with the N5260A.*
3. *For transmission reflection modules with both the 25 dB mechanical attenuator and the 15 dB LO and RF amplifier order N5256AWxx-003. Not available for N5256AW02*

Single channel receive modules (OML Inc.)

Waveguide flange	Frequency GHz	Standard single channel receive modules	Single channel receive modules with 15 dB LO amplifier
WR22	33 - 50	N5257AR22 - STD	N5257AR22 - 001
WR15	50 - 75	N5257AR15 - STD	N5257AR15 - 001
WR12	60 - 90	N5257AR12 - STD	N5257AR12 - 001
WR10	75 - 110	N5257AR10 - STD	N5257AR10 - 001
WR08	90 - 140	N5257AR08 - STD	N5257AR08 - 001
WR06	110 - 170	N5257AR06 - STD	N5257AR06 - 001
WR05	140 - 220	N5257AR05 - STD	N5257AR05 - 001
WR03	220 - 325	N5257AR03 - STD	N5257AR03 - 001
WR02.2	325 - 500	N5257AR02 - STD	Available on request

Dual channel receive modules (OML Inc.)

Waveguide flange	Frequency GHz	Standard dual channel receive module	Dual channel receive module with 15 dB LO amplifier
WR15	50 - 75	N5258AD15 - STD	N5258AD15 - 001
WR12	60 - 90	N5258AD12 - STD	N5258AD12 - 001
WR10	75 - 110	N5258AD10 - STD	N5258AD10 - 001
WR08	90 - 140	N5258AD08 - STD	N5258AD08 - 001
WR06	110 - 170	N5258AD06 - STD	N5258AD06 - 001
WR05	140 - 220	N5258AD05 - STD	N5258AD05 - 001
WR03	220 - 325	N5258AD03 - STD	N5258AD03 - 001

Millimeter-wave calibration kits (OML Inc.)

Waveguide flange	Frequency GHz	Calibration kit
WR22	33 - 50	Q11644A
WR15	50 - 75	V11644A
WR12	60 - 90	N5260AC12
WR10	75 - 110	W11644A
WR08	90 - 140	N5260AC08
WR06	110 - 170	N5260AC06
WR05	140 - 220	N5260AC05
WR03	220 - 325	N5260AC03
WR02.2	325 - 500	N5260AC02
Extended WR12	56 - 94	N5260AC12

Transmission reflection modules (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	N5242A compatible modules	N5244A/45A/47A compatible modules	N5244A/45A/47A compatible modules (with 25 dB mechanical attenuator)	N5261/62 test controller compatible modules
WR15	50 - 75	N5262AW15-026	N5262AW15-STD	N5262AW15-001	N5262AW15-TST
WR10	75 - 110	N5262AW10-026	N5262AW10-STD	N5262AW10-001	N5262AW10-TST
WR8.0	90 - 140	N5262AW08-026	N5262AW08-STD	N5262AW08-001	N5262AW08-TST
WR6.0	110 - 170	N5262AW06-026	N5262AW06-STD	N5262AW06-001	N5262AW06-TST
WR5.1	140 - 220	N5262AW05-026	N5262AW05-STD	N5262AW05-001	N5262AW05-TST
WR3.4	220 - 325	N5262AW03-026	N5262AW03-STD	N5262AW03-001	N5262AW03-TST
WR2.2	325 - 500	N5262AW02-026	N5262AW02-STD	N5262AW02-001	N5262AW02-TST
WR1.5	500 - 750	N5256AW01-026	N5256AW01-STD	No Attenuator Option	Not available for use with test controller
WR1.0	750 - 950	N5262AW01-026	N5262AW01-STD	No Attenuator Option	Not available for use with test set controller
WR1.0	750 - 1.1 THz	Requires N5262AW01-020 and N5262AW01-105	N5262AW01-105	No Attenuator Option	Not available for use with test set controller

Notes:

1. *Dual and single channel receive only frequency extenders are available on request either directly through VDI inc. or through Agilent Technologies.*
2. *Each product number includes a single frequency extender, the required RF, LO and IF cables as well as a power supply.*
3. *For a full 2-port S-parameter measurement solution order quantity 2 each of the model numbers indicated above.*
4. *For the direct connection of modules a dual source 2- or 4-port PNA-X is required with Option 080.*
5. *Modules with TST option work with 2- or 4-Port PNA-X and uses either the N5261A or N5262A test set controller only. These modules come with their own power supply and do not use the power supplied from the test set.*

Calibration kit (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Calibration kit
WR15	50 - 75	N5262AC15
WR10	75 - 110	N5262AC10
WR8.0	90 - 140	N5262AC08
WR6.0	110 - 170	N5262AC06
WR5.1	140 - 220	N5262AC05
WR3.4	220 - 325	N5262AC03
WR2.2	325 - 500	N5262AC02
WR1.5	500 - 750	N5260AC01
WR1.0	750 - 1100	N5262AC01

Option Descriptions

- **Millimeter Module Cable Options (for N5261A and N5262A Millimeter Test Set Controller)**
  - **Option 501:** A set of 4 foot cables for connection of a module to the test set controller.
  - **Option 502:** A set of 2 meter cables for connection of module to the test set controller.
  - **Option 503**: A set of 3 meter cables for connection of module to the test set controller.
  - **Option 505:** A set of 5 meter cables for connection of module to the test set controller.
- **Millimeter-wave modules with bias-tees (Option 017)**
  (Only available with the PNA N5250C)
  Adds 67 GHz bias-tees to the combiner assembly between the input to the combiner and the 67 GHz coupler. The bias-tees have tri-axial connectors for force, sense, and ground. Positioning the bias-tees close to the DUT greatly improves stability for on-wafer and in-fixture devices. The bias-tees added for this option have a voltage rating of 40 volts and a maximum of 0.5 amps.
- **Millimeter-wave modules with bias-tees and port 2 attenuator (Option 018)**
  (Only available with the PNA N5250C)
  Adds 67 GHz bias-tees to the combiner assembly between the input to the combiner and the 67 GHz coupler. The bias-tees have tri-axial connectors for force, sense, and ground. Positioning the bias-tees close to the DUT greatly improves stability for on-wafer and in-fixture devices. The bias-tees added for this option have a voltage rating of 40 volts and a maximum of 0.5 amps. Additionally, Option 018 adds a 25 dB micrometer attenuator to the port 2 test head.
- **IF access (Option H11)**
  Provides hardware to enable antenna, point-in-pulse, and broadband millimeter-wave measurements to 110 GHz. For each of the MW PNA's measurement receivers, IF gates (enabled with pulsed measurement capability, Option H08) and external IF inputs are added. In addition, access to the PNA's internal RF and LO source is provided for remote mixing applications. For basic antenna measurements, only Option H11 is necessary. Pulsed-antenna applications also require the pulsed measurement capability (Option H08). Broadband measurements to 110 GHz, also requires an N5260A.
  - Use external IF access for up to 20 dB more sensitivity when making antenna measurements with a remote mixing configuration
  - Add Option H08 (Pulsed-RF Measurement Capability) to enable advanced pulsed measurements
  - Upgrade an E8361C with Option H11 to a broadband (10 MHz to 110 GHz) VNA system simply by purchasing an N5260A controller test set with Option 110, 120, or 130.
- **Time-domain capability (Option 010)**
  Used for viewing reflection and transmission responses in time or distance domain.
- **Configurable test set (Option 014)**
  Provides six front panel access loops. The loops provide access to the signal path between (a) the source output and the reference receiver, (b) the source output and directional coupler thru arm and (c) the coupled arm of the directional coupler and the port receiver.
- **Extended power range and bias tees (Option UNL)[1]**
  A 50 dB step attenuator and bias-tee set is inserted between the source and test port one and another set between the source and test port two.
- **Frequency offset (Option 080)[1]**
  This option enables the PNA Series microwave network analyzers to set the source frequency independently from where the receivers are tuned.

1. *These options apply to the E8361C and are limited to 67 GHz frequency range.*

- **Reference receiver switch (Option 081)**
  Option 081 adds a solid-state internal RF transfer switch in the R1 reference-receiver path. The switch allows the instrument to easily switch between standard S-parameter (non-frequency-offset) measurements and frequency-offset measurements such as relative phase or absolute group delay that require an external reference mixer.
- **Frequency converter measurement application (Option 083)**[1]
  The frequency converter application adds an intuitive and easy-to-use user interface, advanced calibration choices that provide exceptional amplitude and phase accuracy, and control of external signal sources for use as local oscillators.
- **Add receiver attenuators (Option 016)**[1]
  A 50 dB step attenuator is added between each test port and its corresponding receiver.
- **Pulsed-RF measurement capability (Option H08)**[1]
  Provides software to set up and control pulsed-RF measurements with point-in-pulse capability. The software sets the coefficients of the MW PNA ′s digital-IF filter to null out unwanted spectral components, enables the IF gates provided with IF Access (Option H11), and controls selected Agilent pulse generators. It can be run on the PNA or an external computer. A ".dll "file containing the IF-filter algorithms is included for automated pulsed-RF testing. The pulsed application is configured to work with the Agilent 81110A series pulse generator. For more detailed information regarding pulsed measurement capabilities with the PNA refer to the Agilent Web site **www.agilent.com/find/pna** and download the *PNA Series MW Configuration Guide for Pulsed Measurements*, literature number 5989-7913EN.
- **Rack mount kit without handles (Option 1CM)**
  Adds a rack mount (5063-9217) and rail kit (E3663AC) for use without handles.
- **Rack mount kit with handles (Option 1CP)**
  Adds rack mount (5063-9237) and rail kit (E3663AC) for use with previously supplied handles.

External synthesizers

- Recommended for enhancement of dynamic rrange of systems in certain frequency bands of operation.
- Typically for operations below 110 GHz external synthesizers are not required to achieve the already exceptional dynamic range as stated in the table on Page 6.
- When using a PNA based system and if you need to improve the dynamic range by up to 10 dB a set of external synthesizers are recommended. Note you will not need the external synthesizers when using a PNA-X.
- For frequency bands beyond 220 GHz, an improvement of up to 20 dB may be gained for PNA based configurations. Once again on the PNA-X there is no need to add external sources, please refer to Figure 9 for the typical performance.
- For rack mount configurations a rear panel output is recommended.

Ordering external synthesizers (not required for PNA-X)

- Two external synthesizers are required one for the RF and one for the LO and we recommend the E8257D with options 520 and UNX.
- For rear panel access to the E8257D option 1EM is available, moves all front panel connector to the rear.
- When external synthesizers are added, the following cables are also required and may be purchased separately:
  - 5 x BNC (2 for 10 MHz connections and 3 for Trigger connections)
  - 2 x 3.5mm (11500 E/F depending on setup and distance)
  - 2 x GPIB (10833A 1 meter GPIB cable)

1. *Up to 67 GHz.*

PNA and PNA-X options as related to banded millimeter-wave systems

	PNA series	PNA-X	
	E8362C (10 MHz to 20 GHz) E8363C (10 MHz to 40 GHz) E8364C (10 MHz to 50 GHz) E8361C (10 MHz to 67 GHz)	N5242A (10 MHz to 26.5 GHz) N5244A (10 MHz to 43.5 GHz) N5245A (10 MHz to 50 GHz) N5247A (10 MHz to 67 GHz)	
2-port with configurable test set	Option 014[1]	Option 200[2]	
4-port with configurable test set	n/a	Option 400	
Time domain	Option 010	Option 010	
IF access / IF inputs	Option H11[1] (requires Options 014, UNL, 080 and 081)	Option 020[2]	
2 ports, add internal 2nd source, combiner and mechanical switches	n/a	Option 224	Requires Options 200, 219 and 080
4 ports, add internal combiner and mechanical switches	n/a	Option 423	Requires Option 400, 419 and 080
Built-in pulse modulators	n/a	Option 021 (first source) Option 022 (second source)	
Built-in pulse generators	n/a	Option 025	
Pulse measurements	Option H08	Option H08	
Frequency offset	Option 080[1]	Option 080	
Reference receiver switch	Option 081[1]	(included in Options 200 and 400)	
Extended power range and bias tees	Option UNL[1]	Option 219 (2-port, requires Option 200) Option 419 (4-port, requires Option 400)	

1. Minimum requirement on the PNA configuration to be used in a banded milli-meter-wave system: E8361/2/3/4C with Options H11, 014, UNL, 080 and 081.

2. Minimum requirement on the PNA-X configuration to be used in a banded millimeter-wave system: N5242A with Options 200 and 020.

Please refer to the *Agilent PNA Family Microwave Network Analyzers Configuration Guide*, literature number 5989-7606EN, for details on option descriptions, other configurations and accessories.

Key Web Resources

Engineering services for 8510 to PNA Series migration

Agilent's network analyzer experts can save you time and money by working with you to migrate your 8510 instruments and transition your test code quickly and easily. For more information visit: **www.agilent.com/find/8510**

Information resources

For more information on the N5250C PNA visit: **www.agilent.com/find/pna**
Test and measurement accessories visit: **www.agilent.com/find/accessories**
www.agilent.com/find/mmwave

Agilent channel partners

Our channel partners offer accessories and measurement solutions that extend your network analysis capabilities.

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Web site: **www.cascademicrotech.com**
E-mail: sales@cmicro.com

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