

# Banded Millimeter Wave Network Analysis



## Banded Measurement Solutions to 1.5 THz

Keysight offers a variety of banded millimeter-wave solutions that enable the PNA/PNA-X network analyzers to make S-parameter measurements up to 1.5 THz. These solutions are easily configurable with frequency extenders from OML Inc and Virginia Diodes Inc. Supported solutions through Keysight may be configured with or without a test set controller, depending on the measurements required and the frequency extenders being used.

There is also an affordable E-band solution with PXI-VNA and VDI frequency extenders. V-Band and W-Band VDI frequency extenders for use with PXI-VNA are also available. More information is given at the end of this technical overview.

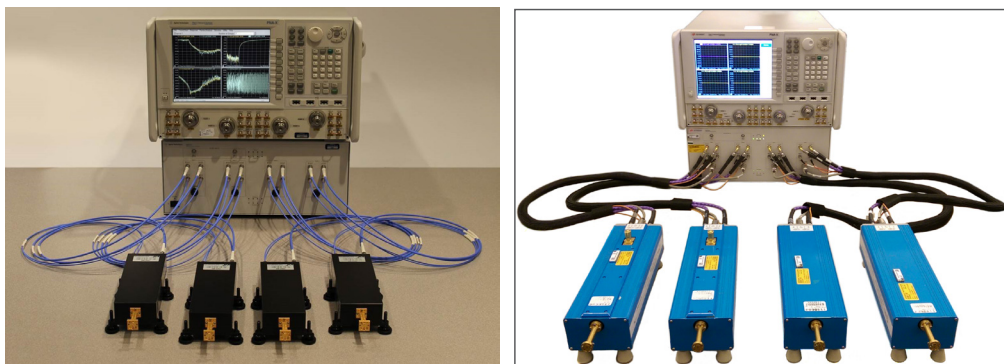
### Supported measurement capability

The following table is a summary of some of the measurement capability that is available using the banded configurations.

Application type	Test set controller support	Direct control support
S-parameters	Yes	Yes
True-mode measurements	Yes	No
Time domain	Yes	Yes
Enhanced Time Domain	No	No
Power measurements <sup>3</sup>	Yes	Yes
Power sweep <sup>3</sup> (single frequency)	Yes	Yes
Power spectrum	Yes	No
Pulse <sup>3</sup>	Yes	Yes
Mixers	Yes	No
Material measurements	Yes	Yes
Antenna measurements	Yes	Yes
On-wafer measurements	Yes	Yes
Inter-modulation distortion	Yes <sup>4</sup>	No
Spectrum Analysis	Yes	No
Noise figure	No	No
Source phase control	No	No
Automatic Fixture Removal	Yes <sup>5</sup>	No
NVNA/X-Parameters	No	No
Differential IQ	No	No

1. The above is not a complete list of capabilities but is what has been verified to date using the banded solution.
2. Please work with your local Keysight Sales representative for measurements not listed above.
3. Note for PNA-X models that work below 67 GHz pulse and RF power leveling is available with the rear panel switched outputs and requires the combiner option. For the PNA models that work below 67 GHz it is required that the front panel connection be used for pulse and power level support.
4. S93087B Inter-modulation distortion application is required when using OML IMD module and PNA/PNA-X.
5. Band pass mode only.

## Test Set Controller Solutions



### Key features

- Uses the N5261/2A and the N5292A test set controller to connect banded waveguide frequency extenders to the PNA/PNA-X.
- The N5261A/62A/92A test set controller enables to configure a 2-port millimeter-wave system with a single source PNA.
- The N5262A/92A test set controller enables to configure a 4-port millimeter-wave system with a dual source PNA.
- The N5261/62A are designed to provide DC supply to the OML frequency extenders.
- The built-in millimeter wave dialog allows users to easily switch between different waveguide band frequency extenders connected to the test set controllers.
- Supports the connection of VDI frequency extenders that cover waveguide bands from 26.5 GHz to 1.5 THz.
- Supports the connection of OML frequency extenders that cover waveguide bands from 50 GHz to 500 GHz.
- The 4-port N5262A and the N5292A Option 400 test controllers support differential and converter measurements using the VDI and OML frequency converters.
- Keysight test set controller with the PNA/PNA-X can be used to calibrate and control the power at the waveguide.

# Test Set Controller Solutions

## Test set controller based solutions performance

The test set controller based solutions offer not only the highest frequency coverage up to 1.5 THz but have also shown the best dynamic range in the industry. The following is an example of a WR2.2 frequency extender dynamic range using a PNA/PNA-X network analyzer, and a N5262A test set controller with a typical performance of 100 dB in a 10 Hz IFBW.

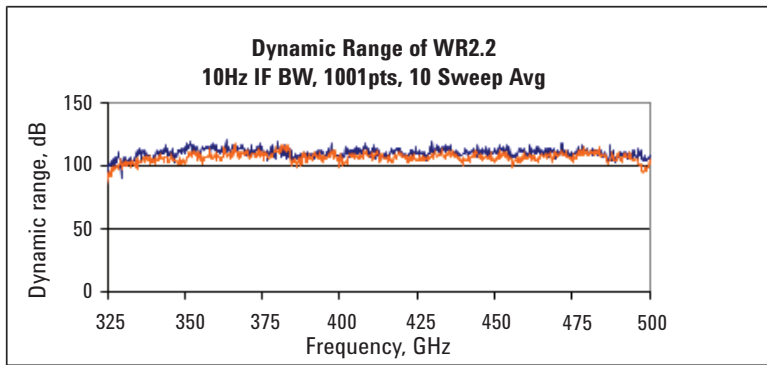


Figure 1. Dynamic range of a 325 to 500 GHz WR 2.20 VDI frequency extender

## Ease-of-use

The banded millimeter-wave system uses built-in firmware, allowing you to leverage the built in software features of the PNA and PNA-X Series network analyzers. Regardless of the frequency range of your measurements, you can manually control the instrument from the front panel or use a mouse to access the simple pull-down menus. In addition, you can utilize Cal Wizard to 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 2. 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.

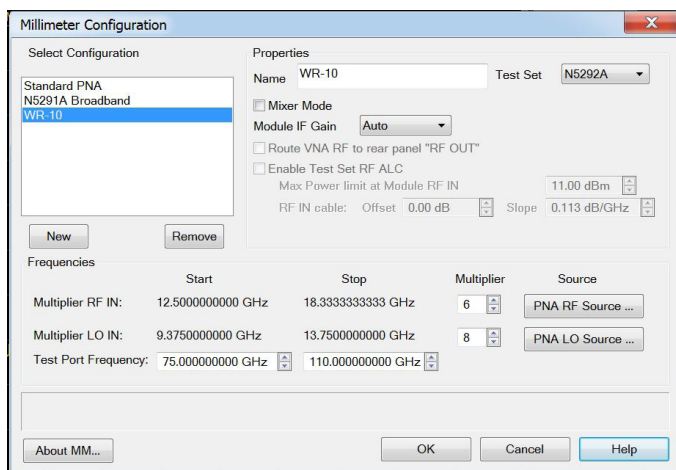


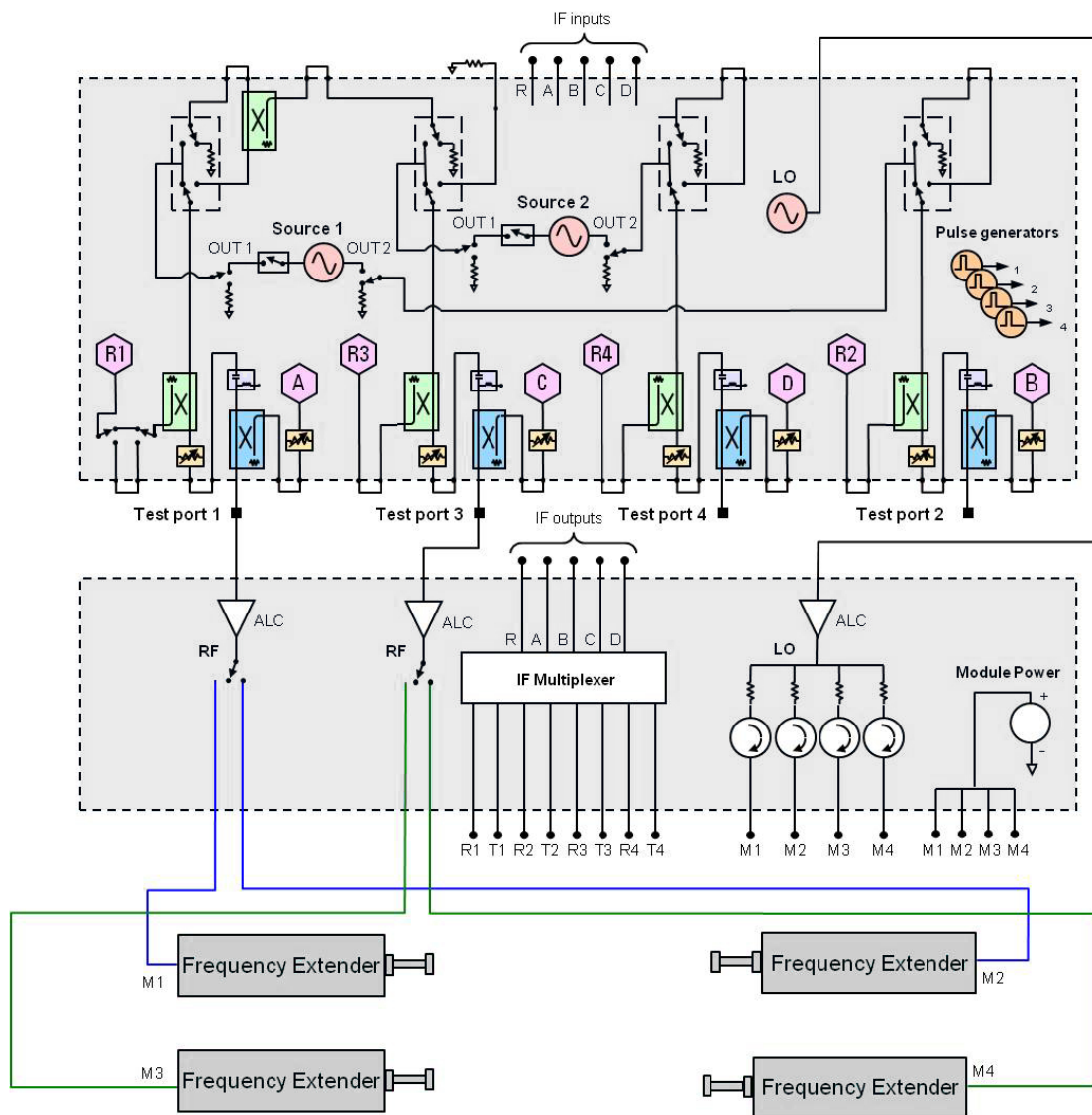
Figure 2. On-screen dialog to configure a banded millimeter-wave setup

## Test Set Controller Solutions

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 controller ALC for pulse measurements. Also available, is the ability to enable mixer sweep for scalar mixer measurements. This interface allows for ease of switching from one configuration to the next without restarting the PNA/PNA-X or reconfiguration of connections.

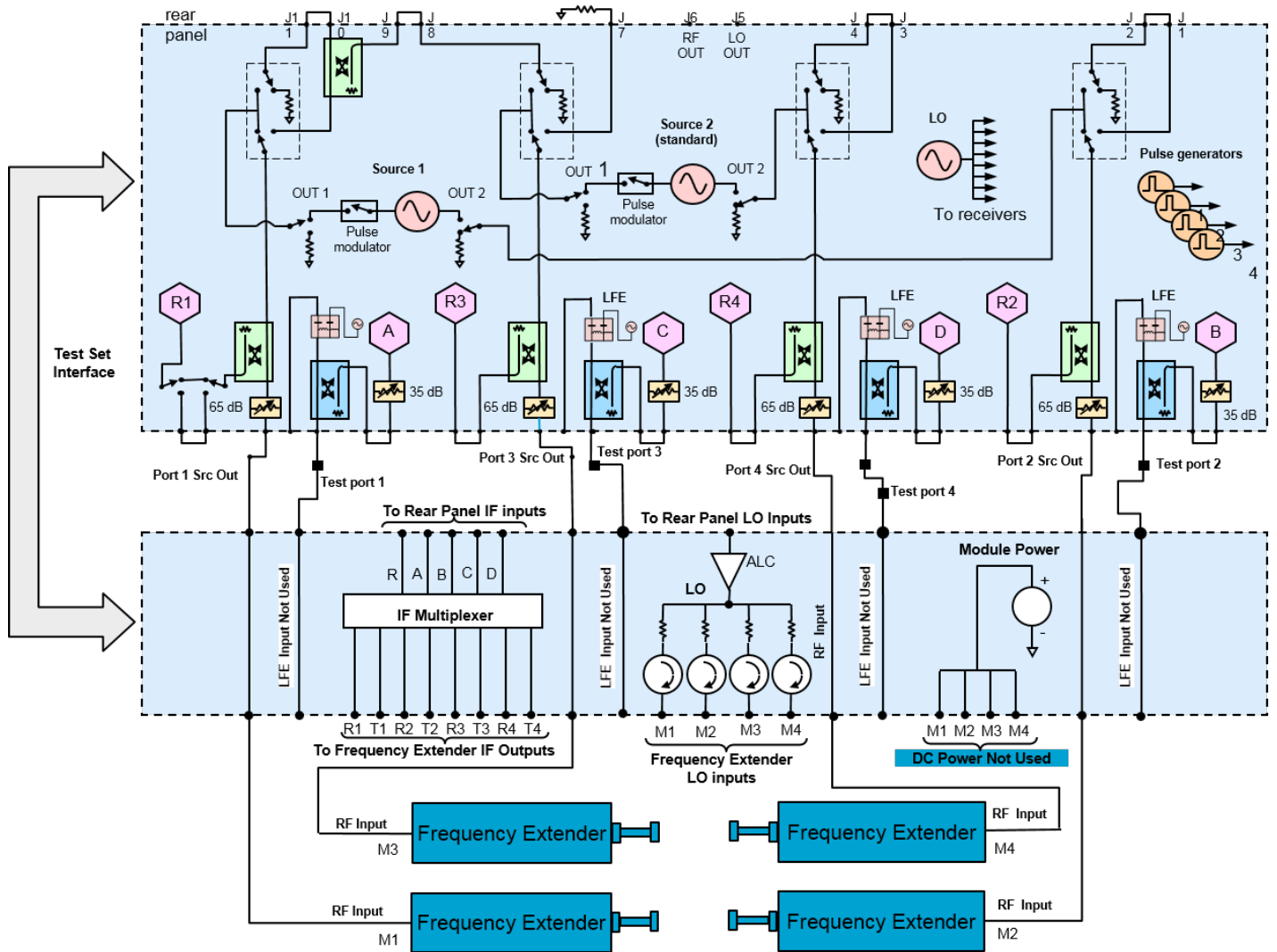
In addition, an extensive, context-sensitive Help system thoroughly explains all of the PNA and PNA-X features. In any dialog box, simply click Help to see a detailed explanation of the feature you are using. Programming examples in both SCPI and COM are also included.

### Test set controller based solution block diagram (N5262A)



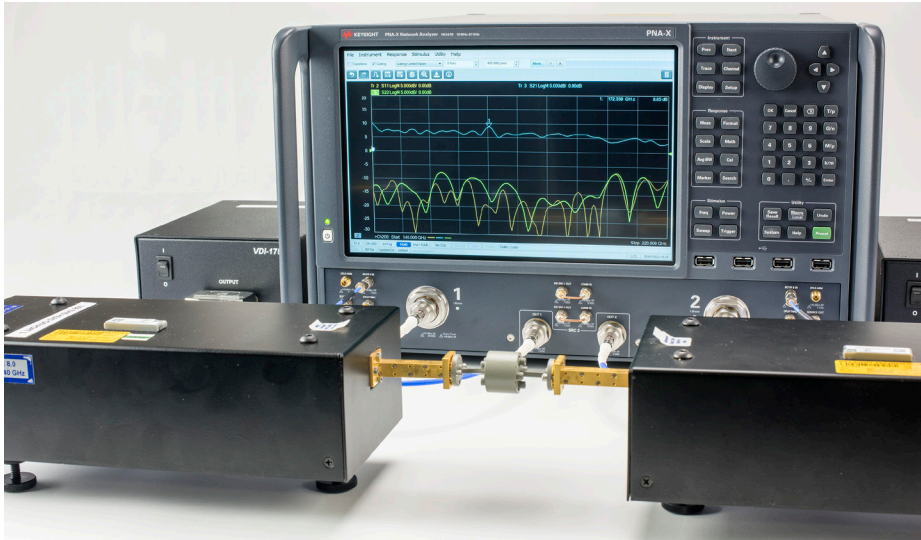
# Test Set Controller Solutions

## Test set controller based solution block diagram (N5292A)



## Direct Connect Solutions

These solutions do not require a millimeter-wave test set controller as they connect directly to the front panel of a dual source PNA or PNA-X. Both VDI and OML frequency extenders are supported with this configuration. Here is an example of a set of VDI modules that are directly connected to a dual source PNA.



### Key features

- This configuration does not require a test set controller.
- Requires a dual source PNA/PNA-X network analyzer with configurable test set option.
- It takes advantage of the FOM mode S93080B, that allows the dual source to provide separate RF and LO signals for the extenders.
- Supports full 2-Port S-parameter measurements within a waveguide.
- The direct connection supports power calibration and power sweep.
- Allows for the use of a higher IF frequency for test and reference signals.
- Can be driven with either a 26.5, 43.5, 50, or 67 GHz PNA/PNA-X.
- A downloadable macro is available from Keysight which simplifies the setup of the frequency offset mode.
- Provides the best dynamic range performance.

The direct connection configuration is currently supported using the frequency offset mode of the PNA/PNA-X and requires at least two sources to be able to do complete 2-port S-parameter measurements. The RF signal for the frequency extenders are supplied via the PNA/PNA-X port 1 and port 2 while the LO is supplied with the second source that drives the PNA/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 S-parameter measurements.

# Direct Connect Solutions

## Key performance

Calibration technology is built into the PNA/PNA-X that enables the most accurate measurements. The following are a few of the performance characteristics of the system. Figure 3 is a demonstration of the achievable stability of this system; it shows the vector magnitude stability of a 500 to 750 GHz solution over a period of 24 hours under typical laboratory conditions of 25 °C.

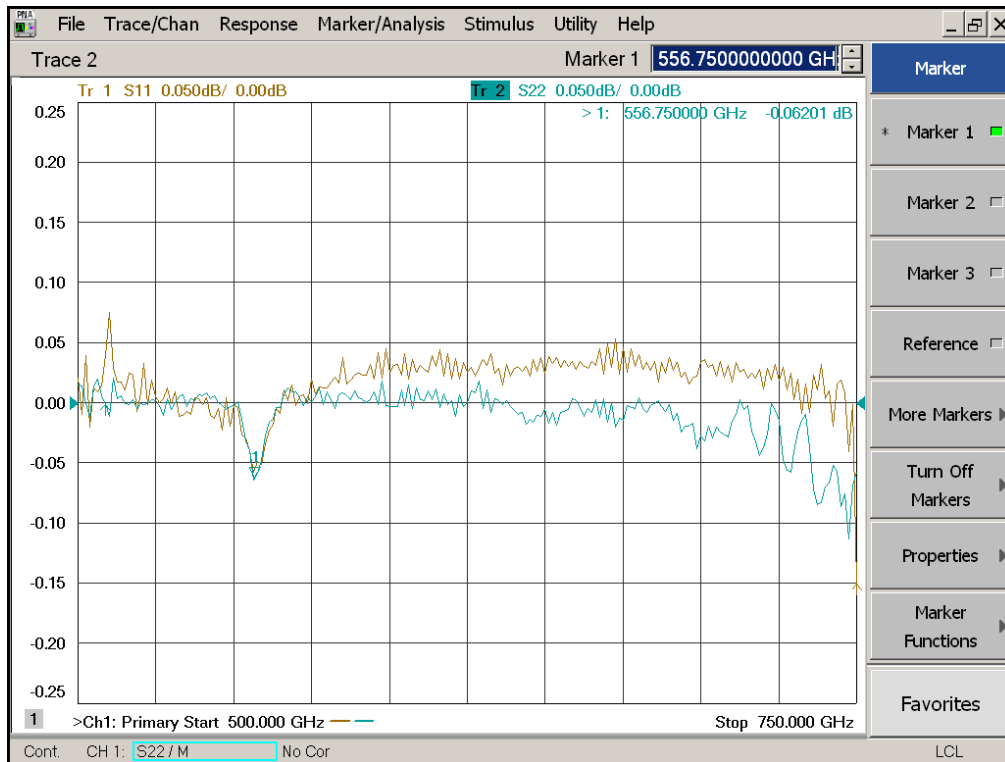


Figure 3. Typical drift performance of the PNA/PNA-X solution at 500 to 750 GHz with Virginia Diodes frequency extenders

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. The key performance characteristic is the excellent dynamic range as illustrated by the 500 to 750 GHz.



## Direct Connect Solutions

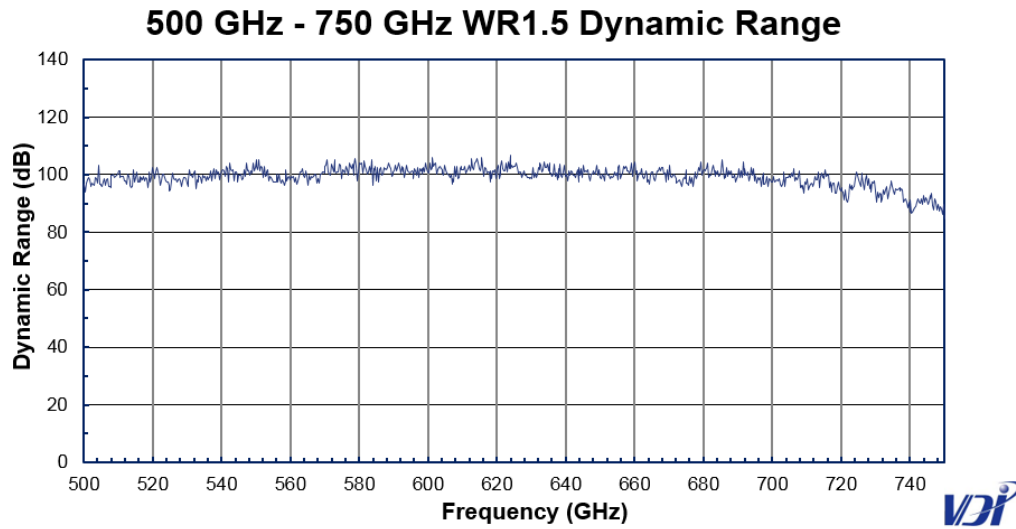


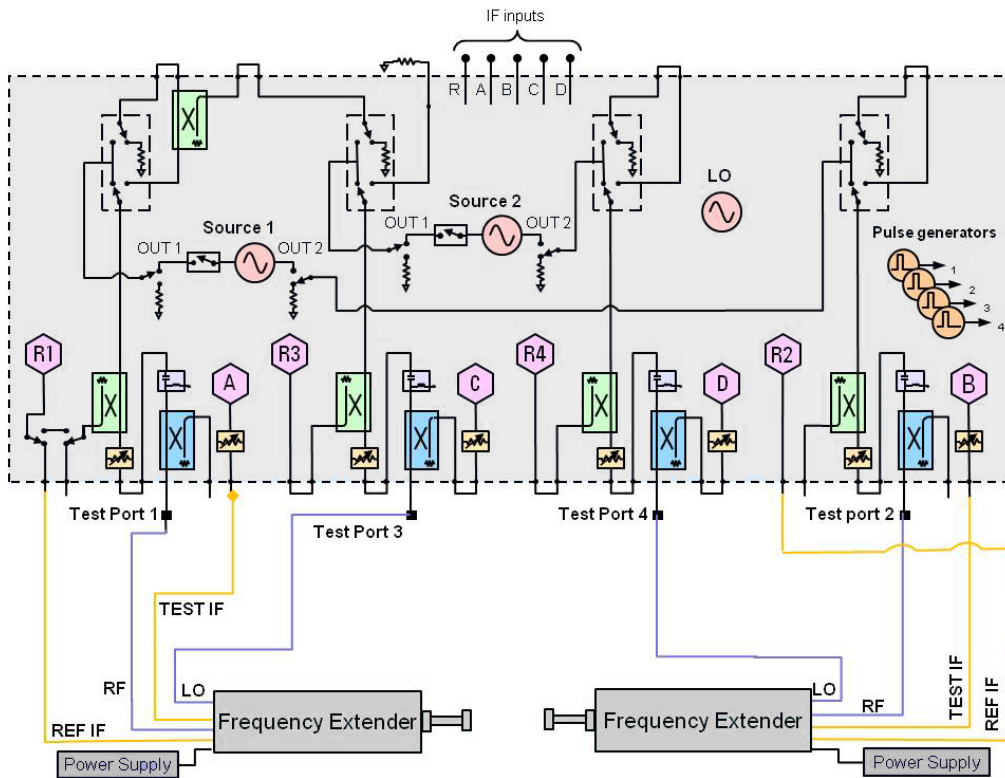
Figure 4. WR1.5 Dynamic range measurements VDI frequency extenders with a PNA-X

This solution provides unsurpassed dynamic range performance as shown in the Figure 4 plot of a 500 to 750 GHz dynamic range measurement using a direct connection of VDI extenders to a PNA/PNA-X. Note the typical performance is around 100 dB of dynamic range.

# Direct Connect Solutions

## Direct connect solution block diagram

This configuration of the PNA/PNA-X with frequency extenders offers the ability to directly connect frequency extenders to a 4-port PNA/PNA-X or a 2-port PNA-X with a second source. This enables vector network analysis measurements up to 1.5 THz.



## Banded Solution Configuration

Configuration of a banded solution is similar to configuration of a single sweep solution using separate components. With the support of several frequency extenders and vector network analyzer options, the banded solutions, offer industry leading flexibility and extensibility for measurements to 1.5 THz.

To configure hardware for a particular solution select the following components:

1. PNA or PNA-X network analyzer configured to support either a test set controller or direct connection of the frequency extenders.
2. 2- or 4-port millimeter test set controller, not required for direct connection. See page 2 for Supported measurement capability.
3. Frequency extenders for the frequency coverage required, see pages 13 to 17 for VDI extenders and pages 18 to 20 for OML extenders (Refer to Configuring a module on page 22).
4. Calibration kit for the frequency coverage required, see pages 17 (VDI Cal kits) and page 20 (OML cal kits).

### Supported PNA and PNA-X configurations for banded waveguide

Product model and description	Minimum option required for N5292A test set controller connection	Minimum option required for N5261A/2A test set controller connection	Minimum option required for direct connection
N5222/4/5/7B 2-port PNA Network Analyzer	Options 201 or 21x and 020	Options 2xx and 020	Unsupported
N5222/4/5/7B 4-port PNA Network Analyzer	Options 401 or 41x and 020	Options 4xx and 020	Option 401 or 41x and S93080B
N5242/4/5/7B 2-port PNA-X Network Analyzer	Options 2xx and 020	Options 2xx and 020	Option 22x and S93080B
N5242/4/5/7B 4-port PNA-X Network Analyzer	Options 4xx and 020	Options 4xx and 020	Option 4xx and S93080B

### Millimeter-wave test set controllers for banded configuration

N5292A-200 2-Port millimeter-wave test set controller <sup>1</sup>	
N5292A-222	Interconnect Kit for 2 Port Test Set and 2 Port VNA with 3.5 mm Ports
N5292A-224	Interconnect Kit for 2 Port Test Set and 2 Port VNA with 2.4 mm Ports
N5292A-242	Interconnect Kit for 2 Port Test Set and 4 Port VNA with 3.5 mm Ports
N5292A-244	Interconnect Kit for 2 Port Test Set and 4 Port VNA with 2.4 mm Ports
N5290A304	Cable Adapter for OML/VDI Frequency Extenders
N5292A-400 4-Port millimeter-wave test set controller <sup>1</sup>	
N5292A-422	Interconnect Kit for 4 Port Test Set and 2 Port VNA with 3.5 mm Ports
N5292A-424	Interconnect Kit for 4 Port Test Set and 2 Port VNA with 2.4 mm Ports
N5292A-442	Interconnect Kit for 4 Port Test Set and 4 Port VNA with 3.5 mm Ports
N5292A-444	Interconnect Kit for 4 Port Test Set and 4 Port VNA with 2.4 mm Ports
N5290A304	Cable Adapter for OML/VDI Frequency Extenders

1. The N5290A304 interface cable is required for each OML/VDI module for both the 2- and 4-port N5292A.

## Banded Solution Configuration

### **N5261A 2-port millimeter-wave test set controller for PNA/PNA-X based configuration**

N5261A-102	A set of cables for 3.5 mm connection to a 2-port N5222B or N5242B
N5261A-104	A set of cables for 3.5 mm connection to a 4-port N5222B or N5242B
N5261A-106	A set of cables for 2.4 mm connection to a 2-port N5224B/N5225B or N5244B/N5245B
N5261A-108	A set of cables for 2.4 mm connection to a 4-port N5224B/N5225B or N5244B/N5245B
N5261A-112	A set of cables for 1.85 mm connection to a 2-port N5227B or N5247B

### **N5262A 4-port millimeter wave test set controller for PNA/PNA-X based configuration**

N5262A-104	A set of cables for 3.5 mm connection to a 4-port N5222B or N5242B
N5262A-108	A set of cables for 2.4 mm connection to a 4-port N5224B/N5225B or N5244B/N5245B
N5262A-114	A set of cables for 1.85 mm connection to a 4-port N5227B or N5247B

- For the N5261A and N5262A, several cable options exist for connecting OML T/R frequency extenders, please refer to the option description section for details on page 19.
- A 2-Port PNA/PNA-X will only support 2-port banded measurements when used with a N5262A 4-port millimeter controller.

Please refer to the “*Millimeter Wave Network Analyzer (N5290A/91A) – Configuration Guide*”, literature number: 5992-2179EN, for more details and required interconnect options to connect the N5292A to the PNA and PNA-X network analyzers.

## Module types

- Transmission/reflection modules
  - TxRx modules (VDI) or Transmission/reflection modules (OML) that have both a receiver and a transmitter and can perform both transmission and reflection measurements.
- Transmitter modules
  - TxRef modules (VDI) that have a transmitter source and a reference output.
- Receiver-only modules
  - Rx modules (VDI) or T modules (OML) that only have a receiver, and require a transmission/reflection module or a TxRef module to perform transmission measurements. Rx modules cannot perform reflection measurements.

## 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 Keysight sales representative.

## Transmission/reflection mini-modules (Virginia Diodes VNAX models)

Waveguide flange	Frequency GHz	Standard transmission reflection modules	Transmission reflection modules with 0 to 30 dB micrometer driven attenuator
WR28	26.5 to 40	N5262BW28-STD	N5262BW28-001
WR19	40 to 60	N5262BW19-STD	N5262BW19-001
WR15 <sup>1</sup>	47 to 77	N5262BW15-STD	N5262BW15-001
WR12 <sup>1,2</sup>	55 to 95	N5262BW12-STD	N5262BW12-001
WR10 <sup>1,2</sup>	67 to 115	N5262BW10-STD	N5262BW10-001
WR8.0	90 to 140	N5262BW08-STD	N5262BW08-001
WR6.5	110 to 170	N5262BW06-STD	N5262BW06-001
WR5.1	140 to 220	N5262BW05-STD	N5262BW05-001
WR4.3	170 to 260	N5262BW04-STD	N5262BW04-001
WR3.4	220 to 330	N5262BW03-STD	N5262BW03-001
WR2.8	260 to 400	N5262BW2B-STD	N5262BW2B-001
WR2.2	330 to 500	N5262BW02-STD	N5262BW02-001

- A power supply is included with each module ordered.
- All modules are compatible with PNA/PNA-X or test set controller and have cable options for direct connection or test set connections.
- RF/LO input power options
  - Option 120: Require +10 dBm at the module input. Recommended for use with the test set and 1.2 m cable set.
  - Option 500: Require +2 dBm at the module input. Recommended for direct connect with 1.2 m or 5 m cable sets, or the test set with 5m cable set
- Cable sets options
  - Cable sets are available for purchase with cable options of the modules. Refer to Section, Configuring a module: Ordering a VDI VNAX mini-module, N526xBxx cable options on page 22.

1. TxRx Mini VNAX modules with extended frequency range.

2. These special options are also available.

N5262BW10-DS0 <sup>3</sup>	Dual source for IMD, WR10+, 67 to 115 GHz
N5262BW10-DS1 <sup>3</sup>	Dual source for IMD with 0 to 30 dB attenuator WR10+, 67 to 115 GHz
N5262BW10-SE0	Export control, TPP < 0 dBm, Maximum Frequency < 110 GHz
N5262BW10-SE1	Export control TPP < 0 dBm, Maximum Frequency < 110 GHz with 0 to 30 dB attenuator
N5262BW12-DS0 <sup>3</sup>	Dual Source module for IMD WR12+ 55 to 95 GHz
N5262BW12-DS1 <sup>3</sup>	Dual Source for IMD with 0 to 30 dB attenuator WR12+ 55 to 95 GHz
N5262BW12-SE0	Export control, 60 to 90 GHz < 15 dBm
N5262BW12-SE1	Export control, 60 to 90 GHz < 15 dBm with 0 to 30 dB attenuator

3. Recommend to use with the S93087A IMD measurement application software for IMD measurements. It requires the use of a N5292A-400 or N5262A 4-port controller.

## Banded Solution Configuration

### Transmission/reflection modules (Virginia Diodes VNAX-LG models)

Waveguide flange	Frequency GHz	Standard transmission/reflection modules	Transmission/reflection modules with 25 dB mechanical attenuator
WR1.5	500 to 750	N5256AW01-700	N5256AW01-701
WR1.0	750 to 1100	N5262AW01-700	No Attenuator Option
WR0.65	1100 to 1500	N5262AW065-700	No Attenuator Option

- Each product number includes a single frequency extender that supports all PNA/PNA-X and test sets.
- A power supply is included with each module ordered.
- For full 2-Port S-parameter measurements order quantity 2 of the Tx/Rx modules listed above.

### Transmitter and reference receiver modules (Virginia Diodes VNAX models)

Waveguide flange	Frequency GHz	Transmitter module	Transmitter/reference receiver modules with 0 to 30 dB attenuator
WR15 <sup>1</sup>	47 to 77	N5262BT15-STD	N5262BT15-001
WR12 <sup>1</sup>	55 to 95	N5262BT12-STD	N5262BT12-001
WR10 <sup>1</sup>	67 to 115	N5262BT10-STD	N5262BT10-001
WR3.4	220 to 330	N5262BT03-STD	N5262BT03-001
WR2.2	330 to 500	N5262BT02-STD	N5262BT02-001

1. We may be able to provide the modules for some other bands. Please check with your Keysight sales representative.

### Receiver mini-modules (Virginia Diodes VNAX models)

Waveguide flange	Frequency GHz	High sensitivity receive only module with external fixed attenuator
WR151	47 to 77	N5262BR15-001
WR121	55 to 95	N5262BR12-001
WR101	67 to 115	N5262BR10-001
WR8.0	90 to 140	N5262BR08-001
WR6.5	110 to 170	N5262BR06-001
WR5.1	140 to 220	N5262BR05-001
WR4.3	170 to 260	N5262BR04-001
WR3.4	220 to 330	N5262BR03-001
WR2.8	260 to 400	N5262BR2B-001
WR2.2	330 to 500	N5262BR02-001

- A power supply is included with each module ordered.
- All modules are compatible with PNA/PNA-X or test set controller and have cable options for direct connection or test set connections.
- RF/LO input power options
  - Option 120: Require +10 dBm at the module input. Recommended for use with the test set and 1.2 m cable set.
  - Option 500: Require +2 dBm at the module input. Recommended for direct connect with 1.2 m or 5 m cable sets, or the test set with 5 m cable set.
- Cable sets options
  - Cable sets are available for purchase with cable options of the modules. Refer to Section, Configuring a module: Ordering a VDI VNAX mini-module, N526xBxx cable options on page 22.

1. TxRx Mini VNAX modules with extended frequency range.

For more information on VDI mini modules, please refer to the product note, “N5262BWxx, N5262BTxx, and N5262BRxx Mini VNA Extension Modules,” N5262-90002.

## Banded Solution Configuration

### Receiver modules (Virginia Diodes VNAX-LG models)

Waveguide flange	Frequency GHz	Standard receiver only modules	High sensitivity receive only module with external fixed attenuator
WR1.5	500 to 750	N5256AR01-700	N5256AR01-701
WR1.0	750 to 1100	N5262AR01-700	Not available
WR0.65	1100 to 1500	N5262AR065-700	N5262AR065-701

- Each product number includes a single frequency extender that supports all PNA/PNA-X and test sets.
- A power supply is included with each module ordered.
- The receiver module requires a transmission module.

### Dimensions for waveguide transmission/reflection modules (Virginia Diodes Inc.)

Module	Width	Length	Height
<b>Standard</b>	5.0 inches	15.275 inches including waveguide, WR1.5 to WR15 10.25 inches including waveguide WR1.0	3.5 inches (feet adjust +1.25 inches)
<b>Mini-modules</b>	3.0 inches	8.5 inches, N5262BWxx and N5262BTxx	1.5 inches (feet adjust +0.75 inches)
	3.0 inches	3.75 inches, N5262BRxx	1.5 inches (feet adjust +0.75 inches)

### Calibration kits (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Calibration kit
WR28	26.5 to 40	N5260AC28
WR19	40 to 60	N5262AC19
WR15	50 to 75	N5262AC15
WR12	60 to 90	N5262AC12
WR10	75 to 110	N5262AC10
WR8.0	90 to 140	N5262AC08
WR6.5	110 to 170	N5262AC06
WR5.1	140 to 220	N5262AC05
WR4.3	170 to 260	N5262AC04
WR3.4	220 to 325	N5262AC03
WR2.8	260 to 400	N5262AC28
WR2.2	330 to 500	N5262AC02
WR1.5	500 to 750	N5260AC01
WR1.0	750 to 1100	N5262AC01
WR0.65	1100 to 1500	N5262AC065

## Power Meter (Virginia Diodes Inc)

### N1913PM5B Calorimetric Power Meter

The N1913PM5B can be operated with an N52xxB PNA/PNA-X banded configuration or the N5252A and also be used to measure the power of banded mm-wave signal sources with E8257DVxx VDI or E8257DSxx OML frequency extension modules.

Waveguide flange	Frequency [GHz]	Power meter
WR10	75 to 110	N1913PM5B
		N1913PM5B-701 (mandatory option)
Waveguide flange	Frequency [GHz]	Waveguide taper options
WR8.0	90 to 140	N1913PM5B-008
WR6.5	110 to 170	N1913PM5B-006
WR5.1	140 to 220	N1913PM5B-005
WR4.3	170 to 260	N1913PM5B-004
WR3.4	220 to 330	N1913PM5B-003
WR2.8	260 to 400	N1913PM5B-02B
WR2.2	325 to 500	N1913PM5B-002
WR1.5	500 to 750	N1913PM5B-01B
WR1.0	750 to 1100	N1913PM5B-001
WR0.65	1100 to 1500	N1913PM5B-065



## Banded Solution Configuration

### Cable Options (Virginia Diodes Inc.)

Cable sets are available for separate purchase as the N5262AKCBL model. These cable sets work for both VNAX and VNAX-LG extenders.

Cable option	Description
N5262AWCBL-N01	Cables not included for Option 700 or 701 Tx/Rx modules which are designed for use with 1.2 m cable set.
N5262AWCBL-N05	Cables not included for Option 700 or 701 Tx/Rx modules which are designed for use with 5 m cable set.
N5262AWCBL-701	1.2 m cable set for Option 700 or 701 Tx/Rx modules, for direct connect to > 43.5 GHz PNA/PNA-X. Includes an additional 50 GHz RF cable for high frequency operation of the Tx/Rx module.
N5262AWCBL-705	5 m cable set for Option 700 or 701 Tx/Rx modules, for connection to a N5261/62A test set.
N5262AWCBL-201	1.2 m cable set for Option 700 or 701 Tx/Rx modules, for direct connects to 26.5 GHz PNA/PNA-X.
N5262AWCBL-205	5 m cable set for Option 700 or 701 Tx/Rx modules, for direct connects to 26.5 GHz PNA/PNA-X.
N5262AWCBL-401	1.2 m cables set for Option 700 or 701 Tx/Rx modules, for direct connect to > 43.5 GHz PNA/PNA-X. Does not include an additional 50 GHz RF cable for high frequency operation of the Tx/Rx modules.
N5262AWCBL-405	5 m cables set for Option 700 or 701 Tx/Rx modules, for direct connect to > 43.5 GHz PNA/PNA-X. Does not include an additional 50 GHz RF cable for high frequency operation of the Tx/Rx modules.
N5262AWCBL-501	1.2 m cable set for Option 700 or 701 Tx/Rx modules, for connecting to N5261/62A test set.
N5262ARCBL-N01	Cables not included for Option 700 or 701 Rx only modules which are designed for use with 1.2 m cable set.
N5262ARCBL-N05	Cables not included for Option 700 or 701 Rx only modules which are designed for use with 5 m cable set.
N5262ARCBL-701	1.2 m cable set for Option 700 or 701 Rx only modules, for direct connect to > 43.5 GHz PNA/PNA-X. Includes an additional 50 GHz RF cable for high frequency operation.
N5262ARCBL-705	5 m cable set for Option 700 or 701 Rx only modules, for connection to a N5261/62A test set.
N5262ARCBL-201	1.2 m cable set for Option 700 or 701 Rx only modules, for direct connect to 26.5 GHz PNA/PNA-X.
N5262ARCBL-205	5 m cable set for Option 700 or 701 Rx only modules, for direct connect to 26.5 GHz PNA/PNA-X.
N5262ARCBL-401	1.2 m cable set for Option 700 or 701 Rx only modules, for direct connect to > 43.5 GHz PNA/PNA-X.
N5262ARCBL-405	5 m cable set for Option 700 or 701 Rx only modules, for direct connection to > 43.5 GHz PNA/PNA-X.
N5262ARCBL-501	1.2 m cable set for Option 700 or 701 Rx modules, for connecting to N5261/62A test set.

Note: Adapters may be purchased separately to allow for connection to both PNA/PNA-X front panel and N5261A/62A test sets.

## Banded Solution Configuration

The single and dual channel receiver modules are used for antenna applications or for 1-port single path S-parameter measurements. For more information, please refer to the user's guide, N5256/7/8A/B Millimeter-wave Module, N5256-90001.

### 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 <sup>1</sup>	Transmission/reflection modules with adjustable attenuator and 15 dB gain LO and RF amplifier
WR15 <sup>1</sup>	50 to 75	N5256BW15-STD <sup>3</sup>	N5256BW15-001 <sup>3</sup>	N5256BW15-002 <sup>3</sup>	N5256BW15-003 <sup>3</sup>
WR12 <sup>1</sup>	60 to 90	N5256BW12-STD <sup>3</sup>	N5256BW12-001 <sup>3</sup>	N5256BW12-002 <sup>3</sup>	N5256BW12-003 <sup>3</sup>
WR10	75 to 110	N5256AW10-STD <sup>3</sup>	N5256AW10-001 <sup>3</sup>	N5256AW10-002 <sup>3</sup>	N5256AW10-003 <sup>3</sup>
WR08	90 to 140	N5256AW08-STD	N5256AW08-001	N5256AW08-002	N5256AW08-003
WR06	110 to 170	N5256AW06-STD	N5256AW06-001	N5256AW06-002	N5256AW06-003
WR05	140 to 220	N5256AW05-STD	N5256AW05-001	N5256AW05-002	N5256AW05-003
WR03	220 to 325	N5256AW03-STD	N5256AW03-001	N5256AW03-002	N5256AW03-003
WR02.2	325 to 500	N5256AW02-STD	Not available	N5256AW02-002	Not available
Extended WR12 <sup>2</sup>	56 to 94	N5256BX12-STD	N5256AX12-001	N5256AX12-002	Not available
Extended WR10	67 to 110	N5256AX10-STD	N5256AX10-001	Not available	Not available

- A power supply is included with each module ordered.
- 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 controller 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.

1. BW15/12 and AW15/12 models cannot be mixed in a system. (BW and AW have different LO multipliers.)
2. BX12 and AX12 model cannot be mixed in a system. (BX and AX have different LO multipliers.)
3. N5256AW12/15 and N5256AX12 are non-RoHS versions.

### IMD transmission/reflection modules (OML Inc.)

Waveguide flange	Frequency GHz	IMD module product number
WR15	50 to 75	N5256AW15-IMD <sup>1</sup>
WR12	60 to 90	N5256AW12-IMD <sup>1</sup>
Extended WR12	56 to 94	N5256AX12-IMD <sup>1</sup>
WR10	75 to 110	N5256AW10-IMD
Extended WR10	67 to 110	N5256AX10-IMD

- Recommend to use with the S93087A IMD measurement application software for IMD measurements with these modules.
- The IMD modules require the use of a N5292A-400 or N5262A 4-port controller.

1. N5256AW12/15 and N5256AX12 are non-RoHS versions.

## Banded Solution Configuration

### Single-channel receiver-only modules (OML Inc.)

Waveguide flange	Frequency GHz	Standard Single-channel receiver-only modules	Single-channel receiver-only modules with 15 dB LO amplifier
WR15 <sup>1</sup>	50 to 75	N5257BR15-STD	N5257BR15-001
WR12 <sup>1</sup>	60 to 90	N5257BR12-STD	N5257BR12-001
WR10	75 to 110	N5257AR10-STD	N5257AR10-001
WR08	90 to 140	N5257AR08-STD	N5257AR08-001
WR06	110 to 170	N5257AR06-STD	N5257AR06-001
WR05	140 to 220	N5257AR05-STD	N5257AR05-001
WR03	220 to 325	N5257AR03-STD	N5257AR03-001
WR02.2	325 to 500	N5257AR02-STD	Available on request
WR12 <sup>1</sup>	60 to 90	N5257BX12-700	N5257BX12-701

– A power supply is included with each module ordered.

1. For the AR15/12 and AX12 model users. BR15/12 and BX12 models can't be mixed in a system with AR15/12 and AX12 models respectively due to different LO multipliers.

### Cables for OML Inc. banded millimeter-wave systems with test set controller

N5261A based OML solution	
Cable option	Description
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

N5262A based OML solution	
Cable option	Description
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

Note: Other special option cables are also available on request.

### Cables for OML Inc. banded millimeter-wave modules - direct connect only

Model number	Description
N5260AK48	4 ft cables (RF, LO, IF, Bias + adapters) for direct connect mm-head TxRx to N5224B, N5225B, N5227B, or N5244B, N5245B, N5247B
N5260AK50	4 ft cables (RF, LO, IF, Bias) to direct connect mm-head T/R to N5222B or N5242B
N5260AK51	4 ft cables (LO, IF, Bias) to direct connect mm-head Rec. only to N5222B or N5242B

## Banded Solution Configuration

### Dual-channel receiver-only modules (OML Inc.)

Waveguide flange	Frequency GHz	Standard Dual-channel receiver-only module	Dual-channel receiver-only module with 15 dB LO amplifier
WR15	50 to 75	N5258AD15-STD <sup>1</sup>	N5258AD15-001 <sup>1</sup>
WR12	60 to 90	N5258AD12-STD <sup>1</sup>	N5258AD12-001 <sup>1</sup>
WR10	75 to 110	N5258AD10-STD	N5258AD10-001
WR08	90 to 140	N5258AD08-STD	N5258AD08-001
WR06	110 to 170	N5258AD06-STD	N5258AD06-001
WR05	140 to 220	N5258AD05-STD	N5258AD05-001
WR03	220 to 325	N5258AD03-STD	N5258AD03-001

1. Non-RoHS compliant.

### Millimeter-wave calibration kits (OML Inc.)

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

### Waveguide designation equivalent table (supplemental information)

MIL-DTL-85/3C	IEEE Std 1785.1	Frequency range
WR-15	WM-3759	50 GHz to 75 GHz
WR-12	WM-3099	60 GHz to 90 GHz
WR-10	WM-2540	75 GHz to 110 GHz
WR-08 (WR8.0) <sup>1</sup>	WM-2032	90 GHz to 140 GHz
WR-06 (WR6.5) <sup>1</sup>	WM-1651	110 GHz to 170 GHz
WR-05 (WR5.1) <sup>1</sup>	WM-1295	140 GHz to 220 GHz
WR-04 (WR4.3) <sup>1</sup>	WM-1092	170 GHz to 260 GHz
WR-03 (WR3.4) <sup>1</sup>	WM-864	220 GHz to 330 GHz
WR-02 (WR2.8) <sup>1</sup>	WM-710	260 GHz to 400 GHz
WR-02 (WR2.2) <sup>1</sup>	WM-570	330 GHz to 500 GHz
WR-1.5	WM-380	500 GHz to 750 GHz
WR-1.0	WM-250	750 GHz to 1.1 THz
WR-0.65	WM-164	1.1 THz to 1.5 THz

Reference: IEEE Standard for Rectangular Metallic Waveguides and Their Interfaces for Frequencies of 110 GHz and Above – Part 1: Frequency Bands and Waveguide Dimensions.

1. VDI band designation.

## Measurement Accessories

The following table lists other accessories that may be used with Keysights millimeter wave network analyzer solutions.

Accessory type	Model number	Description
Calibration kit	85059B	DC to 120 GHz 1.0 mm calibration kit
Verification kit	85059V	1.0 mm verification kit
Power sensors	U8489A	DC to 120 GHz 1.0 mm USB power sensor <sup>1</sup>
	V8486A	50 to 75 GHz waveguide power sensor
	E8486A	60 to 90 GHz waveguide power sensor
	W8486A	75 to 110 GHz waveguide power sensor
Test port cables	11500JK07	110 GHz, 1.0 mm (m-f) test port cable (7 cm)
	11500JK10 <sup>2</sup>	110 GHz, 1.0 mm (m-f) test port cable (10 cm) <sup>3</sup>
	11500JK13 <sup>2</sup>	110 GHz, 1.0 mm (m-f) test port cable (13 cm) <sup>3</sup>
	11500I	110 GHz, 1.0 mm (f-f) test port cable (8.8 cm)
	11500J	110 GHz, 1.0 mm (m-f) test port cable (16 cm)
	11500K	110 GHz, 1.0 mm (m-f) test port cable (20 cm)
	11500L	110 GHz, 1.0 mm (m-f) test port cable (24 cm)
Waveguide adapters	V281C	1.0 mm (f) to V-band waveguide adapter
	V281CS	1.0 mm (f) to V-band waveguide adapter, In-line <sup>4</sup>
	V281D	1.0 mm (m) to V-band waveguide adapter
	V281DS	1.0 mm (m) to V-band waveguide adapter, In-line <sup>4</sup>
	E281CS	1.0 mm (f) to E-band waveguide adapter, In-line <sup>4</sup>
	E281DS	1.0 mm (m) to E-band waveguide adapter, In-line <sup>4</sup>
	W281C	1.0 mm (f) to W-band waveguide adapter
	W281CS	1.0 mm (f) to W-band waveguide adapter, In-line <sup>4</sup>
	W281D	1.0 mm (m) to W-band waveguide adapter
	W281DS	1.0 mm (m) to W-band waveguide adapter, In-line <sup>4</sup>
1.0 mm coaxial adapters	Y1910A	120 GHz, 1.0 mm (m) to 1.0 mm (m) standard adapter
	Y1910B	120 GHz, 1.0 mm (f) to 1.0 mm (f) standard adapter
	Y1910C	120 GHz, 1.0 mm (m) to 1.0 mm (f) standard adapter
1.85 mm coaxial adapters	11921E	1.0 mm (m) to 1.85 mm (m) adapter
	11921F	1.0 mm (f) to 1.85 mm (f) adapter
	11921G	1.0 mm (m) to 1.85 mm (f) adapter
	11921H	1.0 mm (f) to 1.85 mm (m) adapter
2.4 mm coaxial adapters	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
Package launch	11923A	1.0 mm (f) microcircuit connector launch assembly

1. Recommended for use with N5290/91A millimeter wave network analyzer solution.
2. The 11500JKxx cable is recommended for use with the probe positioners on FormFactor's probe station.
3. These cables will operate to 120 GHz mode free even though they are specified to work to 110 GHz.
4. Supplied by SAGE Millimeter Inc.

## Configuring a Module

### Ordering a VDI VNAX-LG module, N5256AW01 and N526xAxx

1. Select model for the frequency range of the module.
2. Select option 700 or option 701 for module with adjustable attenuator.
3. Select the cable option. The cable option selected will set power input requirement.
  - Option 201/401/501/701/N01 for use with 1.2 m cables, RF/LO power input requirement is 10 dBm at module input. Recommend for use with test set.
  - Option 205/405/505/N05 for use with 5 m cables, RF/LO power input requirement is 2 dBm at module input. Recommended for direct connect. Option N05 can also work with 1.2 m cable, which can be ordered separately as the N5262AKCBL for a Wxx or Rxx module. See options -201, -401 or -501.
4. Select the calibration kit and the N1913PM5B calorimetric Power Meter with option 701 and a taper option for the frequency range of the module.

### Ordering a VDI VNAX mini-module, N526xBxxx

1. Select model for the frequency range of the module.
2. Select option STD or option 001 for module with adjustable attenuator. See other options available in table.
3. Select the input power option 120 or 500. The option selected will set the RF/LO input power requirement.
  - Option 120 +10 dBm required at the module input. Recommend for use with the test set with 1.2 m cable set.
  - Option 500 +2 dBm required at the module input. Recommended for direct connect with 1.2 m or 5 m cable set or the test set with 5 m cable set.
4. Select the cable set option.
  - Option 201 Include 1.2 m cables for direct connect to 26.5 GHz PNA/PNA-X
  - Option 205 Include 5 m cables for direct connect to 26.5 GHz PNA/PNA-X
  - Option 401 Include 1.2 m cables for direct connect to 43.5/50/67 GHz PNA/PNA-X
  - Option 405 Include 5 m cables for direct connect to 43.5/50/67 GHz PNA/PNA-X
  - Option 501 Include 1.2 m cables for connect to controller
  - Option 505 Include 5 m cables for connect to controller
  - Option NOC No cables
5. Select the calibration kit and the N1913PM5B calorimetric Power Meter with option 701 and a taper option for the frequency range of the module.

Note:

- WR10 and WR12 modules have export-controlled options SE0 and SE1 for some export restricted countries.
- A and B models can be used together. Larger VNAX-LG modules will need to be placed with feet up to match the height of the VNAX mini module.

### Ordering a OML VxxVNA2 module, N525xAxxx

1. Select model for the frequency range of the module.
2. Select option STD or option 001 for module with adjustable attenuator. See other options available in table.
3. OML modules require RF and LO input power 10dBm, but options that add internal amplifiers are available.
4. Select the calibration kit and the N1913PM5B calorimetric Power Meter with option 701 and a taper option for the frequency range of the module.

Note:

WR12 and WR15 “A” models and “B” models are not compatible. “A” models have LO input multiplier = 5 and “B” models =6. WR10 and WR12 modules have an export-controlled option HLP (low power) for export restricted countries.

# N5252A 2/4-Port E-Band Network Analyzer Test System

The N5252A is an affordable E-band VNA system that consists of PXI-VNAs and E-band VDI frequency extenders. V-band and W-band VDI frequency extenders are also available to enable other PXI mm-wave band system configurations.



# N5252A E-Band (60 GHz to 90 GHz) Network Analyzer System

## Key features

- 2 or 4-port S-parameter measurements
- Power calibration at test ports with an external waveguide sensor (not included)
- More affordable than PNA-based E-band VNA
- Dedicated modules for the use only with Keysight PXI VNAs
- Includes PCI card and cable for customers desktop computer
- Includes waveguide calibration kit

## Key measurement performance

- Frequency range: 60 GHz to 90 GHz
- Dynamic range (BW=10 Hz): 100 dB minimum/110 dB typical
- Test Port Power: +13 dBm typical
- Test Port Interface: WR-12 IEEE 1785-2a compatible with UG-387/UM

## Configuration information

N5252A-200 E-band (60 GHz to 90 GHz) 2-Port system with cal kit

- M9005A PXIe Chassis with two M9374A PXIe network analyzer cards installed
- M9005A-002 PCIe desktop adapter and cable
- Two VDI VNAX mini WR12 (60 GHz to 90 GHz) millimeter-wave modules
- Two 1.2 m cable sets
- One N5262AC12, WR12 E-Band calibration kit from VDI

N5252A-400 E-band (60 GHz to 90 GHz) 4-Port system with cal kit

- M9005A PXIe Chassis with four M9374A PXIe network analyzer cards installed
- M9005A-002 PCIe desktop adapter and cable
- Four VDI VNAX mini WR12 (60 GHz to 90 GHz) millimeter-wave modules
- Four 1.2 m cable sets
- One N5262AC12 WR12 E-Band calibration kit from VDI

## Optional items

Either of these two power sensors/meter combinations is required for power calibration.

Items	Description
A U8489A and an E281CS	120 GHz USB power sensor and 1.0 mm coax (f) to WR-12 waveguide adapter
An E8486A and a power meter	E-band waveguide power sensors and a power meter with USB, LAN or GPIB

The N5252A supports the time domain measurements, but does not support the other PXI-VNA applications

Optional software application	Description
M9374AU-010	Time Domain
M9374AU-007	Automatic Fixture Removal

For higher measurement performance, frequency offset or other measurement applications, the PNA/-X based banded configuration is required.

A desktop computer, monitor and keyboard required for this system are not supplied. Desktop computer requirement

- Operating systems: Windows 7 64-bit or Windows 10 64-bit
- Processor speed: 2.4 GHz recommended, (1.5 GHz dual core x64 minimum)
- Available memory: 8 GB recommended; 1 GB minimum
- Available disk space: 1.5 GB available hard disk space minimum
- Instrument driver: Keysight IO libraries Ver. 18.1.23218.2
- One open PCIe slot



# Millimeter-wave Frequency Extenders for PXI-VNAs

These three models allow individual purchase of a pair of VDI VNAX mini millimeter-wave modules for V, E or W band that work with PXI-VNAs and allow you to configure your own millimeter-wave PXI-VNA system.

- N5252AW15 (50 GHz to 75 GHz)
- N5252AW12 (60 GHz to 90 GHz)
- N5252AW10 (75 GHz to 110 GHz)

The frequency extenders come in a Pelican case, which includes the two extenders, two sets of 1.2 meter cables, two power supplies, and two USB memory drives.

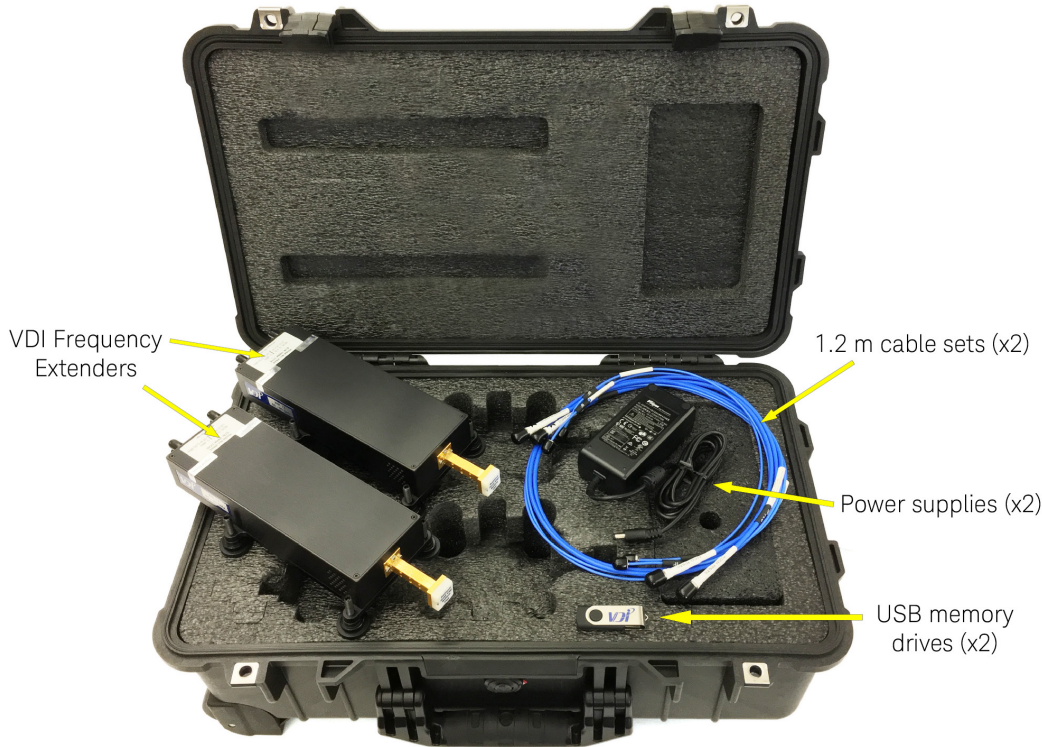


Figure 5. N5252AW12 System in Pelican Case

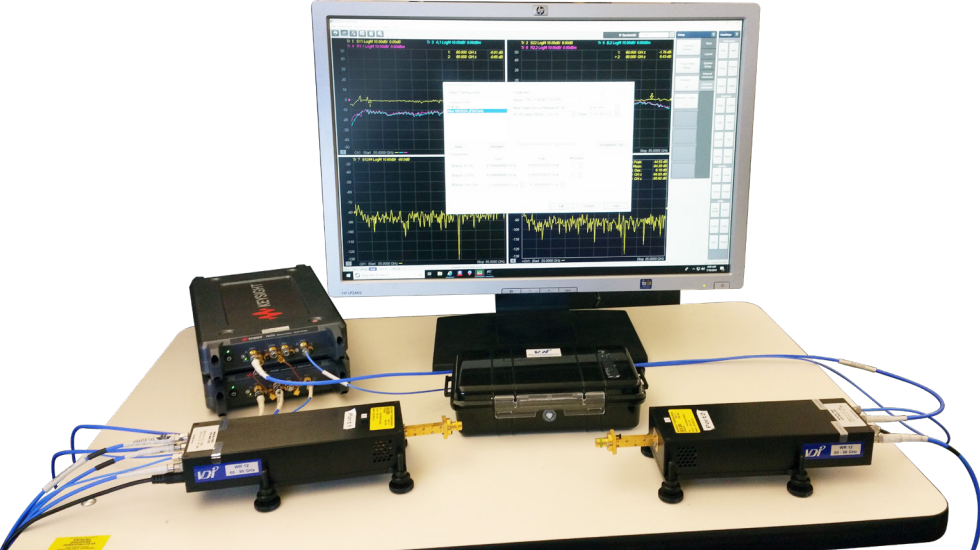
Table 1. Contents list

Part number	Description
N5252-80002 <sup>1</sup>	Pair of N5252AW12 TxRx VNAX Modules, with 1.2 m cable sets (2 sets of 3), power supplies (2), and USB drives (2), in a Pelican case. 60 to 90 GHz.
N5252-80003 <sup>1</sup>	Pair of N5252AW10 TxRx VNAX modules, with 1.2 m cable sets (2 sets of 3), power supplies (2), and USB drives (2), in a Pelican case. 75 to 110 GHz.
N5252-80004 <sup>1</sup>	Pair of N5252AW15 TxRx VNAX modules, with 1.2 m cable sets (2 sets of 3), power supplies (2), and USB drives (2), in a Pelican case. 50 to 75 GHz.
N5252-90002	N5252A User's Guide
N5252-90003	Product Note - VNAX mm-Wave Extenders for PXI Network Analyzers
9320-6695	China RoHS Addendum for Test Accessories-RF and Microwave
9320-6797	Keysight Safety Leaflet

1. Refer to the product ordered (N5252AW10, N5252AW12, or N5252AW15).

Note: The N5252A system is only available for E-band, and V and W bands are individual purchase only.

Also, if you have two P9374A/75As or four P9374A/5As, you can configure the same 2-port or 4-port VNA system with the USB VNAs. There is no system with the USB VNAs available for the purchase. Individual purchase only.



## Key Web Resources

### Engineering services for 8510 to PNA Series migration

Keysight'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.keysight.com/find/8510](http://www.keysight.com/find/8510)

For information about the frequency extender modules, get on the VDI or OML websites.

### Virginia Diodes, Inc.

[www.vadiodes.com](http://www.vadiodes.com)

### OML, Inc.

[www.omlinc.com](http://www.omlinc.com)

### For information about probing equipment and accessories, contact:

Cascade Microtech, Inc.  
2430 NW 206th Avenue  
Beaverton, Oregon 97006, USA  
Toll-free telephone: (800) 550-3279  
Telephone: (503) 601-1000  
Fax: (503) 601-1002  
Web site: [www.cascademicrotech.com](http://www.cascademicrotech.com)  
E-mail: [sales@cmicro.com](mailto:sales@cmicro.com)

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

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

