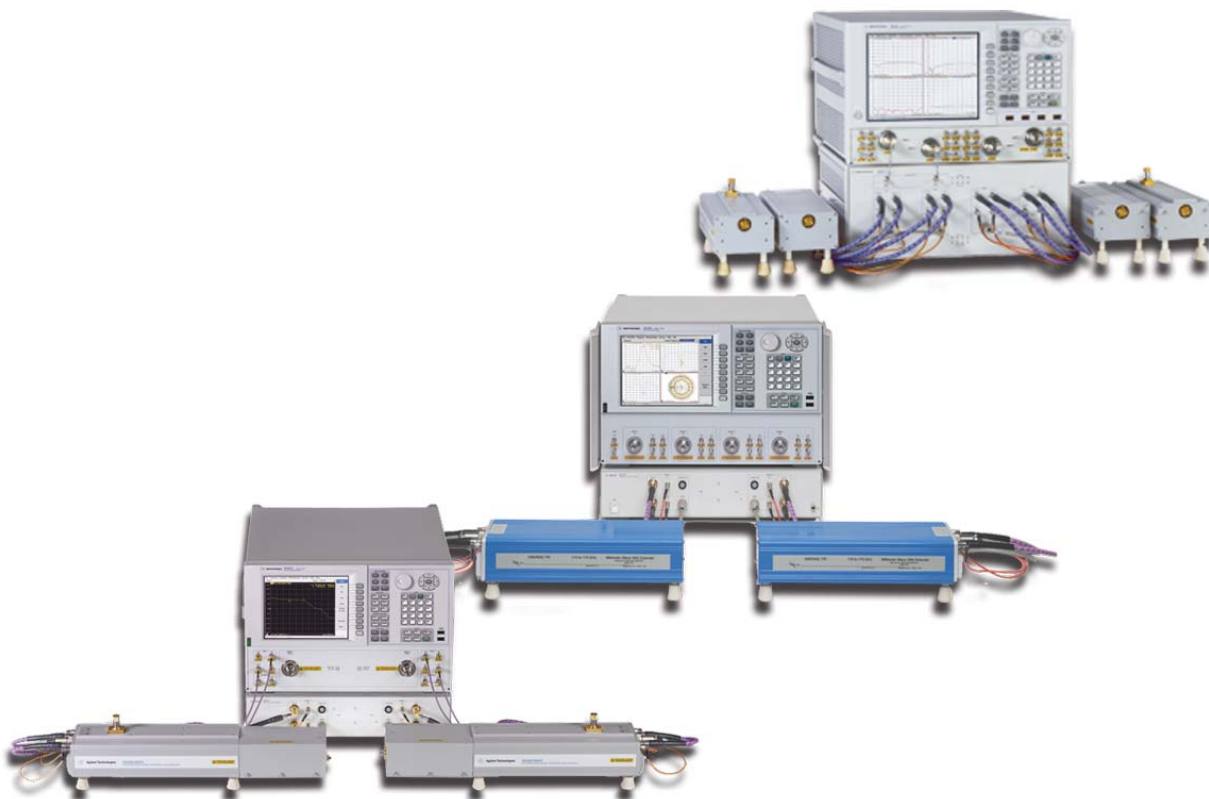


# Agilent Millimeter-Wave Network Analyzers 10 MHz to 110 GHz, with Extensions to 0.5 THz

## Technical Overview



### High Performance Bench-Top Network Analyzers

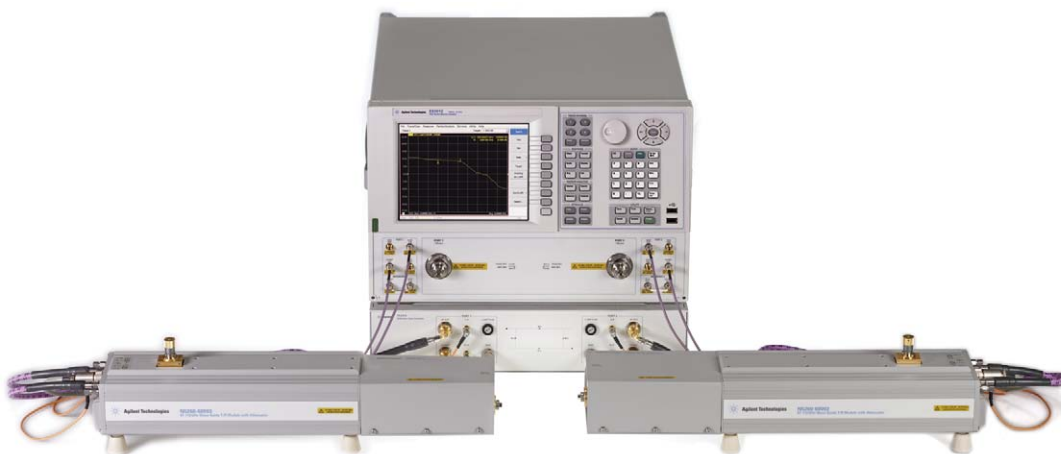
- Maximize your frequency coverage with a single sweep from 10 MHz to 110 GHz, and realize measurements to 0.5 THz with frequency extensions
- Minimize space and maintenance costs with compact test heads and two built-in synthesizers
- Optimize your test setup with 29 IFBW settings, 32 channels, 64 traces, and 20,001 points
- Capitalize on high performance with exceptionally accurate measurements inherent to the PNA Series of network analyzers
- Extend your measurement capability with four port mm-wave measurements in waveguide bands up to 0.5 THz



**Agilent Technologies**

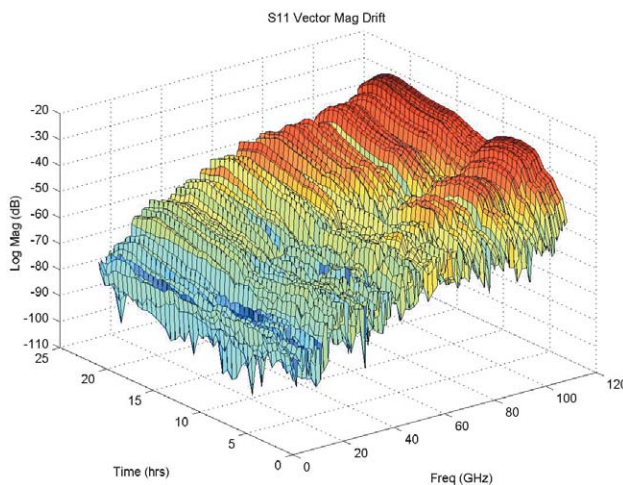
*Built on a solid foundation, the Agilent millimeter-wave solutions bring PNA Series **performance, flexibility, ease-of-use, and connectivity** to your design and test challenges in millimeter-wave applications.*

The Agilent N5250C 110 GHz system is the only bench-top, broadband system with integrated tri-axial bias tees that provides accurate control of device bias through its force/sense ability. This system is ideal for device characterization, modeling and parameter extraction in coaxial or on-wafer because accurate biasing leads to precise characterization, and broad frequency coverage down to 10 MHz offers superb time domain resolution.



## N5250C Key Features and Benefits

- 10 MHz to 110 GHz frequency range in a single sweep.
- Deliver accurate biasing through tri-axial bias tees near test ports.
- 20,001 points allow you to calibrate once over a wide frequency range and then focus in on frequencies of interest.
- Two new calibration capabilities, data-based calibration standards and expanded calibration algorithm, offer enhanced accuracy and design confidence.
- Code compatibility available to help Agilent 8510 users to migrate to the innovative and flexible PNA series platform.



## N5250C PNA Millimeter-Wave Network Analyzer

### 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.

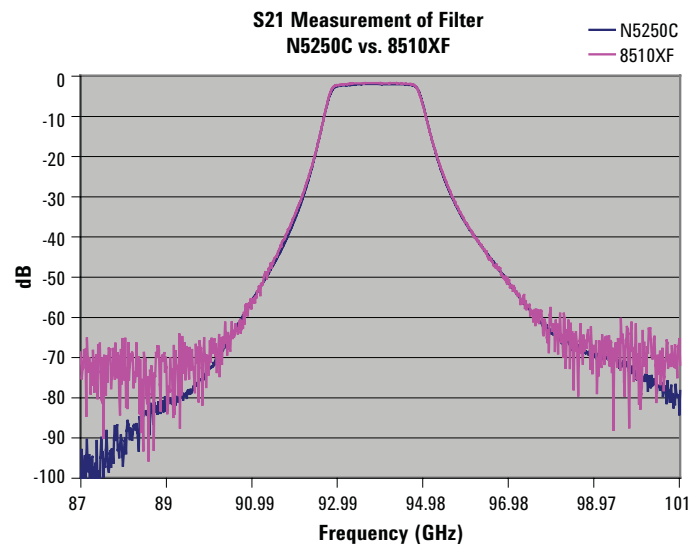


Figure 1.  $S_{21}$  filter measurement comparisons with Agilent's N5250C and 8510XF systems.

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 for force, sense, and ground. Positioning the bias-tees close to the DUT greatly improves stability for on-wafer and in-fixture devices.

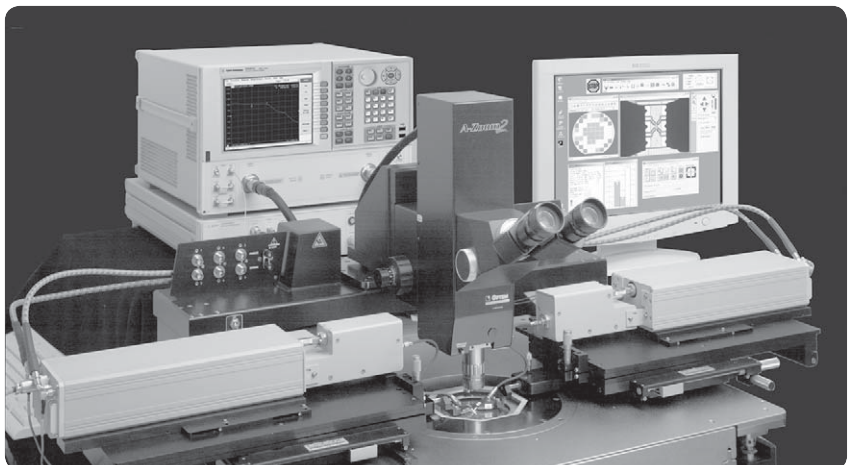


Figure 2. 110 GHz millimeter-wave system with Cascade Microtech's probe station.

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

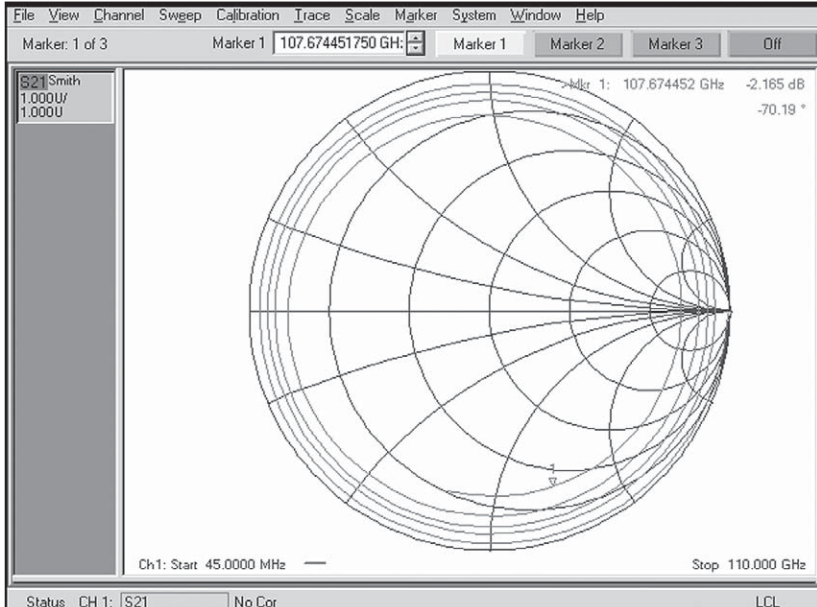


Figure 3.  $S_{21}$  measurement of a 40 ps transmission line made on a Cascade Microtech Summit probe station with Infinity probes.

## 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](http://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 <sup>1</sup>		
Test port power (dBm)	1.0 mm test port (standard configuration <sup>2</sup> or Option 017 <sup>3</sup> )	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 <sup>4</sup> (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 <sup>4</sup> (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.

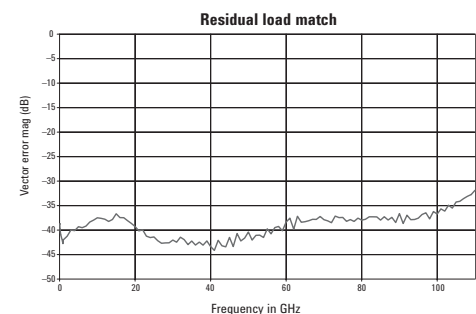
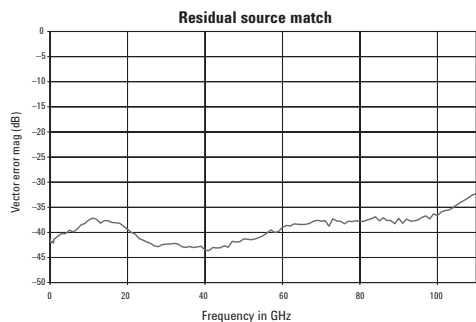
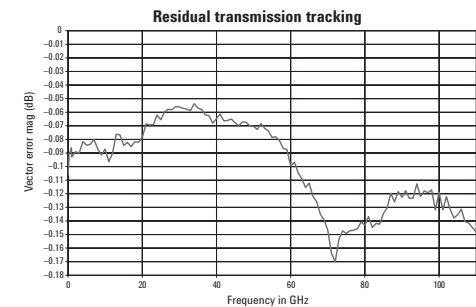
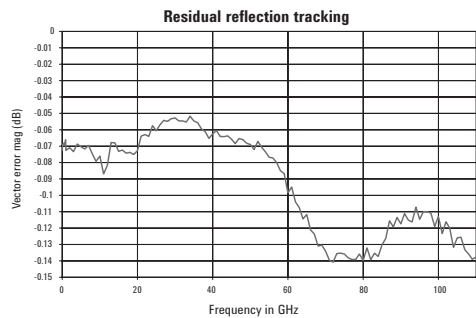
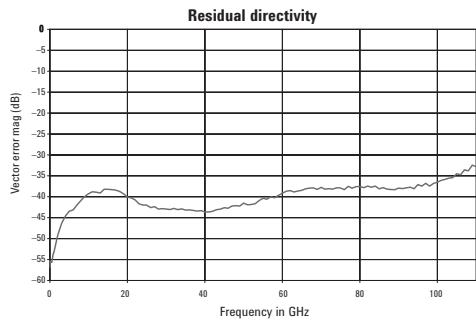


Figure 4. Plots showing residual calibration errors based on a coverage factor of 2 (2 sigma).

Measurement cycle time<sup>1</sup> (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 <sup>1</sup>	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 <sup>2</sup>
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 <sup>3</sup>	-7 to -13 dBm
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Rear panel RF power – test port frequencies (see 836x H11 specs for test port frequencies up to 67 GHz)

67 GHz to 76 GHz <sup>4</sup>	-4 to -10 dBm
76 GHz to 96 GHz <sup>4</sup>	+1 to -5 dBm
96 GHz to 110 GHz <sup>4</sup>	+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 (PRF) 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

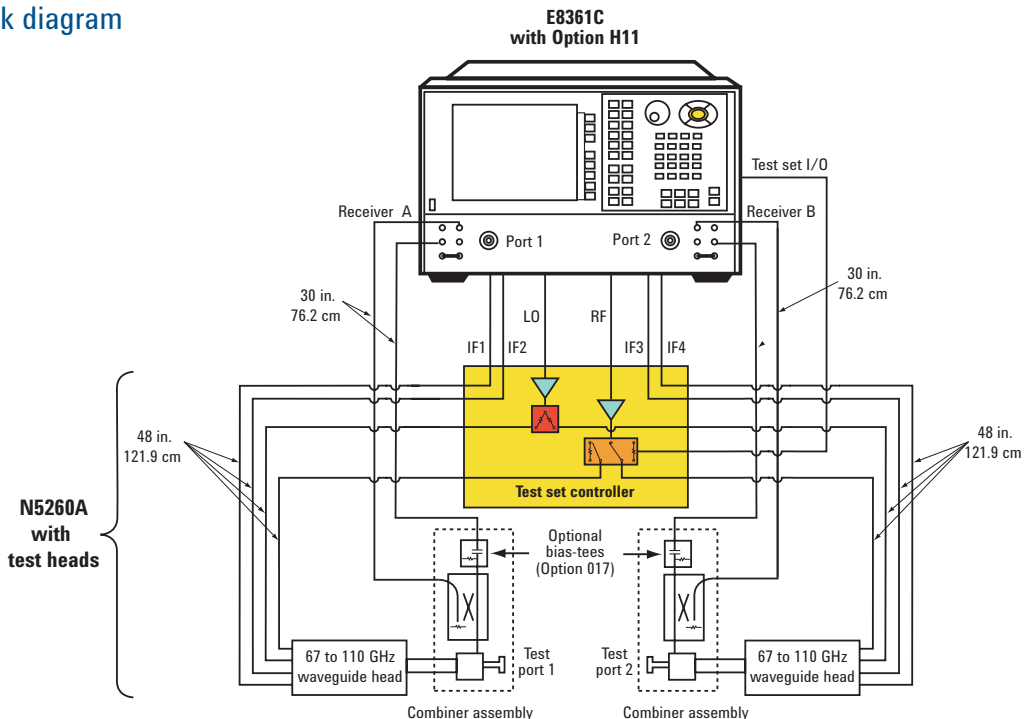


Figure 5. With Option 017, the signal is routed out of PNA from the front panel jumpers rather than the ports. Without Option 017, the signal is routed from the front panel ports to the combiner assembly, allowing access to the PNA's internal bias-tees.

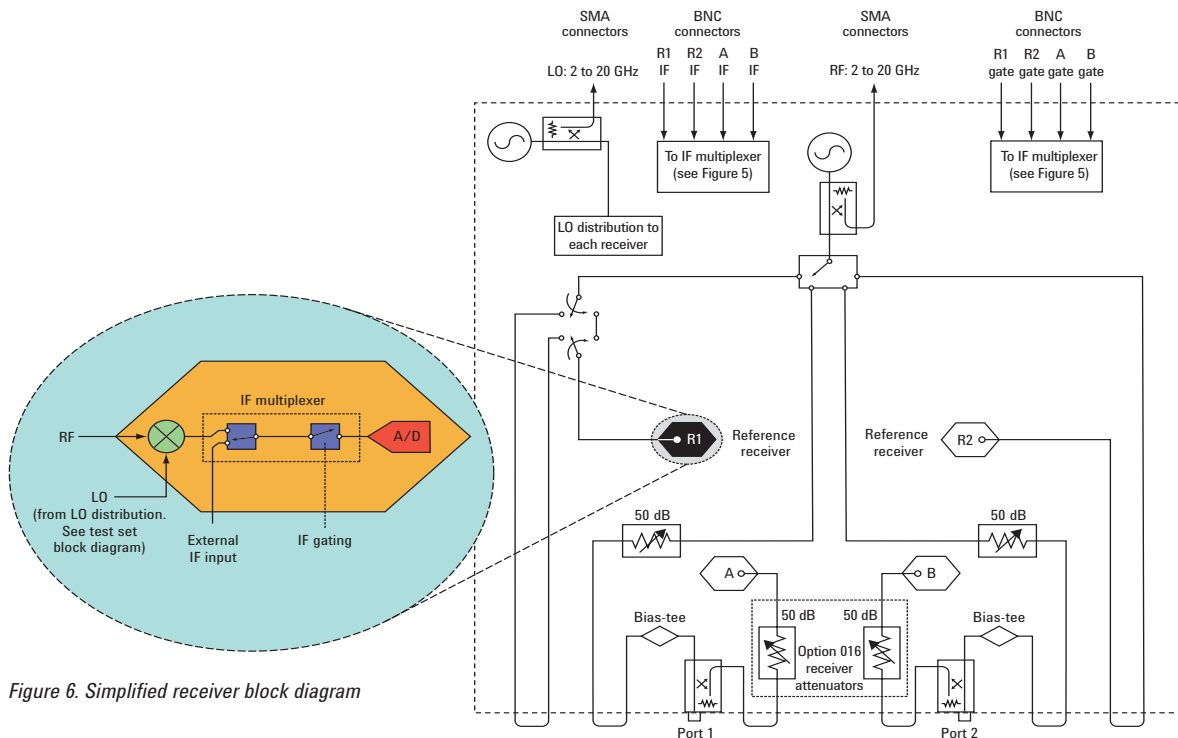


Figure 6. Simplified receiver block diagram

Figure 7. PNA test set block diagram



## Banded Millimeter-Wave Key Features and Benefits

The Agilent banded millimeter-wave system provides measurement capabilities up to 0.5 THz! Systems are extremely easy to configure and can be adapted to different needs as your measurement requirements change.



### Banded mm-wave Features

- Use the 2-port N5260A millimeter-wave test set controller to interface your PNA to the millimeter-wave module of your choice
- Use the 2-port N5261A or 4-port N5262A millimeter-wave test set controller to interface the PNA-X to the millimeter-wave module of your choice
- Wide selection of waveguide modules available to cover from 50 GHz to 0.5 THz<sup>1</sup>
- Flexible configuration, evolve as your needs grow
- Up to 20 dB improvement of dynamic range can be achieved by adding external synthesizers<sup>2</sup>

### Performance

Banded millimeter-wave systems configured with the PNA-X offer exceptional dynamic range all the way to 0.5 THz without additional external synthesizers. See Figure 9 for comparisons of waveguide band WR-03. Plus, pulsed millimeter-wave measurements can easily be achieved by simply adding built-in pulse generators and modulators, with no extra external equipment required.

With the PNA banded millimeter-wave system configured to make measurements from 140 GHz to 220 GHz (WR-05 waveguide band), dynamic range better than 60 dB across the entire band is achievable without any external synthesizers. As shown in Figure 8, adding two external synthesizers<sup>3</sup> can improve dynamic range up to 10 dB across the frequency range.

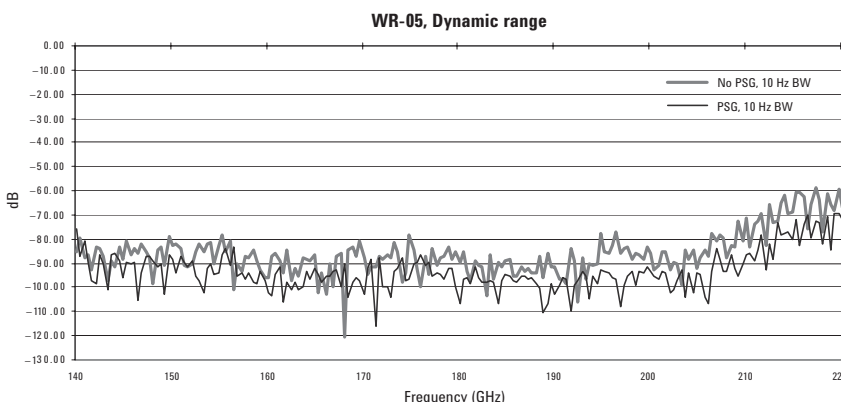


Figure 8. Dynamic range<sup>4</sup> of frequency band WR-05 (140 to 220 GHz), PNA System with and without external synthesizers<sup>3</sup>.

1. VNA2 waveguide modules from OML, Inc. are compatible with PNA and PNA-X banded millimeter-wave systems. VNA1 waveguide module from OML, Inc. may be used with 8510 systems. These VNA1 waveguide modules can be upgraded to VNA2 modules. Please contact OML, Inc. for details of upgrade, or visit OML, Inc. at [www.omlinc.com](http://www.omlinc.com)
2. For systems based on the PNA (not PNA-X), adding external synthesizers can improve dynamic range significantly at or above 220 GHz, while slight improvement can be seen between 110 GHz and 220 GHz.
3. External synthesizers used are the Agilent PSG Series, E8257D with Options 520 (20 GHz) and UNX (Ultra-low Phase Noise). Two external synthesizers are required; one for the RF signal and the other for the LO signal.
4. This plot is intended for use as a reference, and not as specifications. PNA system configuration included the E8362C 20 GHz MW PNA with Options H11, UNL, 014, 080 & 081, the N5260A mm-wave test set controller with one WR-05 Transmission/Reflection (T/R) test head module and one WR-05 Transmission-only (T) test head module. (One T/R module and one T module allow for S11 and S21 measurements. Two T/R modules allow for S11, S21, S12 and S22 measurements.) External synthesizers were added for dynamic range comparison. Measurement setup: 201 points, 10 Hz IF BW, and no average.

Figure 9 illustrates achievable dynamic range from 220 to 325 GHz (WR-03 waveguide band). By adding external synthesizers to the PNA setup, an improvement of up to 20 dB is achievable, resulting in better than 60 dB in dynamic range across the entire frequency band, which is similar to that of the PNA-X (without external synthesizer). For additional details and millimeter-wave configuration information refer to Application Note 1408-15: *Banded Millimeter-Wave Measurements with the PNA*, literature number 5989-4098EN, found on the PNA Web page: [www.agilent.com/find/pna](http://www.agilent.com/find/pna)

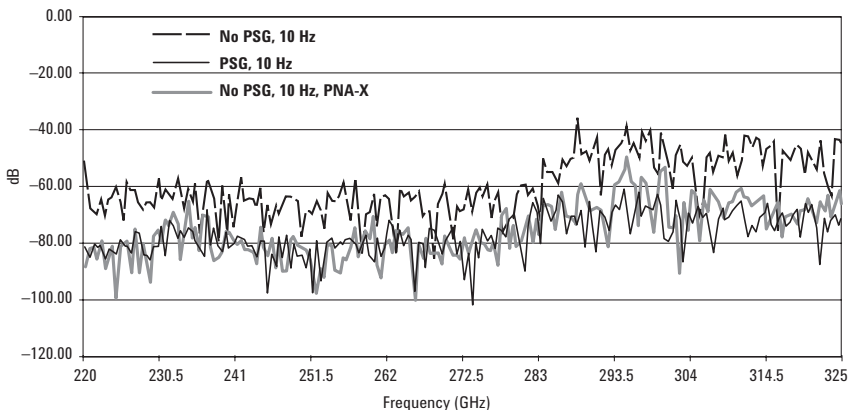


Figure 9. Dynamic range<sup>1</sup> of frequency band WR-03 (220 to 325 GHz), PNA system with and without external synthesizers<sup>2</sup> and PNA-X.

The PNA 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 10 shows the waveguide version of Cascade’s Infinity probe to 220 GHz.

1. This plot is intended for use as a reference, and not as specifications. PNA system configuration included the E8362C 20 GHz MW PNA with Options H11, UNL, 014, 080 and 081, the N5260A mm-wave test set controller with one WR-03 Transmission/Reflection (T/R) test head module and one WR-03 Transmission-only (T) test head module. (One T/R module and one T module allow for S11 and S21 measurements. Two T/R modules allow for S11, S21, S12 and S22 measurements.) External synthesizers were added for dynamic range comparison. PNA-X system configuration included the N5242A with options 200 and 020, the N5260A millimeter-wave test set controller with one WR-03 T/R module and one WR-03 T module. Measurement setup: 201 points, 10 Hz IF BW, and no average.
2. External synthesizers used are the Agilent PSG Series, E8257D with Options 520 (20 GHz) and UNX (Ultra-low Phase Noise). Two external synthesizers are required; one for the RF signal and the other for the LO signal.
3. The following Microwave PNA’s are compatible: E8361/2/3/4C; each unit must include Options H11, 014, UNL, 080 and 081. PNA-X configuration includes N5242A with Options 200 and 020.
4. External synthesizers can be added to the PNA system as desired.



Figure 10. Cascade Infinity Probe (GSG 150), waveguide versions to 220 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 by simply replacing the test head modules with the waveguide modules of your choice. A banded millimeter-wave system can also be configured from any of the Microwave PNA Series<sup>3</sup> or the PNA-X by simply adding the N5260A millimeter-wave test set controller and a pair of waveguide band test head modules<sup>4</sup>.

## Ease-of-use

The banded millimeter-wave system 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.

The banded millimeter-wave system can easily be configured using the dialogue box shown in Figure 11. 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.

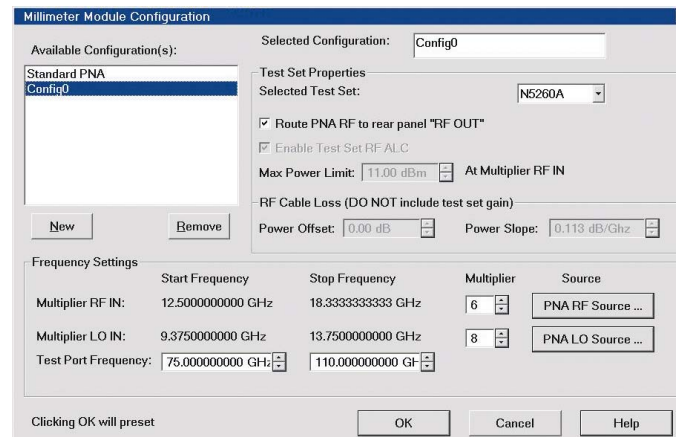


Figure 11. On-screen dialog to configure a banded millimeter-wave setup

A number of different configurations are available that allow setup for your system with added control on the ALC for the N5261A and N5262A test sets. 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's 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 millimeter-wave series 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.

## Banded millimeter-wave block diagram

Figure 12. N5261A/62A Test Set Block Diagram

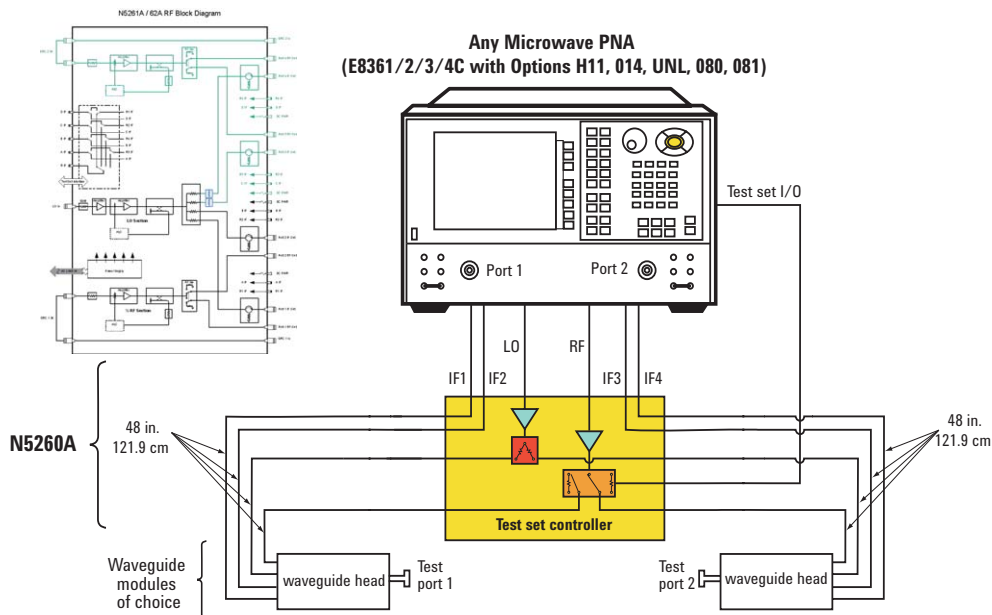


Figure 13. A banded millimeter-wave system consists of three major components: (1) Microwave PNA (E8361/2/3/4C with Options H11, 014, UNL, 080, 081) or PNA-X (N5242A with Options 200 and 020), (2) N5260A and (3) Test head modules.

## 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<sup>1</sup>, pulsed-RF measurements<sup>1</sup>, and time-domain transform applications

Note: Requires a completed ISP at time of 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

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<sup>2</sup>
- Time-domain capability – Option 010
- Pulsed-RF measurement capability – Option H08<sup>2</sup>
- Frequency converter application – Option 083<sup>2</sup>

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).

## 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.

### 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 TEI-14949 from Trompeter part TEI-14949 (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 are limited to 67 GHz frequency range.

### 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)<sup>1</sup>
- 11500K 1.0 mm (m-f) test port cable (20.0 cm)<sup>1</sup>
- 11500L 1.0 mm (m-f) test port cable (24.0 cm)<sup>1</sup>
- 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

## 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<sup>1</sup>
- Time-domain capability – Option 010
- Pulsed-RF measurement capability – Option H08<sup>1</sup>
- Frequency converter application – Option 083<sup>1</sup>

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.

## Banded Millimeter Wave System Configuration

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

1. A performance network analyzer
2. Millimeter wave test set controller
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

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

## 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 Opt. 2xx	26.5 GHz 2-port PNA-X network analyzer	Option 020
N5242A Opt. 4xx	26.5 GHz 4-port PNA-X network analyzer	Option 020

Note: When configuring the N5242A (Option 200 and 224 required) with a N5262A 4-port millimeter wave test set controller, also include Option 551 for 4-port calibration capability.

Optionally for rear panel connection of the RF source to the N5261A/N5262A test set controller include the switch combiner options to the N5242A selected above. For N5242A with Option 2xx, add Option 224 and for the N5242A with Option 4xx, add Option 423.

For E836x based systems used with modules above 200 GHz, these systems require a pair of external synthesizers (one for RF and the other for LO) to increase the dynamic range, see Figure 9 for improvement. Recommended synthesizers are E8257D with Options 520 and UNX.

## Millimeter wave test set controllers

Product number	Description	Options
N5260A	2-port test controller for PNA based solution	Includes all cables for connection to PNA as well as two sets of 48 inch RF, LO, DC and IF cables for connection to a pair of T/R millimeter modules.
N5261A	2-port test set controller for PNA-X based configuration	<ul style="list-style-type: none"> <li>Option 102 – A set of cables for connection to a 2-port PNA-X</li> <li>Option 104 – A set of cables for connection to a 4-port PNA-X</li> <li>Option 50x – A single set of RF, LO, DC and IF cables for connection to a single T/R millimeter module (see Option Descriptions for details).</li> </ul>
N5262A	4-port test set controller for PNA-X based configuration	<ul style="list-style-type: none"> <li>Option 102 – A set of cables for connection to a 2-port PNA-X</li> <li>Option 104 – A set of cables for connection to a 4-port PNA-X</li> <li>Option 50x – A single set of RF, LO, DC and IF cables for connection to a single T/R millimeter module (see Option Descriptions for details).</li> </ul>

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.

## 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

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 <sup>1</sup>
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 <sup>2</sup>
Extended WR12	56 - 94	N5256AX12 - STD	N5256AX12 - 001	Available on request

- 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.
- These modules require an external DC power supply (e.g. E3615A) when using them with the N5260A.
- 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

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

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

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



## Option Descriptions

- **Millimeter Module Cable Options ( for N561A 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)<sup>1</sup>**

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)<sup>1</sup>**

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)<sup>1</sup>**  
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)<sup>1</sup>**  
A 50 dB step attenuator is added between each test port and its corresponding receiver.
- **Pulsed-RF measurement capability (Option H08)<sup>1</sup>**  
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](http://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 range 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 N5242A 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)	
2-port with configurable test set	Option 014 <sup>1</sup>	Option 200 <sup>2</sup>	
4-port with configurable test set	n/a	Option 400	
Time domain	Option 010	Option 010	
IF access / IF inputs	Option H11 <sup>1</sup> (requires Options 014, UNL, 080 and 081)	Option 020 <sup>2</sup>	
2 ports, add internal 2 <sup>nd</sup> source, combiner and mechanical switches	n/a	N5245A-224	Requires Options 200, 219 and 080
4 ports, add internal combiner and mechanical switches	n/a	N5245A-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 <sup>1</sup>	Option 080	
Reference receiver switch	Option 081 <sup>1</sup>	(included in Options 200 and 400)	
Extended power range and bias tees	Option UNL <sup>1</sup>	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 Series 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](http://www.agilent.com/find/8510)

### Information resources

For more information on the N5250C PNA visit: [www.agilent.com/find/pna](http://www.agilent.com/find/pna)  
 Test and measurement accessories visit: [www.agilent.com/find/accessories](http://www.agilent.com/find/accessories)  
[www.agilent.com/find/mmwave](http://www.agilent.com/find/mmwave)

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Revised: July 2, 2009

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 Printed in USA, August 21, 2009  
 5989-7620EN

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