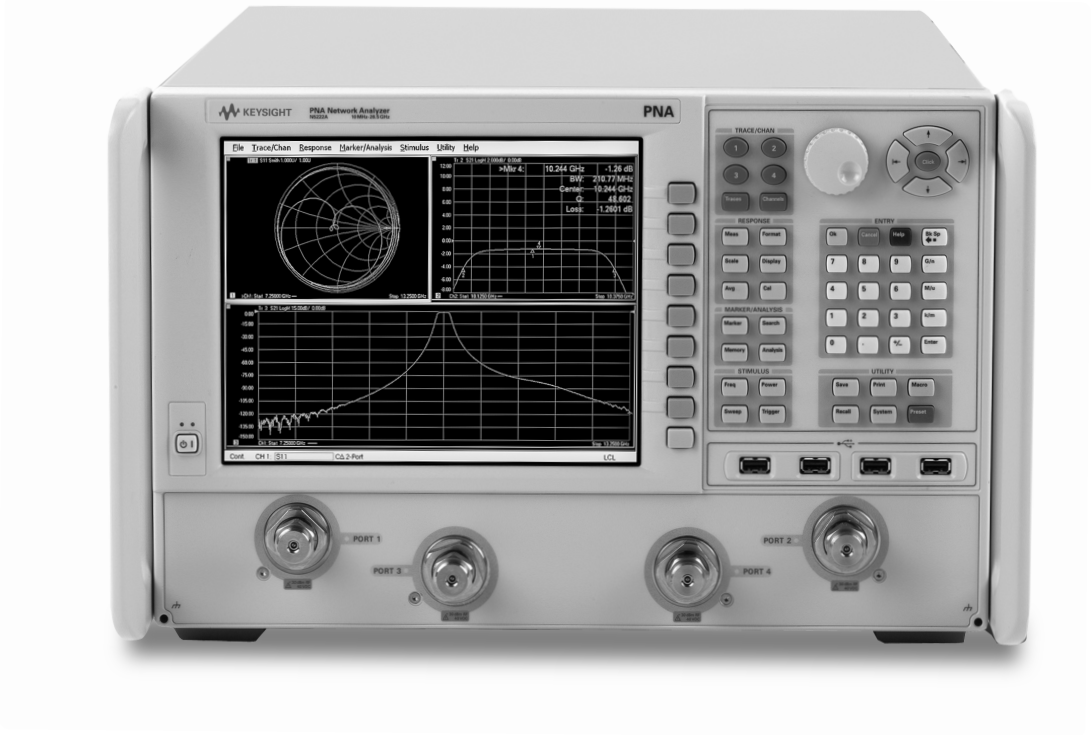
Keysight Technologies
Antenna Test

Selection Guide



KEYSIGHT TECHNOLOGIES

1. Introduction

Keysight Technologies, Inc. provides many of the components you need to make accurate antenna and radar cross-section (RCS) measurements. This Antenna Test Selection Guide will help you select the hardware necessary to meet your antenna measurement requirements. This note is primarily for customers who want to design, integrate, and install their own antenna measurement system using Keysight antenna test equipment, and for customers migrating to Keysight's latest network analyzers. For the experienced do-it-yourself customer, this selection guide will describe the input and output characteristics of antenna measurement components available through Keysight. Your Keysight Technologies sales engineer will be glad to assist you in procuring the instrumentation. Keysight Technologies does not provide software or integration services for antenna measurement systems. However, Keysight Productivity Services can provide these services for a fee.

Some customers may prefer the design, integration, and installation of an antenna system be performed for them by a solution supplier who has extensive antenna test configuration experience. Keysight Technologies works with channel partners who can provide this service. Our channel partners will work with you to understand your measurement needs and design an antenna test system that meets those needs. They will design the RF subsystem, the positioning subsystem, the measurement application software, and provide system installation and training.

This selection guide is meant as an aid for those with extensive antenna test experience. Refer to the Keysight website: **www.keysight.com/find/antenna** for access to technical papers and current antenna test equipment information.

Use this guide to:

- Understand how Keysight instruments can be integrated into your configuration
- Learn about interface requirements between components
- Understand issues related to selecting the equipment required to make antenna measurements
- Learn how to migrate from the 8510 to PNA network analyzer or 8530 to N5264A PNA-X measurement receiver.

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Main parts of an antenna range

A typical antenna range measurement system can be divided into two separate parts: the transmit site and the receive site (see Figure 1). The transmit site consists of the microwave transmit source, amplifiers (optional), the transmit antenna, and the communications link to the receive site. The receive site consists of the antenna under test (AUT), a reference antenna, receiver, LO source, RF downconverter, positioner, system software, and a computer.

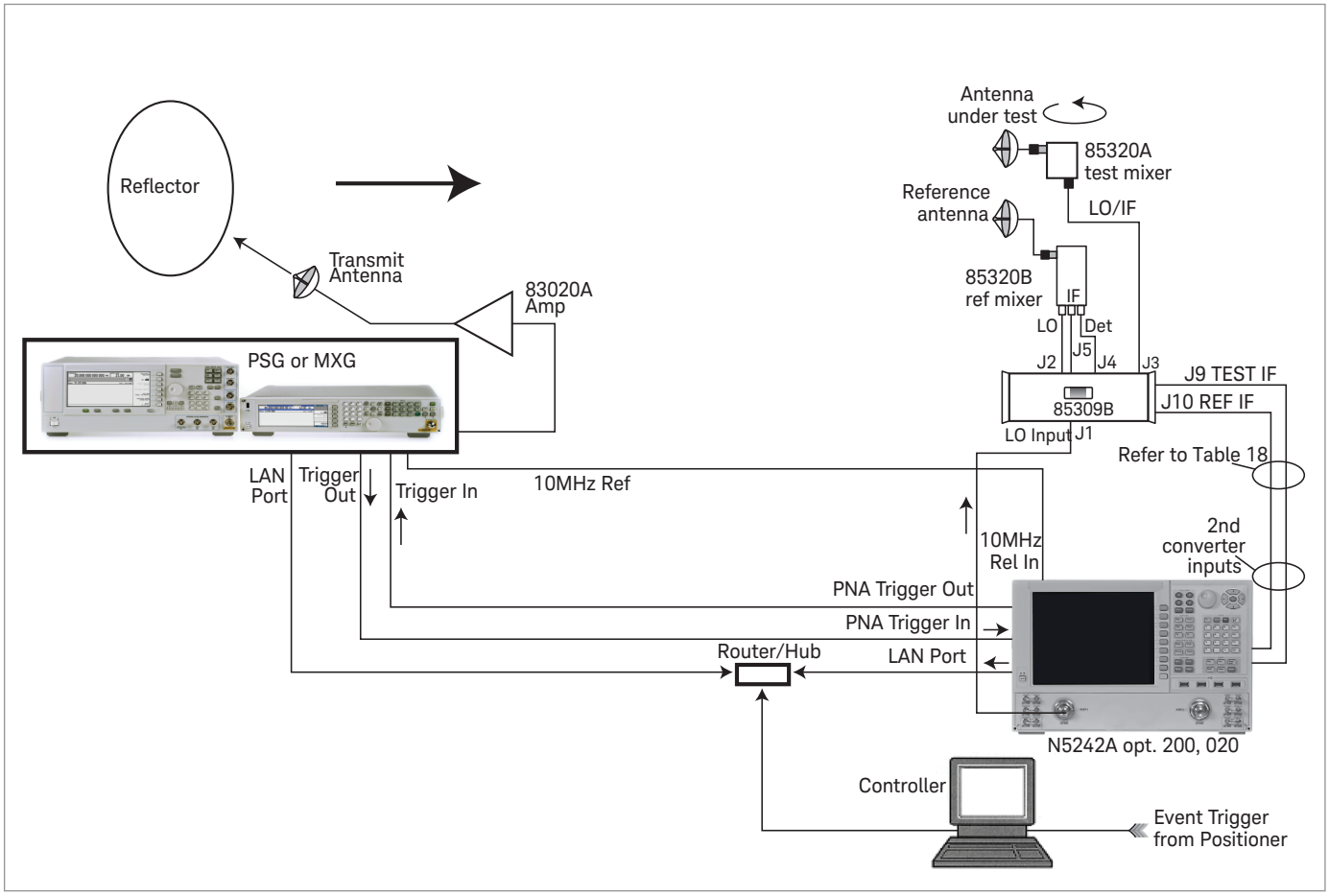


Figure 1. Simplified far-field antenna range example with MXG Source and N522xA PNA or N5264A PNA-X Measurement Receiver with LO source (Option 108).

Channel Partners

Keysight works with channel partners who develop complete antenna test and antenna range solutions. These partners build and install antenna measurement systems working with Keysight engineers to solve customer problems. Keysight instruments such as measurement receivers, network analyzers, sources and accessories, are sold either directly to the end-user or through Keysight channel partners. Contact your Keysight sales representative for a channel partner in your local area.

2. Overview of antenna applications using Keysight PNA Series network analyzers

The Keysight PNA-X measurement receiver and PNA/PNA-X series network analyzers incorporate new technologies and features to provide better performance and capabilities for antenna and radar cross-section (RCS) test applications.

High sensitivity

The Keysight PNA-X measurement receiver is a direct replacement for the previous 8530A model with fast throughput and higher measurement sensitivity.

The PNA/PNA-X analyzer has a mixer-based architecture providing excellent sensitivity. With the PNA/PNA-X Series, you have the ability to select from a minimum of 29 different IF bandwidths. This allows you to optimize the sensitivity versus measurement speed tradeoff to fit particular measurement and application requirements.

With the PNA/PNA-X Series analyzer, you can maximize sensitivity with remote mixing by adding Option 020, IF Access. This option allows you to use an externally generated IF and bypass the PNA-X's internal first down-converter. Front loops can also improve sensitivity by about 15 dB by bypassing the coupler.

Legacy (E836xC) PNA Series analyzers provide maximum sensitivity with remote mixing by adding Option H11, IF Access. This option allows you to use an externally generated 8.33 MHz IF and bypass the PNA's internal first down-converter. Option 014 can also improve sensitivity by about 15 dB by adding reference links that allow you to bypass the coupler.

Increased speed

Extremely fast data transfer rates with the network analyzers are accomplished using the COM/DCOM features. LAN connectivity through a built-in 10/100 Mb/s LAN interface enables the PC to be distanced from the test equipment. Together these features provide remote testing and reduced test time.

Option 118 ads fast CW mode and provides a data acquisition speed of more than 400,000 points per second; with up to five measurement receivers simultaneously.

Flexibility and accuracy

Up to five simultaneously test receivers (A, B, C, D and R) are available in the PNA-X measurement receiver, four receivers in PNA/PNA-X standard, and five receivers in PNA/PNA-X Option 020; with each receiver capable of measuring up to 400,000 points of data.

Option 080 enables the PNA/PNA-X Series analyzers to set the source frequency independently from where the receivers are tuned. The user may enter multiplier and offset values to describe how the instrument's receivers track the source frequency. With Option 080, PNA reference receiver power levels can be below the phase lock level since phase locking is performed separately. You can attain exceptionally accurate antenna measurements by combining Option H11, IF access, with Option 080, Frequency-offset capability and advanced triggering.

PNA-X measurement receivers and PNA/PNA-X analyzers support synchronization with external signal generators which can further enhance performance and greatly improve measurement accuracy.

Pulsed measurements

PNA/PNA-X Series Option 021 port-one internal modulator and 025 internal pulse generators add pulsed-RF for pulsed antenna test applications. Combined with Option 008, these gates augment the PNA/PNA-X's pulse measurement capability by enabling point-in-pulse testing, with pulse widths smaller than 33 ns.

Security

For secure environments, the PNA family features a removable hard drive to completely ensure the security of the data that is acquired by the PNA. Refer to "Appendix 1" on page 71 for detailed information.

The following sections demonstrate how the PNA can be integrated into your near-field, far-field, RCS, and millimeter-wave systems.

Near-field antenna measurements

In near-field applications, the probe is located very close to the antenna under test (AUT), so sensitivity and dynamic range are not as important a performance consideration as in a far-field antenna range. The user selectable bandwidth feature can be used to optimize the measurement speed vs. sensitivity tradeoff. By selecting the widest bandwidth available (5 MHz for DSP-4, 15 MHz for DSP-5), the measurement speed is maximized. The PNA-X analyzer is mixer based, with fundamental mixing to 26.5 GHz, providing a 24 dB increase in sensitivity and dynamic range over sampler based analyzers. This more than makes up for the sensitivity reduction realized when the IF bandwidth of the PNA-X is opened up to its maximum to maximize measurement speed. Therefore, the PNA-X can achieve faster data acquisition speeds with increased sensitivity in near-field applications over legacy configurations. See Figure 2.

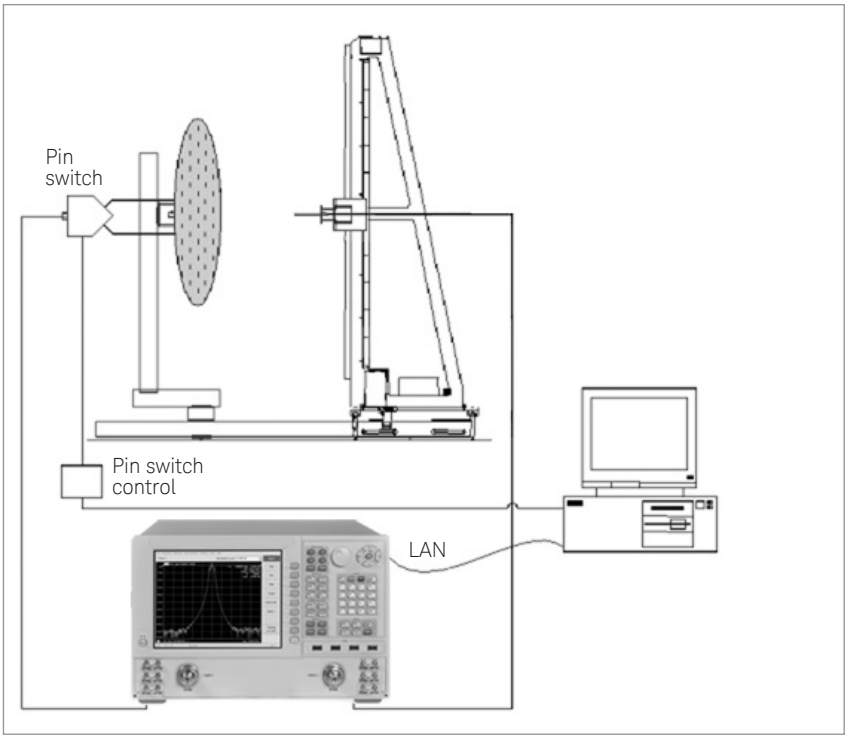


Figure 2. Typical near-field antenna measurement configuration using a PNA/PNA-X.
In addition, PNA-L with direct receiver access can be used.

Far-field antenna measurements

The N5264A PNA-X measurement receiver based system uses 85320A/B broadband external mixers and a 85309B distributed frequency converter and provides the best measurement solution (shown in Figure 4). With Option 108, the internal microwave synthesized source can be used as the LO source for the 85309B LO/IF Distribution Unit.

Alternatively, PNA/PNA-X Option 020 or Legacy (E836xC) PNA with Option H11, IF access can achieve high sensitivity required for far-field antenna measurements. Higher sensitivity can be achieved since the IF signal bypasses the first down conversion stage in the PNA/PNA-X, and is routed directly to the input of the second down conversion stage in the rear panel.

Note: With Option H11, the first IF of the PNA is at 8.33 MHz, so when using H11 inputs, the user should offset external mixer LO inputs by 8.33 MHz.

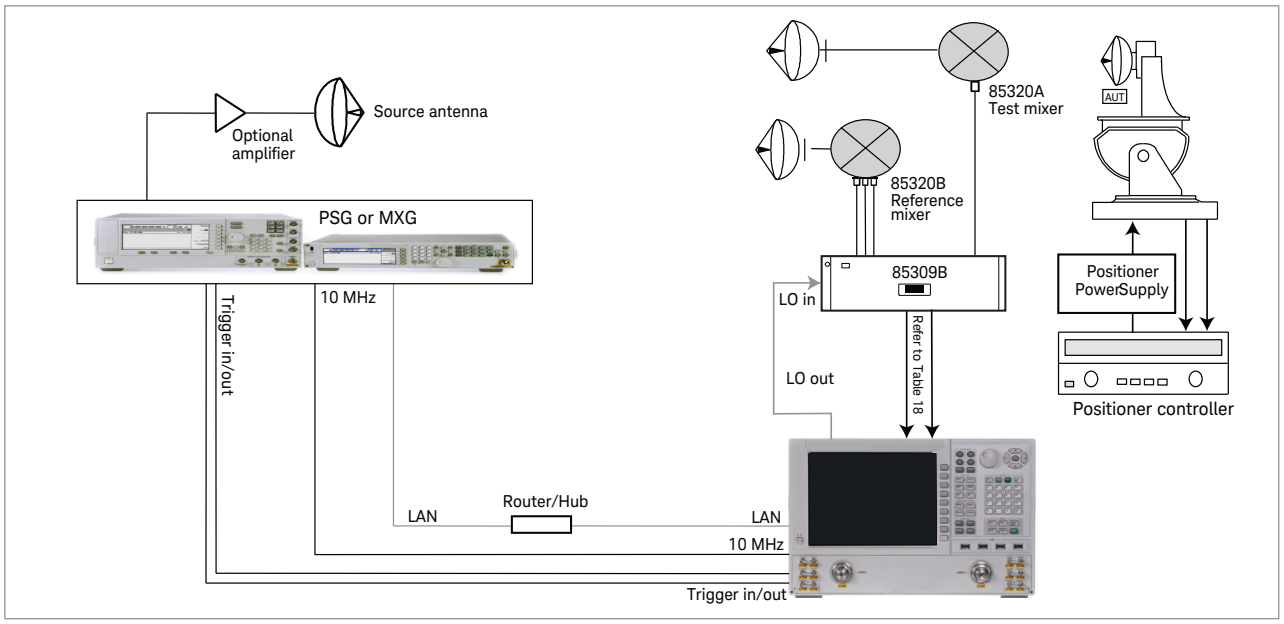


Figure 3. Typical far-field antenna measurement configuration using a PNA-X network analyzer.

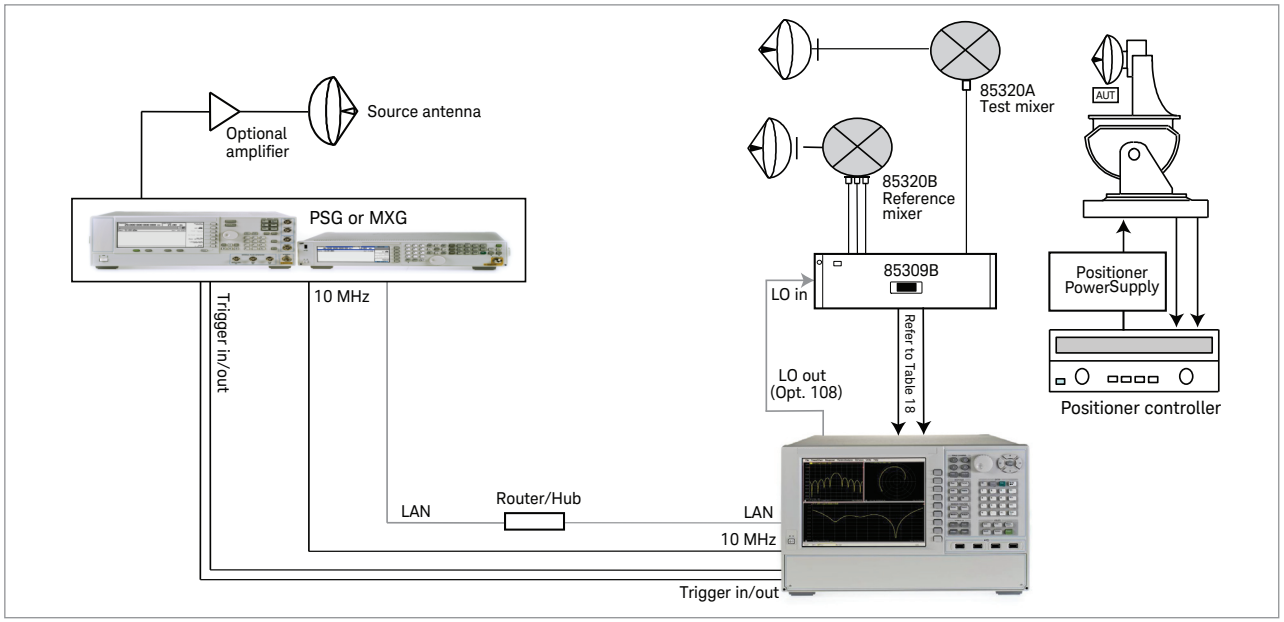


Figure 4. Typical configuration for a compact antenna range using using a PNA-X measurement receiver.

Far-field antenna measurements (continued)

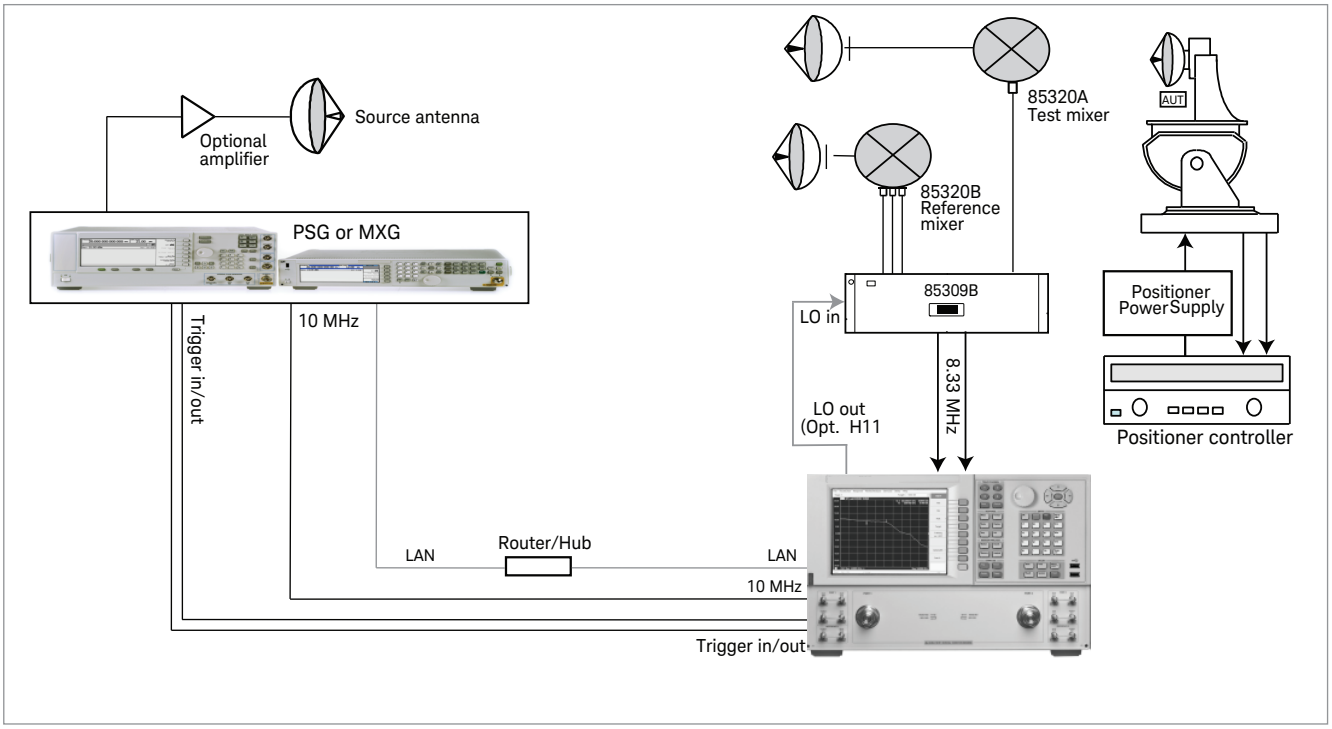


Figure 5. Typical antenna measurement configuration using PNA network analyzers with Option H11.

Fast PNA-X data acquisition time and more than 400,000 points of data per second with the PNA-X measurement receiver makes it the ideal choice for far-field antenna range applications. With the PNA bandwidth set to 10 kHz, the data acquisition time is 119 uS per point. With the PNA-X bandwidth set to 600 kHz, the data acquisition time is 2.4 uS per point. Extremely fast data processing is particularly useful in applications where ranges include active array antennas and data acquisition is quite intensive. Alternatively, these features may not be as useful when there are antennas with limited positioner rotation speeds. Overall, with faster data acquisition speeds, the IF bandwidth can be narrowed; significantly improving measurement sensitivity without increasing total measurement times.

Far-field antenna measurements (continued)

If the range allows the use of amplifiers instead of a PSG, you can take advantage of the excellent frequency agility of the PNA/PNA-X which minimizes the frequency switching time for far-field measurements configurations. See Figure 6.

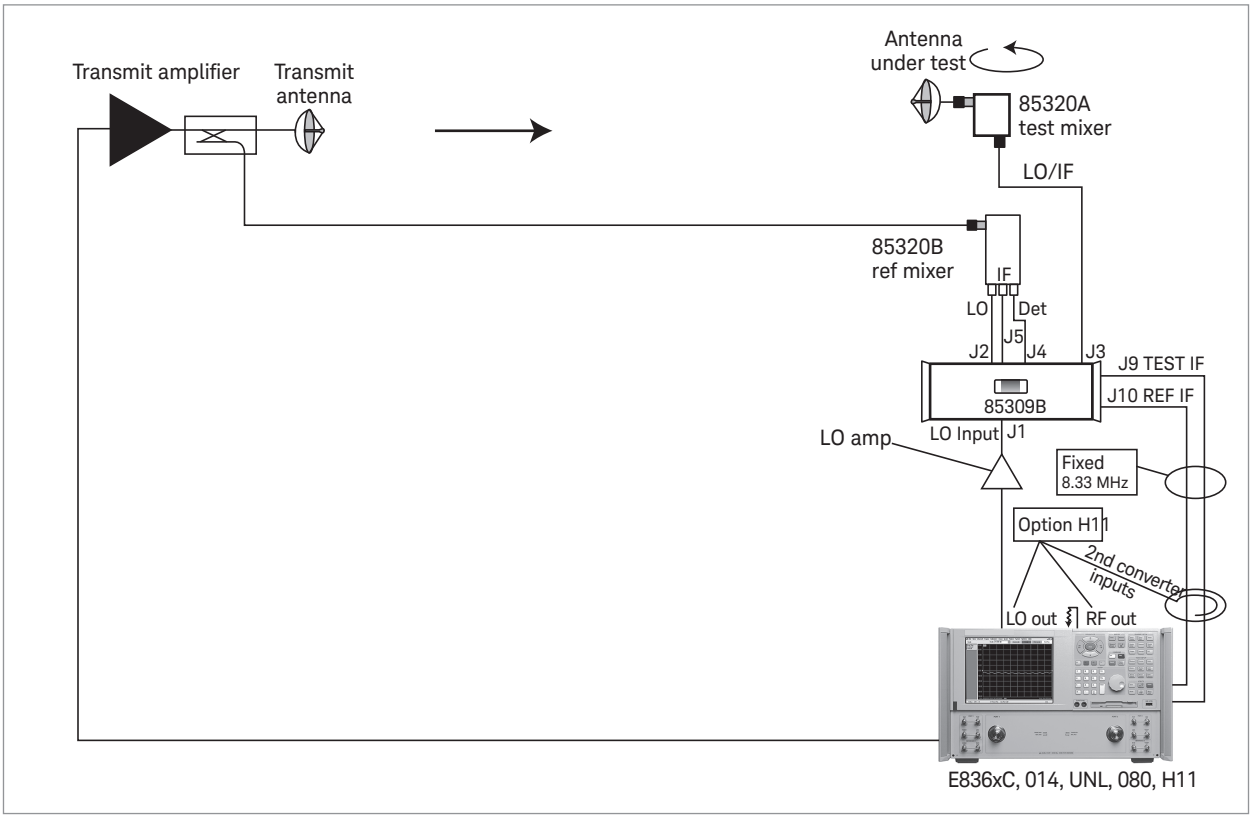


Figure 6. Far-field antenna configuration utilizing internal sources from the Legacy (E836xC) PNA Option H11.

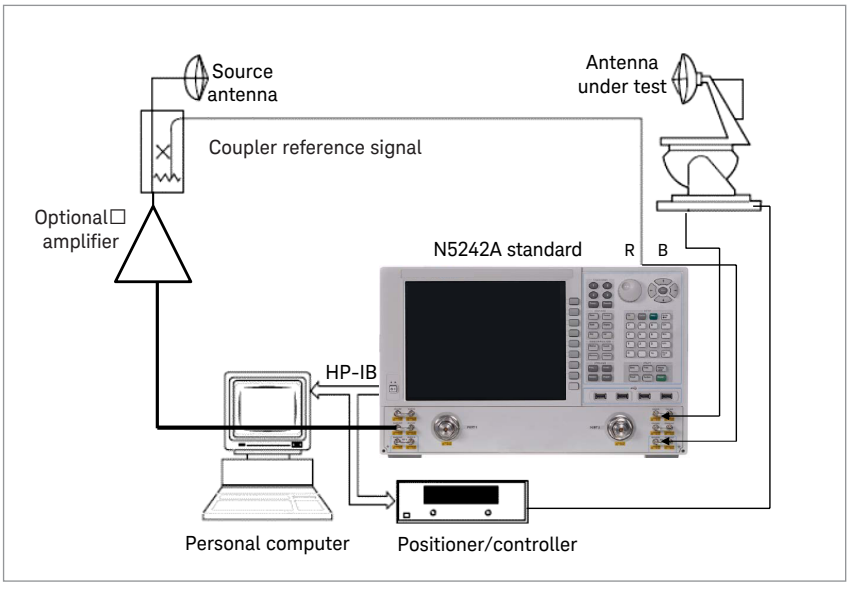


Figure 7. Far-field antenna configuration utilizing internal sources with PNA-L Option 216, PNA Option 201, PNA-X standard.

Radar cross-section measurements

The PNA Series provides the excellent measurement sensitivity, fast frequency agility and data acquisition speeds necessary for RCS measurements. Excellent measurement sensitivity is provided by mixer based downconversion technology; very fast frequency agility is achieved through the source and receiver being located in the same instrument. The PNA's user selectable IF bandwidths, ranging from 1 Hz to 40 kHz, let you optimize the bandwidth and measurement speed tradeoff to meet a particular test requirement.

High-power pulses are often used in RCS measurements to overcome the high losses due to low device reflection and two-way transmission path loss. For this reason, receiver gating is often required in RCS measurements to avoid overloading the receiver during the transmission of the pulsed-RF signal. Figure 8 shows an example of pulse hardware gating, which could easily be added to a PNA RCS configuration for those applications requiring pulse hardware gating.

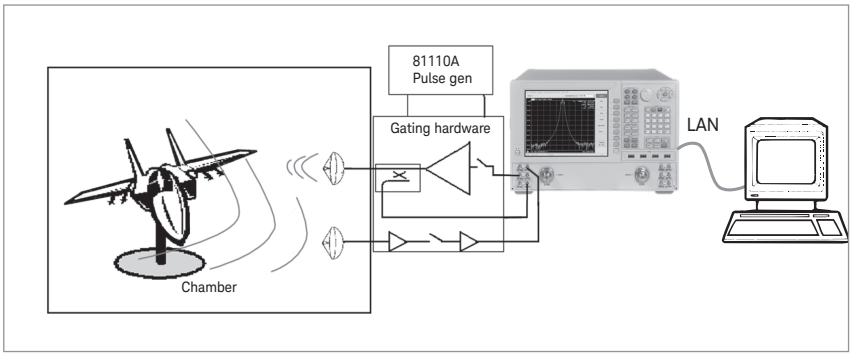


Figure 8. Typical RCS measurement configuration using a PNA Option 201, PNA-X network analyzer.

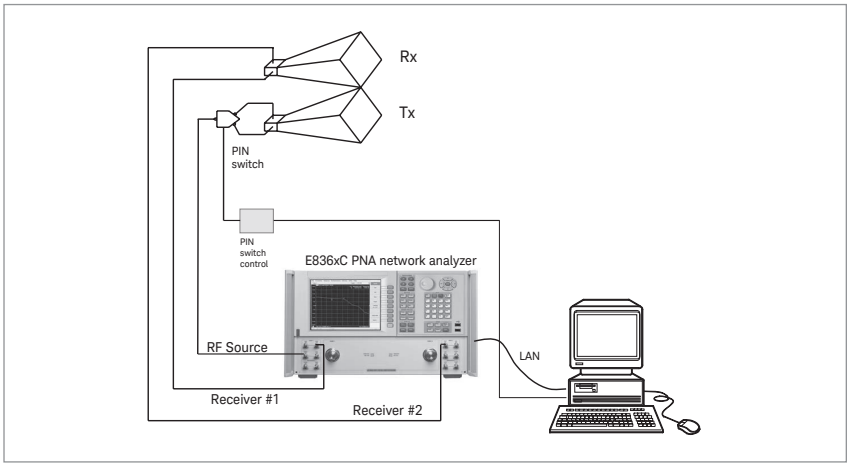


Figure 9. Typical RCS measurement configuration using a Legacy (E836xC) PNA network analyzer. PNA-L Option 216, PNA Option 201, or PNA-X can also be used.

Several additional features of the PNA Series are particularly useful in RCS configurations.

- Having the source and receiver integrated into the same instrument, with a choice of frequency ranges is very cost effective in RCS applications.
- For PNA-X, 100,000 data points are available per measurement; and 20,001 data points are available per measurement for PNA. This provides extremely long, alias-free,
- down-range resolution for RCS measurements.
- The PNA has a removable hard drive to comply with data security requirements. For detailed security information, refer to "Appendix 1" on page 71.

Banded millimeter-wave measurements

With firmware version A.04.00 or later, the PNA microwave E836xC network analyzers are capable of supporting banded millimeter-wave modules, extending the frequency range of your network analyzer up to 500 GHz. Additionally, you can customize the most cost-effective solution specific for your application by purchasing just the module and frequency range you need. Figure 10 shows a typical millimeter-wave configuration.

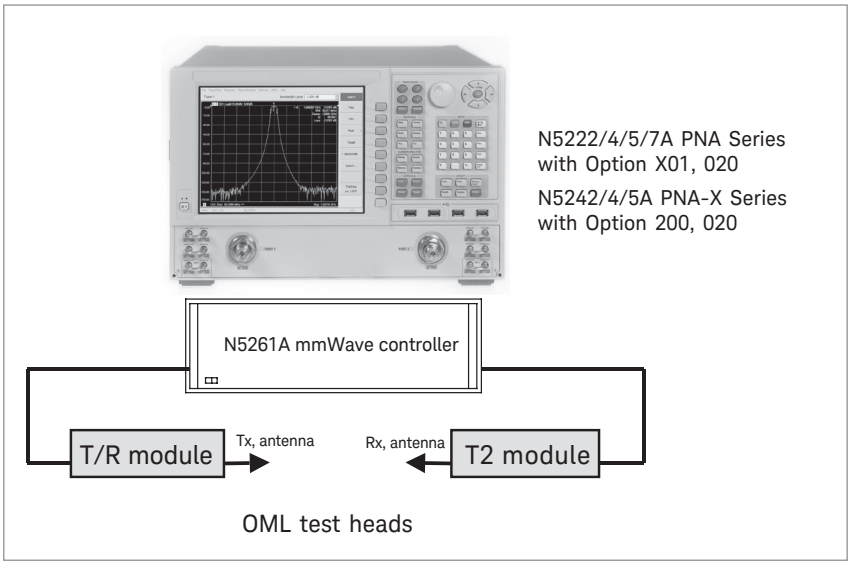


Figure 10. Typical millimeter-wave configuration using a Keysight PNA-X, a mm-wave controller and Oleson Microwave Laboratory mm-wave modules.

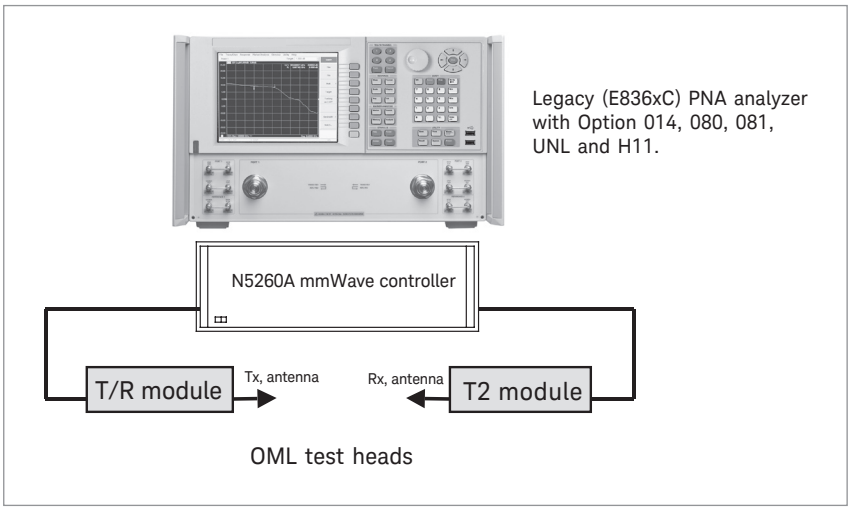


Figure 11. Typical millimeter-wave configuration using a Keysight PNA, a mm-wave controller and Oleson Microwave Laboratory mm-wave modules.

Note: Refer to Keysight Technologies Millimeter-Wave Network Analyzers 10 MHz to 110 GHz, with Extensions to 1.1 THz Technical Overview part number 5989-7620EN for the most current information.

Broadband Solution Configuration

Configuring a 10 MHz to 110 GHz solution using separate components

Configuration of the single sweep solution using individual system components is easily done by selecting one each of the following components

1. 67 GHz PNA with configurable test set or PNA-X network analyzer
2. Either a N5261A (2-port) or N5262A (4-port) millimeter-wave test set controller
3. A set of N5250CX10 67 GHz to 110 GHz frequency extenders

The following table provides a list of available system components that may be selected to create a 10 MHz to 110 GHz solution.

N5227A PNA or N5247A PNA-X based single sweep solution hardware configuration table

Product/ options	Description
	67 GHz PNA-X/PNA network analyzer1
N5227A -201/ 219 or N5247A -200	2-ports, single source 10 MHz to 67 GHz PNA-X or PNA with configurable test set
N5227A-401/ 419 or N5247A-400	4-ports, dual source PNA-X or PNA with configurable test set
N5227A -020 N5247A -020 Required	Adds rear panel direct access IF Inputs for either N5227A or N5247A[2]
	2-port millimeter wave test set controller3
N5261A	2-port millimeter-wave test set controller for PNA/ PNA-X based configuration
N5261A-112, required	A set of cables for 1.85 mm connection to a 2-port PNA/ PNA-X N5247A
Must choose one of the following connection cables. One per module.	
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 meter
N5261A-503	A single set (1-port) of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 3 meter
N5261A-505	A single set (1-port) of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 5 meter[4]
	4-port millimeter wave test set controller3
N5262A	4-port millimeter-wave test set controller for PNA/ PNA-X based configuration
N5262A-114, required	A set of cables for 1.85 mm connection to a 4-port PNA/ PNA-X N5247A
Must choose one of the following connection cables. One per module.	
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 meter
N5262A-503	A single set of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 3 meter
N5262A-505	A single set of RF,LO,DC and IF cables for connection to a single T/R millimeter module, 5 meter[4]
	Millimeter-wave frequency extenders
N5250CX10-L05	67 to 110 GHz, left T/R module & 1.00 mm combiner assembly without adjustable attenuator, or bias tee
N5250CX10-L10	67 to 110 GHz, left T/R module & 1.00 mm combiner assembly with adjustable attenuator, and no bias tee
N5250CX10-L15	67 to 110 GHz, left T/R module & 1.00 mm combiner assembly with bias tee, and no adjustable attenuator
N5250CX10-L20	67 to 110 GHz, left T/R module & 1.00 mm combiner assembly with adjustable attenuator and bias tee
N5250CX10-R10	67 to 110 GHz, right T/R module & 1.00 mm combiner assembly without adjustable attenuator, or bias tee
N5250CX10-R15	67 to 110 GHz, right T/R module & 1.00 mm combiner assembly with adjustable attenuator, and no bias tee
N5250CX10-R20	67 to 110 GHz, right T/R module & 1.00 mm combiner assembly with bias tee and no adjustable attenuator
N5250CX10-R30	67 to 110 GHz, right T/R module & 1.00 mm combiner assembly with adjustable attenuator and bias tee

Notes

1. For PNA/PNA-X options select either a 2-port option for a 2-port 110 GHz configuration or a 4-port option for 4-port 110 GHz solutions.
2. Option 020 is a required option that allows for direct connection of the IF into the back of the PNA/PNA-X.
3. The millimeter-wave test set controller will include cables and the lock link kit to interface to the PNA/PNA-X when either Option 112 or 114 is selected.
4. When selecting Option 505, cable set external RF and LO amplifiers will be required because of cable loss around 6.6 dB.
5. The Kelvin bias-tees have a voltage rating of 40 volts and a maximum of 0.5 amps.

Broadband Solution Configuration

Measurement options

The following is a list of measurement options that are supported with the N5251A or the individually configured PNA/PNA-X solution. These measurement options are supported across the 10 MHz to 110 GHz frequency range and are required if using the N5227A PNA or N5247A PNA-X.

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

For additional measurement options that are currently only supported up to 67 GHz on the N5227A or N5247A, please refer to the Keysight Network Analyzer Configuration Guide, literature number 5990-7745EN.

Accessories

S-Parameter calibration accessories

Please refer to the sidebar for the details of available 1.0 mm test port cables. It is recommended for accurate S-parameter measurements at the 1.0 mm port that a 85059A calibration kit be used. In the case of on-wafer calibrations Cascade Microtech offers a full range of ISS calibration standards for full on-wafer S-parameter calibrations.

Source power calibration accessories

For calibration of source power at the calibration port, it is recommended that three power sensors be used to cover the entire 10 MHz to 110 GHz band. In addition to the recommended power sensors, a set of adapters are required to interface to the 1.0 mm calibration port for power calibration.

Product number	Description	Requirement
N8487A	50 GHz Thermocouple power sensor	Required to calibrate power over the 10 MHz to 50 GHz band
11921F	1.0 mm (f) to 1.85 mm (f), DC to 67 GHz	Required to connect the N8487A to 1.0 mm (M) test port
V8486A	50 GHz to 75 GHz V-band power sensor	Required to calibrate power over the 50 GHz to 75 GHz band
V281C	V-Band to 1.0mm (f) adapter	Required to connect the V8486A to 1.0 mm (M) test port
W8486A	75 GHz to 110 GHz W-band power sensor	Required to calibrate power over the 75 GHz to 110 GHz band
W281C	W-Band to 1.0mm (f) adapter	Required to connect the W8486A to 1.0 mm (M) test port
N1914A	Dual channel power meter	Require 2 power meters that allow for all 3 sensors to be configured for the measurement
11730A	Power sensor cable	Require 3 to connect each of the sensors to the two N1914A power meters
10833A	GPIB cable	Required to connect the 2 power meters to the PNA/PNA-X

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

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 1.1 THz.

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

1. Performance 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 13 for Supported measurement capability.
3. Select the required frequency extenders for the frequency coverage required

Supported PNA and PNA-X configurations for banded waveguide

Product model	Description	Minimum option required for test set controller connection	Minimum option required for direct connection PNA	Minimum option required for direct connection PNA-X
N5222A or N5242A	2-port 26.5 GHz PNA or PNA-X network analyzer	Option 020	Unsupported	Option 200 or 200/219 and Option 080 with Option 224
N5222A or N5242A	4-port 26.5 GHz PNA or PNA-X network analyzer	Option 020	Requires Option 080 and Options 401, or 417, or 419 for N5222A	Option 400 or 400/419 and Option 080
N5224A or N5244A	2-port 43.5 GHz PNA or PNA-X network analyzer	Option 020	Unsupported	Option 200 or 200/219 and Option 080 with Option 224
N5224A or N5244A	4-port 43.5 GHz PNA or PNA-X network analyzer	Option 020	Requires Option 080 and Options 401, or 417, or 419 for N5224A	Option 400 or 400/419 and Option 080
N5225A or N5245A	2-port 50 GHz PNA or PNA-X network analyzer	Option 020	Unsupported	Option 200 or 200/219 and Option 080 with Option 224
N5225A or N5245A	4-port 50 GHz PNA or PNA-X network analyzer	Option 020	Requires Option 080 and Options 401, or 417, or 419 for N5225A	Option 400 or 400/419 and Option 080
N5227A or N5247A	2-port 67 GHz PNA or PNA-X network analyzer	Option 020	Unsupported	Option 200 or 200/219 and Option 080 with Option 224
N5227A or N5247A	4-port 67 GHz PNA or PNA-X network analyzer	Option 020	Requires Option 080 and Options 401, or 417, or 419 for N5227A	Option 400 or 400/419 and Option 080

Banded Solution Configuration

Millimeter-wave test set controllers for banded and single sweep

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 N5222A or N5242A
N5261A-104	A set of cables for 3.5 mm connection to a 4-port N5222A or N5242A
N5261A-106	A set of cables for 2.4 mm connection to a 2-port N5224A/N5225A or N5244A/N5245A
N5261A-108	A set of cables for 2.4 mm connection to a 4-port N5224A/N5225A or N5244A/N5245A
N5261A-112	A set of cables for 1.85 mm connection to a 2-port N5227A or N5247A
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 N5222A or N5242A
N5262A-108	A set of cables for 2.4 mm connection to a 4-port N5224A/N5225A or N5244A/N5245A
N5262A-114	A set of cables for 1.85 mm connection to a 4-port N5227A or N5247A

Notes
1. For the N5261A and N5262A several cable options exist for connecting OML Inc. T/R frequency extenders please refer to the option description section for details, page 25.
2. A 2-Port PNA/PNA-X will only support 2-port banded measurements if used with a N5262A 4-port millimeter controller.

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 engineer.

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

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]
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 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.
2. These modules require an external DC power supply (e.g. U8001A) 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.

IMD transmission reflection modules (OML Inc.)

Waveguide flange	Frequency GHz	IMD module product number
WR12	60 - 90	N5256AW12 - IMD
Extended WR12	56 - 94	N5256AX12 - IMD
WR10	75 - 110	N5256AW10 - IMD

Notes
1. Note the above modules maybe used to make as IMD measurements using Option 087 measurement class for the PNA-X
2. It is currently in banded mode only.
3. The above option requires the use of a 4-port controller N5262A.
4. The access to the swept IMD application in millimeter-wave mode requires an upgrade to Windows 7.0.
5. Requires N5260A-501 cable set and an additional 20 GHz 3.5 mm (male-male) RF cable for connecting the second source. The additional cable may be purchased as a separate part number 8121-1221.

Banded Solution Configuration

Single channel receive modules (OML Inc.)

Waveguide flange	Frequency GHz	Standard single channel receive modules	Single channel receive modules with 15 dB LO amplifier
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

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 N5224A, N5225A, N5227A, or N5244A, N5245A, N5247A
N5260AK50	4 ft cables (RF, LO, IF,Bias) to direct connect mm-head T/R to N5222A or N5242A
N5260AK51	4 ft cables (LO, IF, Bias) to direct connect mm-head Rec. only to N5222A or N5242A

Note
When configuring an OML Inc. frequency extender for direct connect please include a 12 V, 1.3 A power supply (e.g. Keysight U8001A). Requires one power supply per extender being used for direct connection.

Cables for test set controlled OML frequency extenders

Choose one of the following cable options per module to be connected to 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.

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

Banded Solution Configuration

Millimeter-wave calibration kits (OML Inc.)

Waveguide flange	Frequency GHz	Calibration kit
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

Banded waveguide transmission reflection modules (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Standard transmission/reflection modules	Standard transmission/reflection modules with 25 dB mechanical attenuator
WR15	50-75	N5262AW15-700	N5262AW15-701
WR10	75-110	N5262AW10-700	N5262AW10-701
WR8.0	90-140	N5262AW08-700	N5262AW08-701
WR6.0	110-170	N5262AW06-700	N5262AW06-701
WR5.1	140 - 220	N5262AW05-700	N5262AW05-701
WR3.4	220 -325	N5262AW03-700	N5262AW03-701
WR2.2	325-500	N5262AW02-700	N5262AW02-701
WR1.5	500 - 750	N5256AW01-700	N5256AW01-701
WR1.0	750 – 1100	N5262AW01-700	No Attenuator Option

Notes
1. Each product number includes a single frequency extender that supports all PNA/PNA-X and test sets.
2. Add required power supply and cable option for the frequency extenders.
3. For full 2-Port S-parameter measurements order quantity 2 of the Tx/Rx modules listed above.
4. When used with N5261A or N5262A test set controller, add a power supply and cable options.
5. Options 700 /701 WR1.5 extenders are not supported for use with the N5261A/62A.

Banded waveguide receive only modules (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Standard receiver only modules	High sensitivity receive only module with external fixed attenuator
WR15	50-75	N5262AR15-700	N5262AR15-701
WR10	75-110	N5262AR10-700	N5262AR10-701
WR8.0	90-140	N5262AR08-700	N5262AR08-701
WR6.0	110-170	N5262AR06-700	N5262AR06-701
WR5.1	140 - 220	N5262AR05-700	N5262AR05-701
WR3.4	220 -325	N5262AR03-700	N5262AR03-701
WR2.2	325-500	N5262AR02-700	N5262AR02-701
WR1.5	500 - 750	N5256AR01-700	N5256AR01-701
WR1.0	750 - 1100	N5262AW01-700	Not Available

Notes
1. Each product number includes a single frequency extender only.
2. Add required power supply and cable options at time of order.
3. The above are receiver only and require a Tx/Rx module for 1 path 2-port S-parameter measurement capability.
4. When used with N5261A or N5262A test set controller, add a power supply and cable options.
5. Options 700 /701 WR1.5 extenders are not supported for use with the N5261A/62A.

Banded Solution Configuration

Cable options (Virginia Diodes Inc.)

Cable option	Description
N5262AWCBL-N01	Cables not included for Option 700 or 701 Tx/Rx modules, designed for use with 1.2m cable set.
N5262AWCBL-N05	Cables not included for Option 700 or 701 Tx/Rx modules, designed for use with 5m cable set.
N5262AWCBL-701	1.2m cable set for Option 700 or 701 Tx/Rx modules, for direct connect to 43.5 GHz or higher PNA/PNA-X. Includes additional 50 GHz RF cable for high frequency operation. Adapter set N5262AWADP-A01 available for connection to 26.5 GHz PNA and test set.
N5262AWCBL-705	5m cable set for Option 700 or 701 Tx /Rx modules, for direct connection to test set with operation limited to < 26.5 GHz. Adapter set N5262AWADP-A05 available for connection to 26.5 GHz or >43.5 GHz PNA.
N5262ARCBL-N01	Cables not included for Option 700 or 701 Rx only modules, designed for use with 1.2m cable set.
N5262ARCBL-N05	Cables not included for Option 700 or 701 Rx only modules, designed for use with 5m cable set.
N5262ARCBL-701	1.2m cable set for Option 700 or 701 Rx only modules, for direct connect to 43.5 GHz or higher PNA/PNA-X. Adapter set N5262ARADP-A01 available for connection to 26.5 GHz PNA and test set.
N5262ARCBL-705	5m cable set for Option 700 or 701 Rx only modules, for direct connection to test set with operation limited to < 26.5 GHz. Adapter set N5262ARADP-A05 available for connection to 26.5 GHz or >43.5 GHz PNA.
N5262AWCBL-201	1.2m cable set for Option 700 or 701 Tx/Rx modules, for direct connect to 26.5 GHz PNA/PNA-X.
N5262AWCBL-205	5m cable set for Option 700 or 701 Tx/Rx modules, for direct connect to >43.5 GHz PNA/PNA-X.
N5262AWCBL-401	1.2m cable set for Option 700 or 701 Tx/Rx modules, for direct connect to 43.5 GHz or higher PNA/PNA-X. Does NOT include 50 GHz RF cable for high frequency operation.
N5262AWCBL-405	5m cable set for Option 700 or 701 Tx /Rx modules, for direct connection to 43.5 GHz or higher PNA/PNA-X with operation limited to < 26.5 GHz.
N5262AWCBL- 501	1.2m cable set for Option 700 or 701 Tx/Rx modules, for connect to test set
N5262ARCBL- 201	1.2m cable set for Option 700 or 701 Rx modules, for direct connect to 26.5 GHz PNA/PNA-X.
N5262ARCBL - 205	5m cable set for Option 700 or 701 Rx modules, for direct connect to >43.5 GHz PNA/PNA-X.
N5262ARCBL-401	1.2m cable set for Option 700 or 701 Rx modules, for direct connect to 43.5 GHz or higher PNA/PNA-X.
N5262ARCBL-405	5m cable set for Option 700 or 701 Rx modules, for direct connection to 43.5 GHz or higher PNA/PNA-X with operation limited to < 26.5 GHz.
N5262ARCBL- 501	1.2m cable set for Option 700 or 701 Rx modules, for direct connect to test set.

Adapter kits for use with N5262AWCBL-701 and N5262AWCBL-705

Adapter kit option	Description
N5262AWADP-A01	Adapter set for N5262AWCBL-701 to connect to 26.5 GHz PNA or controller
N5262AWADP-A05	Adapter set for N5262AWCBL-705 to connect to 26.5 GHz or >43.5 GHz PNA
N5262ARADP-A01	Adapter set for N5262ARCBL-701 to connect to 26.5 GHz PNA or controller
N5262ARADP-A05	Adapter set for N5262ARCBL-705 to connect to 26.5 GHz or >43.5 GHz PNA

Power supply option (Virginia Diodes Inc.)

Option number	Description
N5262VDI-175	VDI-175 power supply for VDI Modules

Notes
Must be ordered with N5262AWxx. See table above for product option numbers.

Millimeter-wave calibration kits (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Calibration kit
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
WR3.4	220 to 325	N5262AC03

Millimeter-wave calibration kits (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Calibration kit
WR2.2	325 to 500	N5262AC02
WR1.5	500 to 750	N5260AC01
WR1.0	750 to 1.1 THz	N5262AC01

Banded waveguide transmission reflection mini-modules (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Standard transmission reflection modules	Transmission reflection modules with 0 to 30 dB micrometer driven attenuator
WR15	47 to 77	N5262BW15 - STD	N5262BW15 - 001
WR12	55 to 95	N5262BW12 - STD	N5262BW12 - 001
WR10	67 to 110	N5262BW10 - STD	N5262BW10 - 001

Notes
1. Modules include a selectable option for use with a 1.2 m cable set (Option 120) or a 5m cable set (Option 500).
2. A power supply is included with each module ordered.
3. All modules are compatible with PNA/PNA-X or test set controller and have cable options for direct connection or test set connections.

Banded waveguide receiver mini-modules (Virginia Diodes Inc.)

Waveguide flange	Frequency GHz	Standard receiver only modules	High sensitivity receive only module with external fixed attenuator
WR15	47 to 77	N5262BR15 - STD	N5262BR15 - 001
WR12	55 to 95	N5262BR12 - STD	N5262BR12 - 001
WR10	67 to 110	N5262BR10 - STD	N5262BR10 - 001

Notes
1. The high sensitivity modules have the same dynamic range, with about 25 dB lower noise floor and lower saturation point.
2. Modules include a selectable option for use with a 1.2 m cable set (Option 120) or a 5m cable set (Option 500).
3. A power supply is included with each module ordered.
4. All modules are compatible with PNA/PNA-X or test set controller and have cable options for direct connection or test set connections.

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

Module	Width	Length	Height
Standard	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)
Mini-modules	3.0 inches	10.8 inches including waveguide, WR10 to WR15	2.35 inches (feet adjust +0.75 inches)

Waveguide designation equivalent table

MIL-DTL-85/3C	IEEE Std 1785.1	Frequency range
WR-15	WM-3759	50 GHz – 75 GHz
WR-12	WM-3099	60 GHz – 90 GHz
WR-10	WM-2540	75 GHz – 110 GHz
WR-08	WM-2032	90 GHz – 140 GHz
WR-06	WM-1651	110 GHz – 170 GHz
WR-05	WM-1295	140 GHz – 220 GHz
WR-04	WM-1092	170 GHz – 260 GHz
WR-03	WM-864	220 GHz – 330 GHz
WR-02	WM-570	330 GHz – 500 GHz
WR-1.5	WM-380	500 GHz – 750 GHz
WR1.0	WM-250	750 GHz – 1.1 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

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.
- 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 008) 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 008). 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 008 (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 008)[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 Keysight 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 Keysight 81110A Series pulse generator. For more detailed information regarding pulsed measurement capabilities with the PNA refer to the Keysight Web site **www.keysight.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

- For frequency bands beyond 220 GHz, an improvement of up to 20 dB may be gained for the E836xC PNA Option H11 based configurations. N524xA PNA-X and N522xA PNA Series there is no need to add external sources, please refer to Keysight Millimiter-Wave Network Analyzers Technical Overview, part number 5989-7620EN for 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.

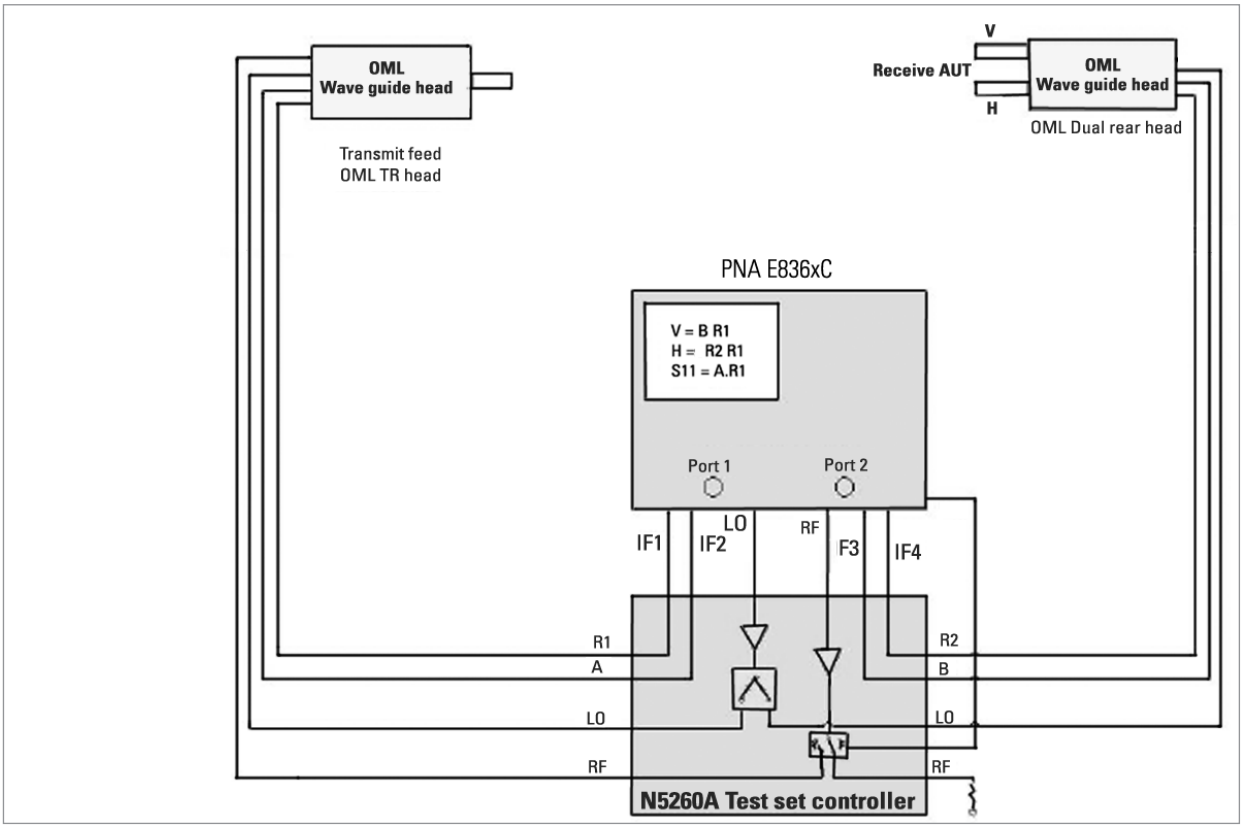


Figure 12. Typical millimeter-wave antenna application with PNA E836xC with Option 014, 080, 081, UNL and H11.

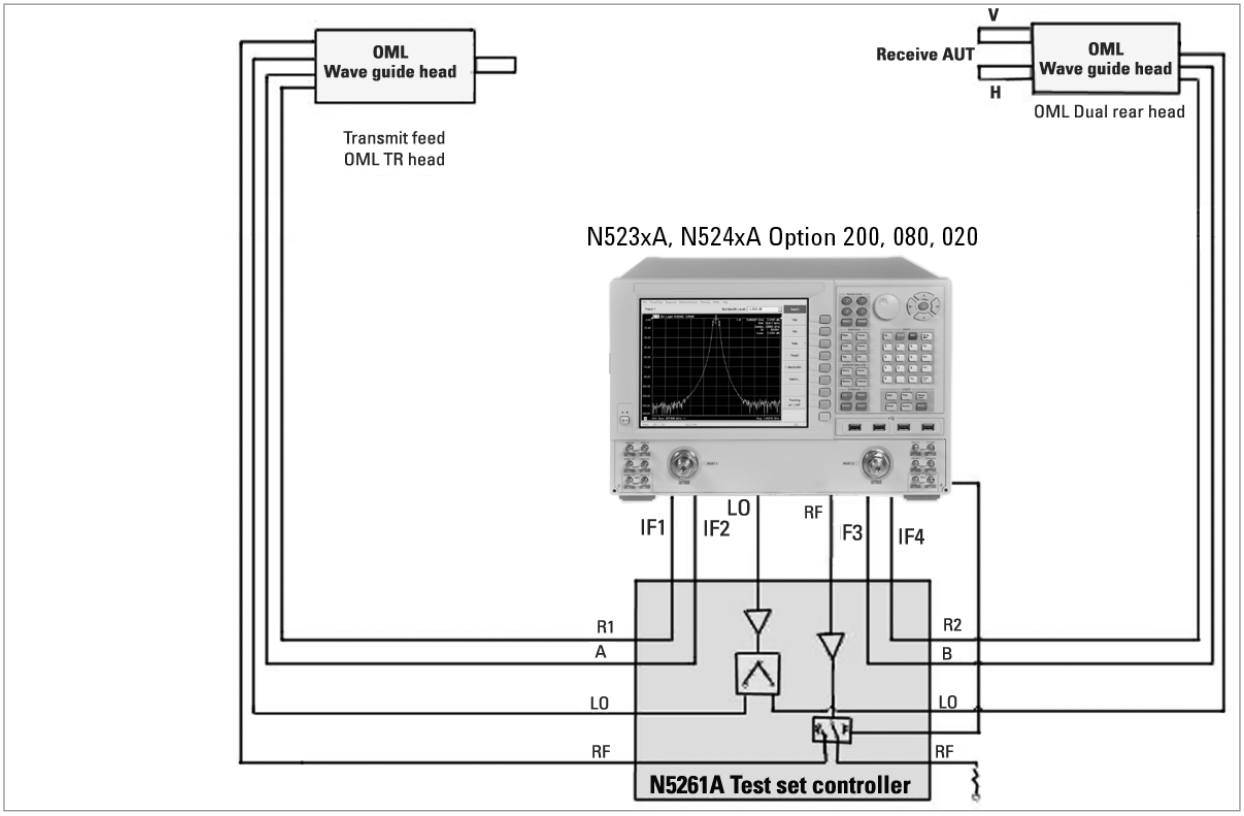


Figure 13. Typical millimeter-wave antenna application with N5242A PNA-X Option 020.

For additional information about millimeter measurements, see *Application Note 1408-15: Banded Millimeter-Wave Measurements with the PNA*, literature number 5989-4098EN.

3. Antenna measurement design considerations

When designing an antenna measurement system, there are many parameters that must be considered in order to select the optimum equipment. Begin by considering the components for the transmit site, then move to the receive site. Designing a complete antenna system often requires you to configure the transmit site, then the receive site, and then make adjustments to the transmit site and recalculate the values for optimum performance.

Transmit site configuration

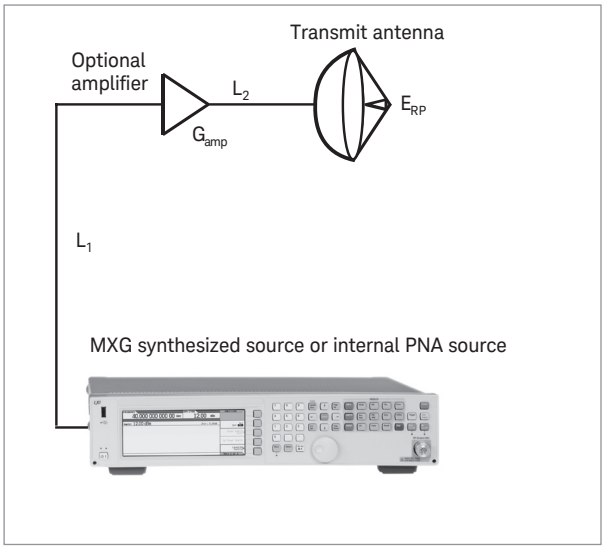


Figure 14. Transmit site configuration.

Select the transmit source

In selecting the transmit source, consider the frequency range of the antenna under test, the distance to the transmit antenna, the available power of the source, and the speed requirements for the measurements. For compact ranges and near-field ranges, the internal PNA source will typically be the best source to meet your measurement needs. The internal source is faster than an external source and may lower the cost of the complete system by eliminating a source. Large outdoor ranges may require an external source that can be placed at a remote transmit site.

Will a transmit amplifier be used?

Begin by making your power calculations without an amplifier. If after doing the power calculations the transmit power is not high enough, then add an amplifier and run the calculations again.

Calculate the effective radiated power

The effective radiated power (ERP) is the power level at the output of the transmit antenna.

$E_{RP} = P_{source} - (L_1 + L_2) + G_{amp} + G_t$

Where E_{RP} = Effective radiated power (dBm)
P_{source} = Power out of the source (dBm)
L_1 & L_2 = Loss from cable(s) between source and antenna (dB)
G_{amp} = Gain of the amplifier (if used) (dBi)
G_t = Gain of transmit antenna (dBi)

Calculate the free-space loss

The free-space loss (or power dissipation, P_D) of an antenna range determines the difference in power levels between the output of the transmit antenna and the output of an isotropic (0dBi) antenna located at the receive site. This free-space loss is due to the dispersive nature of a transmitting antenna. A transmitting antenna radiates a spherical wavefront; only a portion of this spherical wavefront is captured by the receiving antenna.

For a free-space, far-field range, this range transfer function is easily determined as follows:

$P_D = 32.45 + 20*\log(R) + 20*\log(F)$

where P_D = Free-space loss (power dissipation) (dB)
R = Range length (meters)
F = Test frequency (GHz)

Note: A calculator which will derive this number for you can be found at: http://na.tm.keysight.com/pna/antenna

This equation does not account for atmospheric attenuation, which can be a significant factor in certain millimeter-wave frequency ranges.

Compact antenna test ranges (CATRs) achieve greater transfer efficiency by collimating, or focusing the transmitted power using one or more shaped reflectors. Transfer functions for most CATRs are available from the manufacturer's data sheet or on request. If the transfer function is unavailable, use the free-space loss as a worst-case estimate.

Calculate your range transfer function for the minimum and maximum test frequencies.

Calculate the maximum power level at the output of the AUT

The test channel received power level must be calculated to determine the approximate maximum power level present at the output of the antenna-under-test (AUT). The required measurement sensitivity is determined from the test channel received power level, the required dynamic range, and the required measurement accuracy. The maximum test channel received power level will occur when the AUT is boresighted relative to the transmit antenna.

$P^{AUT} = E_{RP} - P_D + G^{AUT}$

where P^{AUT} = Test channel received power level at output of AUT (dBm)
E_{RP} = Effective radiated power (dBm)
P_D = Free-space loss (dB, at the maximum test frequency)
G^{AUT} = Expected maximum gain of AUT (dBi)

Note: PAUT must not exceed the specified compression input levels of the next components (typically either the PNA or in more complex systems, a mixer). See the individual component specifications for detailed information.

Dynamic range

The dynamic range required to test the AUT is the difference, in decibels, between maximum boresite level and minimum AUT level that must be measured. Examples of these include side-lobe level, null depth, and cross-polarization levels.

Measurement accuracy/signal-to-noise ratio

Measurement accuracy is affected by the measurement sensitivity of the system. The signal-to-noise ratio will directly impact the measurement accuracy of the system for both amplitude and phase measurements. Figure 15 illustrates the relationship between signal-to-noise ratio and magnitude and phase errors.

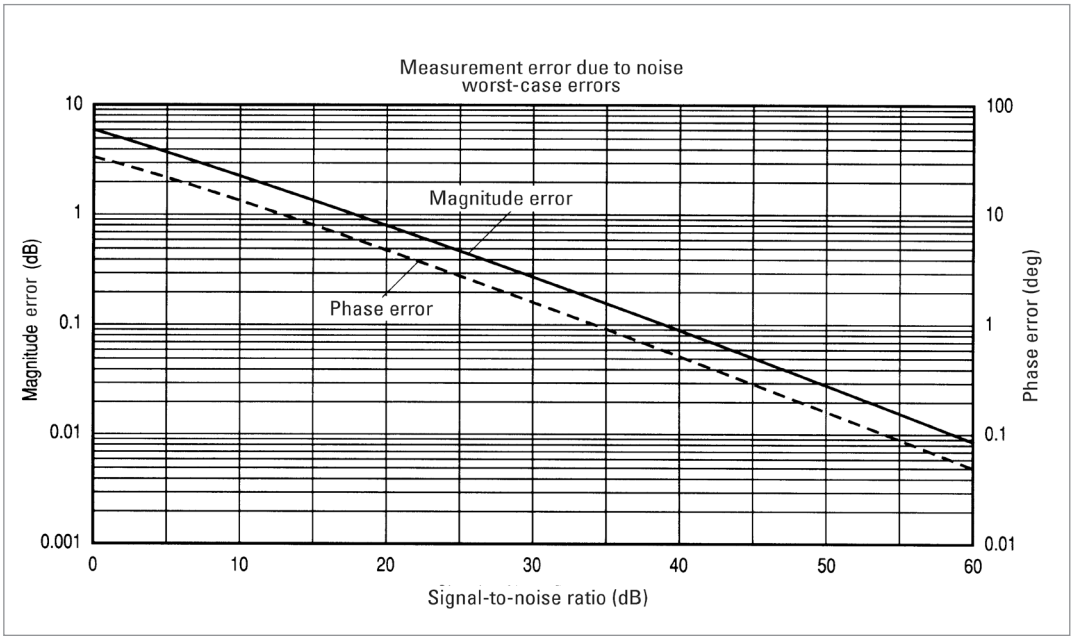


Figure 15. Measurement accuracy as a function of signal-to-noise ratio.

Determine your signal-to-noise ratio based on the magnitude and phase errors you can accept.

Sensitivity

The PNA should be located as closely as possible to the test antenna to minimize the RF cable lengths. The measurement sensitivity of the PNA must be degraded by the insertion loss of the RF cable(s) to determine the system measurement sensitivity needed.

Now, determine the sensitivity required of the PNA

Sensitivity = P_{AUT} – DR – S/N – L

Note: This equation assumes the simplest antenna system with no remote mixing.

See Figure 10.

where PAUT = Power at the output of the AUT (dBm)
DR = Required dynamic range (dB)
S/N = Signal-to-noise ratio determined above (dB)
L = Cable Loss (dB) from AUT to PNA input

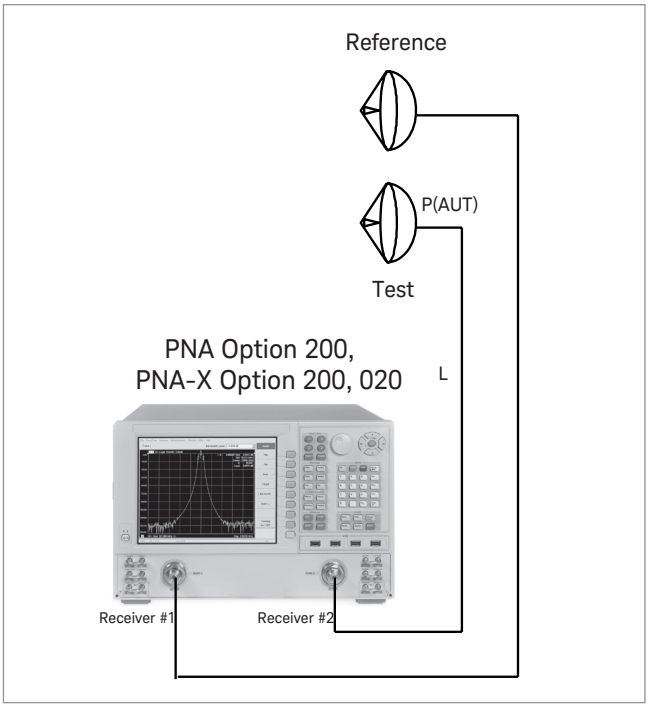


Figure 16. Receive site configuration without external mixing.

Choosing a network analyzer

The frequency and sensitivity requirements of your antenna system will determine the network analyzer specifications. Keysight offers three families of network analyzers: the PNA Series, the PNA-L Series and the ENA Series. Keysight has developed options for the PNA Series specifically for antenna measurements. Because of these options, the PNA Series is often the preferred analyzer for antenna solutions. However, there are applications which do not require these options and the lower cost PNA-L Series or ENA Series analyzers may be the right solution. For secure environments, a PNA or PNA-L Series analyzer must be used. Select an analyzer from the following table that meets your frequency and sensitivity requirements.

Refer to the ENA data sheet, literature number 5988-3780EN or the PNA and PNA-L data sheets, literature numbers 5988-7988EN and 5989-0514EN for more detailed information.

Table 1. Keysight network analyzer typical values

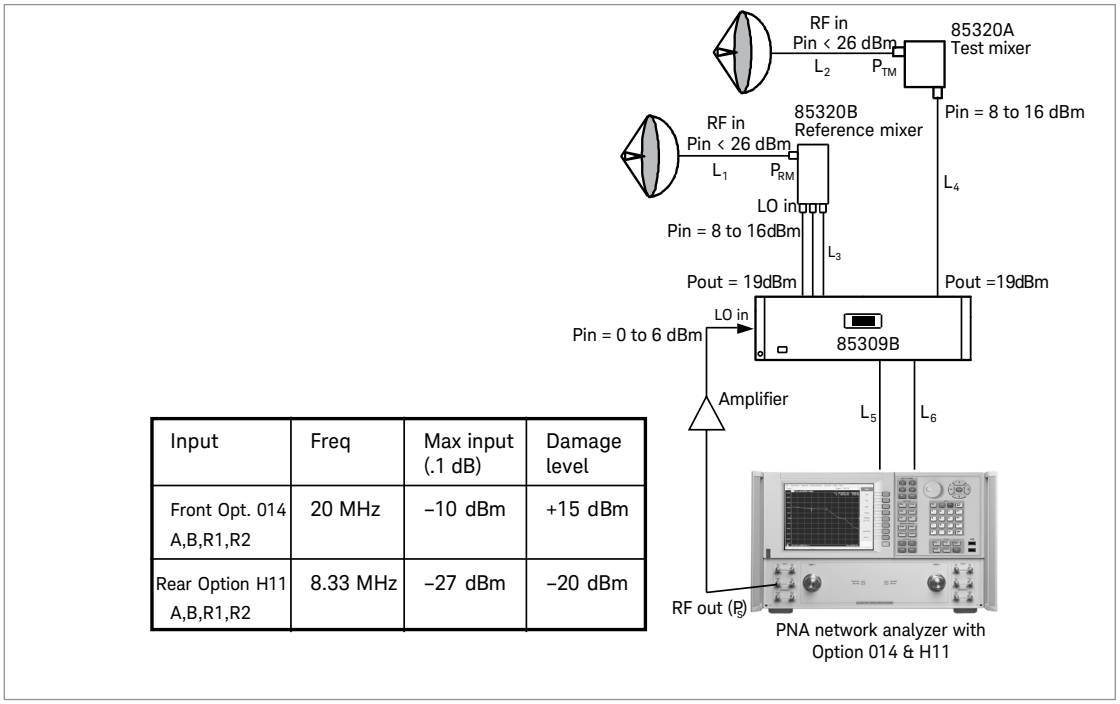
Family	Model/option (std./configurable test set)	Frequency range	Frequency stepping speed (10 MHz/pt at max IF BW with no band crossings at 1 GHz)	Sensitivity at test port with 1 kHz IF BW at Fmax	Sensitivity at direct receiver input with 1 kHz IF BW (w/ Option 014 for PNA) at Fmax	Power out at Fmax
ENA	E5070C	300 kHz to 3 GHz	*	< –90 dBm	**	+10 dBm
	E5071C	300 kHz to 8.5/20 GHz	*	<–103 dBm/-86 dBm	**	+5 dBm
PNA-L	N5230C Option 020/025	300 kHz to 8.5 GHz	160 µs	< –99 dBm	< –108 dBm	+10 dBm
	N5231A 2/4-port	300 kHz to 13.5 GHz	160 µs	< –90 dBm	< –106 dBm	+2 dBm
	N5232A 2/4-port	10 MHz to 20 GHz	160 µs	< –86 dBm	< –97 dBm	+10 dBm
	N5234A 2-port	10 MHz to 43.5 GHz	160 µs	< –80 dBm	< –86 dBm/-95 dBm	–5 dBm
	N5235A 2-port	10 MHz to 50 GHz	160 µs	< –80 dBm	< –78 dBm/-93 dBm	–9 dBm
PNA	E8362C/N5222A	10 MHz to 20 GHz	278 µs/100 µs	< –100 dBm/-94 dBm	< –114 dBm/-110 dBm	+3 dBm/ +13 dBm
	E8363C/N5224A	10 MHz to 40 GHz	278 µs/100 µs	< –94 dBm/-94 dBm	< –105 dBm/-108 dBm	–4 dBm/ +11 dBm
	E8364C/N5225A	10 MHz to 50 GHz	278 µs/100 µs	< –94 dBm/-94 dBm	< –103 dBm/-105 dBm	–10 dBm/ +8 dBm
	E8361C/N5227A	10 MHz to 67 GHz	278 µs/100 µs	< –79 dBm/-94 dBm	< –88 dBm/-103 dBm	–5 dBm/ +5 dBm
PNA-X	N5242A	10 MHz to 26.5 GHz	100 µs	< –100 dBm	< –115 dBm	+11 dBm
	N5244A	10 MHz to 43.5 GHz	100 µs	< –100 dBm	< –100 dBm	+5 dBm
	N5245A	10 MHz to 50 GHz	100 µs	< –100 dBm	< –115 dBm	–8 dBm

1. Note: Option H11 sensitivity is typically –127 dBm * Data not available ** Option not available

What to do if the sensitivity requirement cannot be met

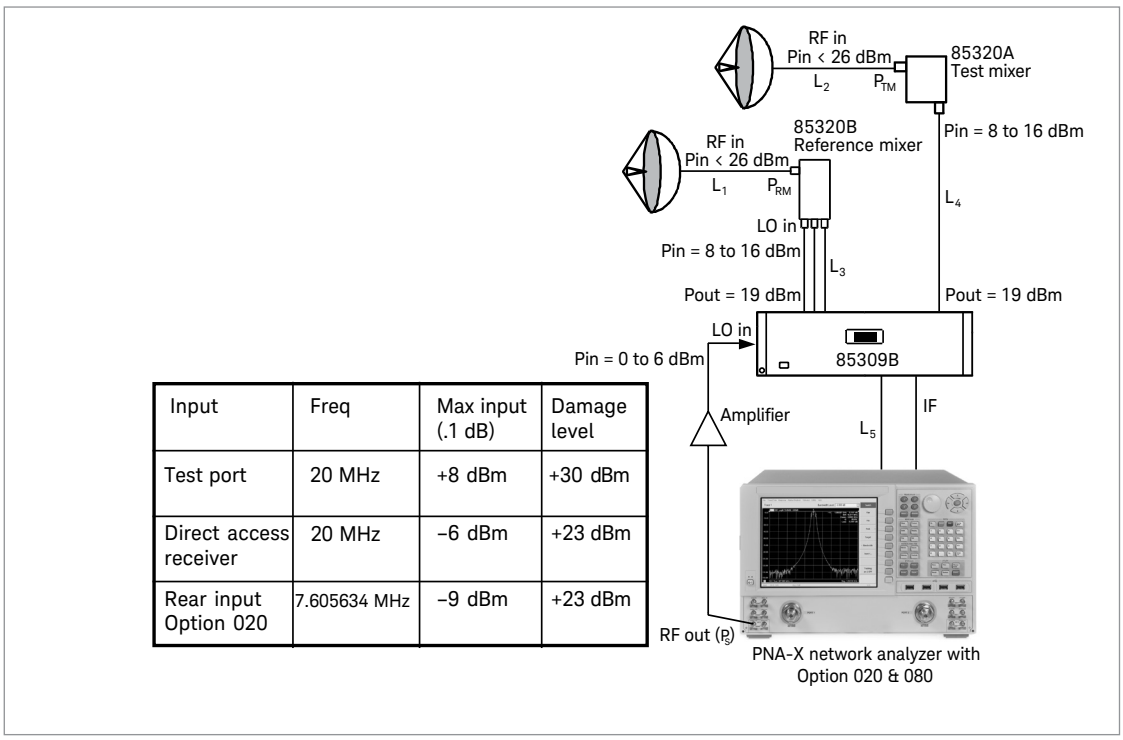
If the AUT is located far from the analyzer, requiring long cables, then the loss caused by the cables could be significant, reducing accuracy and dynamic range. You may also be unable to find an analyzer that meets your sensitivity requirements. In this situation, downconverting the signal to an IF signal by using the 85309 LO/IF distribution unit with 85320A/B remote mixers brings the measurement closer to the AUT. This reduces RF cable loss and maximizes accuracy and dynamic range. Options H11 and 014 on the PNA network analyzers both support a remote mixing configuration. Refer to “Receive site configuration with external mixing” to configure your system.

Receive site configuration with external mixing



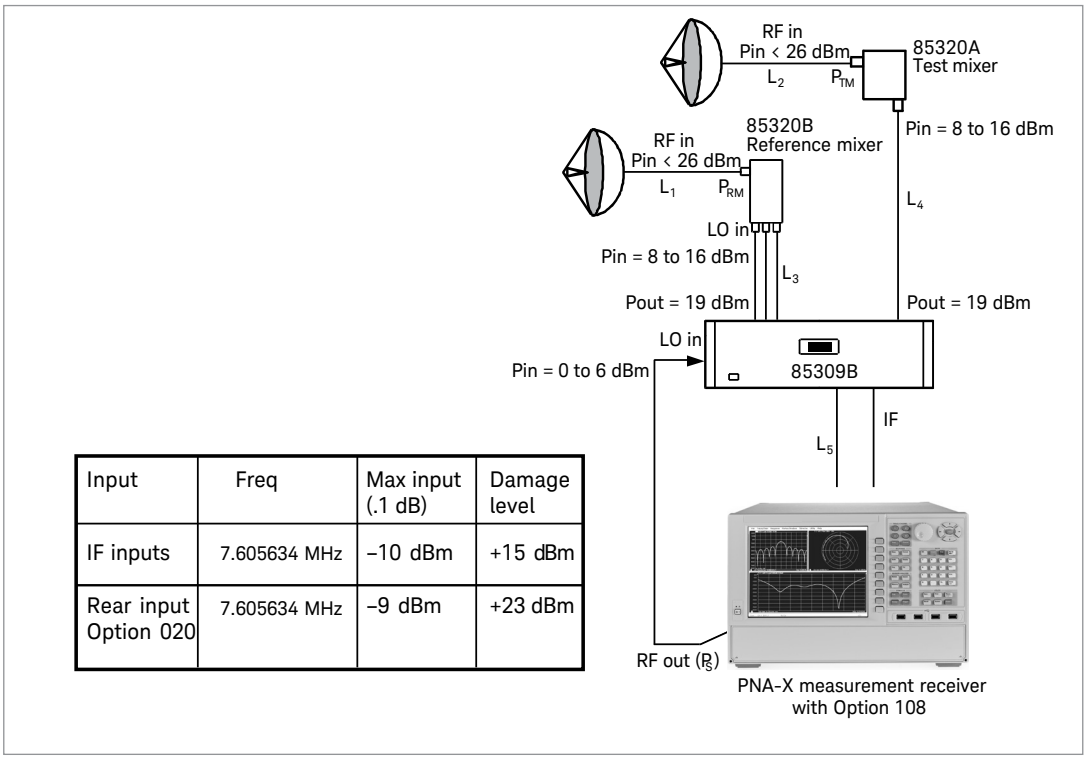
Input	Freq	Max input (.1 dB)	Damage level
Front Opt. 014 A,B,R1,R2	20 MHz	–10 dBm	+15 dBm
Rear Option H11 A,B,R1,R2	8.33 MHz	–27 dBm	–20 dBm

Figure 17. Receive site configuration with external mixing using the PNA E836xC network analyzer.



Input	Freq	Max input (.1 dB)	Damage level
Test port	20 MHz	+8 dBm	+30 dBm
Direct access receiver	20 MHz	–6 dBm	+23 dBm
Rear input Option 020	7.605634 MHz	–9 dBm	+23 dBm

Figure 18. Receive site configuration with external mixing using the PNA-X N5242A network analyzer.



Input	Freq	Max input (.1 dB)	Damage level
IF inputs	7.605634 MHz	–10 dBm	+15 dBm
Rear input Option 020	7.605634 MHz	–9 dBm	+23 dBm

Figure 19. Receive site configuration with external mixing using the N5264A PNA-X measurement receiver.

Select the LO Source

The recommended microwave mixers use fundamental mixing from 300 MHz to 18 GHz, and harmonic mixing for frequencies above 18 GHz. Thus, an LO source that operates over the frequency range of 0.3 to 18 GHz will be adequate for all frequencies of operation. A large selection of sources is available for the LO source. In many situations the PNA Series can supply the LO signal since the LO sources only need to operate over the frequency range of 0.3 to 18 GHz.

The LO source must be able to supply 0 to 6 dBm power at the 85309B LO input. To determine whether the source has enough power, cable losses must first be considered.

Loss of LO cables is dependent on frequency; lower frequencies have lower loss per unit length, and higher frequencies have higher loss. Therefore the maximum LO frequency utilized will result in the maximum cable loss. The maximum LO frequency is dependent on the frequency specified for the antenna range and whether fundamental or harmonic mixing is used. There is a trade-off between LO frequency and system sensitivity. Fundamental mixing provides the lowest conversion loss in the mixer, and the best system sensitivity. Harmonic mixing allows lower LO frequencies to be used (with longer cable lengths), but has higher conversion loss in the mixer, and less system sensitivity.

Select the LO Source (continued)

Before calculating cable loss, you must first determine the LO frequency. If using PNA Series Option H11, the LO frequency must be set so that an 8.33MHz IF is produced. The PNA Series' LO is offset from its RF by 8.33 MHz automatically if the PNA is operated below 20 GHz and frequency offset is turned off. Refer to "Setting up the PNA LO for an 8.33 MHz IF", later in this document, for more information.

The PNA Series' internal LO can be accessed through a rear panel output port if Option H11 is installed. Its frequency range is limited to 1.7 GHz to 20 GHz. The signal on the rear panel is very low power and always requires an amplifier to achieve the required power level at the 85309B. The front panel RF can only be used as the LO for the 85309B if it is not used as the system RF.

Calculate required power of LO source

P_s= cable length (meters) X cable loss (dB/meter) + P_{in} (85309B)

where P_s = Power out of the LO source (dBm)
P_{in} = Required power into 85309B (0 to 6 dBm)

Select a source that meets your individual preferences and needs. Higher-output power sources or an amplifier must be used if P_{in} is insufficient.

Reference signal level

The reference mixer provides a phase reference for the measurement and a reference signal for a ratioed measurement (test/reference), to ratio out any variations in signal levels from the system. If you select RF and LO sources that are synthesized, or use the internal source of the PNA, then phase locking the receiver is not required. The only requirement for the reference channel is that the signal level be high enough to achieve the desired accuracy for the measurement. Figure 9 shows the magnitude and phase errors as a function of signal-to-noise ratio; this also applies to errors contributed by the reference channel. For most applications, it is desirable to maintain a 50 to 60 dB signal-to-noise ratio.

Determine Cable Length from 85309B unit to mixers

Mixers require a certain LO drive power level; the output power of the 85309B LO/IF distribution unit and the RF loss of the cables will determine the maximum allowable cable lengths. To assure you have enough power at your mixers, use the following equation to calculate the maximum cable length allowed for your setup:

Cable length (meters) = (P_{out} 85309B – P_{in} mixer)/(cable loss/meter at frequency)

High quality, low loss, phase stable cables are recommended.

Note: The same LO cable type and length is required for both the reference and test mixer modules. This is to ensure that the insertion losses through the reference and test mixer module LO paths are the same. Using the same LO cable type also optimizes cable phase tracking versus temperature and therefore, system phase measurement, stability, and accuracy.

When a rotary joint is used, the equivalent cable length must be added to the reference mixer LO cable due to the rotary joint insertion loss. To determine the equivalent cable length, first determine the insertion loss from the input to the output of the rotary joint at the maximum LO frequency. Then, using insertion loss curves for the LO cables between the 85309B and the mixer module, calculate the equivalent length in meters at the maximum LO frequency. The reference LO cable length must be increased by this amount.

Power at reference mixer

Calculation of the power level at the reference mixer depends on the method used to obtain the reference signal. Almost all ranges obtain the reference channel signal using a stationary reference antenna to receive a portion of the radiated transmit signal. Select one of the two methods below for your configuration.

1. Radiated reference signals
   When using a radiated reference, the power at the reference mixer can be determined from the following equation:

$$P_{RM} = E_{RP} - P_D + G_{REF} - L_1$$

where P_{RM} = Power level at the reference mixer (dBm)
E_{RP} = Effective radiated power (dBm)
P_D = Free-space loss (power dissipation) (dB)
G_{REF} = Gain of the reference antenna (dBi)
L_1= Cable loss between reference antenna and reference mixer (dB)

Note: If the calculated power level at the mixer is insufficient to achieve the desired accuracy from the reference channel, the transmit power or the reference antenna gain must be increased.

Caution: P_{RM} must not exceed the maximum power level of the mixer[1]
P_{RM} – Mixer conversion loss[2] must be less than +5 dBm so as to not exceed the 1 dB compression level for the LO/IF input for the 85309B.

2. Coupled reference signals
   When using a coupled reference, the reference channel power level can be determined by subtracting the cable insertion losses and the coupling factor of the directional coupler and adding amplifier gain, if any, to the output power of the transmit source.

Power at the test mixer

The power at the test mixer is equivalent to the power at the output of the AUT (calculated earlier) if the mixer is attached directly to the AUT. The power level at the test mixer can be determined from the following equation:

$$P_{TM} = E_{RP} - P_D + G_{AUT} - L_2$$

where P_{TM} = Power level at the test mixer (dBm)
E_{RP} = Effective radiated power (dBm)
P_D = Free-space loss (power dissipation) (dB)
G_{AUT} = Gain of the test antenna (dBi)
L_2 = Cable loss between AUT and test mixer (dB)

Caution: PTM must not exceed the maximum power level of the mixer[1]
PTM – Mixer Conversion Loss[2] must be less than +5 dBm so as to not exceed the 1 dB compression level for the IF input to the 85309B.

1. +26 dBm (85320A/B, 85320A/B-H50), +20 dBm (85320A/B-H20).
2. Refer to Table 10 in the “Antenna measurement components catalog” section on page 58 for mixer conversion loss.

Power at the analyzer inputs

Calculate the IF power levels at the receiver using the following equations:

$P_{REF} = P_{RM}$ – conversion loss of mixers[1] + conversion gain of 85309B – (L3 + L5)
$P_{TEST} = P_{TM}$ – conversion loss of mixers[1] + conversion gain of 85309B – (L4 + L6)

Where L = Cables losses as shown in Figure 11
Conversion gain of 85309B: ~23 dB (typical)

Caution: These values must not exceed the maximum input power level (0.1 dB compression level) of the receiver (-27 dBm for Option H11 or -14 dBm for Option 014). Reduce the power level of the RF source if necessary or add attenuators prior to the mixers or the analyzer inputs.

Sensitivity

Now, determine the sensitivity required of the PNA network analyzer.

Sensitivity = P_{REF} – DR – S/N

Where DR = Required dynamic range
S/N = Signal-to-noise ratio calculated previously

With this sensitivity number, select an analyzer from Table 1 that meets your measurement needs.

1. Refer to Table 10 in the "Antenna measurement components catalog" section on page 58 for mixer conversion loss.

Determining measurement speed

Table 1 shows the measurement speed (for data taking only) of the analyzer. The actual measurement speed also includes frequency stepping time, settling time, bandcrossing time, retrace time and handshake time (if two PNAs are used). If external sources are used, the measurement speed is often determined by the remote source which is usually the slowest resource in the system. All measurement times in this section are nominal values.

Upgrade note: In general, the PNA will provide significant speed improvements over the 8510 or 8530 analyzers. However, some measurement setups will require additional external component speed improvements in order to fully capture the PNA speed benefits.

1. Measure the speed

Calculating the measurement speed of your antenna test system is not straightforward. Two methods can be used to determine the speed of the PNA, either measure it directly or use the following equation to calculate the approximate speed.

To measure the speed, either use a program to time when the PNA completes the measurement, or use an oscilloscope and monitor the “ready for trigger” line out the rear panel BNC labeled I/O 2 (Trig Out). Put the PNA in external trigger mode, set it to the default of “hi level” trigger (If there is no trigger in, you do not have to enable Trigger Out). A pull up on the “trig in” line will cause the PNA to run at max speed. The total measurement time is the spacing between “trig outs”.

2. Calculate the speed

To calculate the approximate measurement speed use the following equation:

Total Measurement time = data taking + pre-sweep time + band crossing + retrace

Data taking: Measurement time per point is determined by the larger of 1/BW or the maximum sweep rate. For wide spans with fewer points, sweep rate is more likely to dominate. Sweep rate is approximately 600 MHz/ms for the PNA and approximately 900 MHz/ms for the PNA-L.

Pre-sweep time: In swept mode, pre-sweep time is 222 uS for the PNA and 56 uS for the PNA-L. In step mode, calculate the sweep time from the following information: PNA fastest step speed at 1 Hz/pt, max IF BW is 170 us, and at 10 MHz/pt, max IF BW is 278 us; PNA-L fastest step speed at 1 Hz/pt, max IF BW is 80 us, and at 10 MHz/pt, max IF BW is 160 us.

Band crossings take on the order of 4 – 8 ms per crossing for the PNA and 2 ms for the PNA-L. However, the number of band crosses increases when in frequency offset mode. In that mode, band crossings of source and receiver may not coincide. Exact band crossing locations can be found in the Microwave PNA Service Manual on Table 5.2.

Retrace takes 10-15 mSec with the display on, or 5-8 mSec with the display off. Retrace will take the system back to the start frequency of the previous sweep.

Example measurement time for a PNA network analyzer

PNA with 201 points, 1 GHz span and 10 kHz BW sweep

First, determine if most PNA points are in step or swept mode. If BW ² 1kHz or time/point > 1mS, all points will be stepped, otherwise it will be swept. In addition, source power cal, power sweep and frequency offset mode all force step mode.

Data taking: time/point = 1/BW = 1/10 kHz = 100 uSec (Since this is faster than 1 mS, the PNA is probably in swept mode.)
So, 201 points at 100 uS/point is 20.1 mS

Next, check the sweep rate limit. A 1 GHz span at 600 MHz/mSec = 1.7 mS . So, the sweep speed is dominated by “time/point” (data taking) not sweep rate.
Therefore, “data taking” = 20.1 mS

Pre-sweep time: 222 uS

Band-crossings: None

Retrace time: 10 to 15 mS

Total measurement time = 20.1 mS + 222 uS + 10 to 15 mS
= 30 to 35 mS (NOMINAL)

Optimizing speed and dynamic range

Some applications require the fastest speed a system can provide, others are concerned with the best dynamic range available. With the PNA Series network analyzer, users can adjust their setup according to their specific needs.

Options available to improve sensitivity

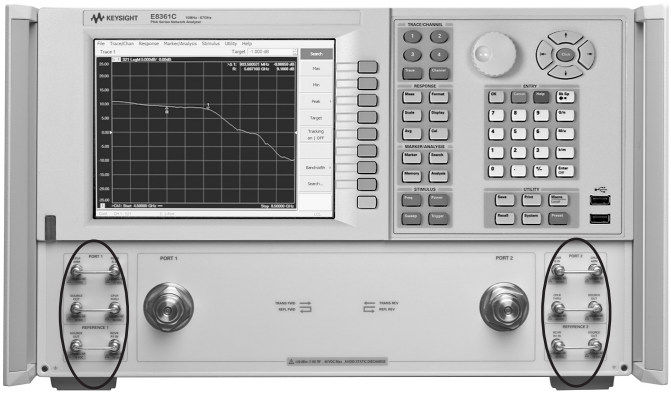
Option 014 (Direct receiver access) – Sensitivity improvements
Option H11 (IF MUX access) – Best dynamic range when using external mixers

Other tradeoffs

Reducing the IF BW improves the dynamic range, but reduces the speed. Users must determine the optimum settings for their applications. For example changing from a 1 kHz IF BW to a 100 Hz IF BW gives a 10 dB improvement in dynamic range, but a 10 times reduction in speed.

Legacy PNA interface requirements

When configuring the PNA it is critical that power levels are considered to avoid damaging the PNA. Ideally, power should not exceed the 0.1 dB compression levels indicated in the figures below. Damage levels are printed on the instrument, as shown in Figure 20.



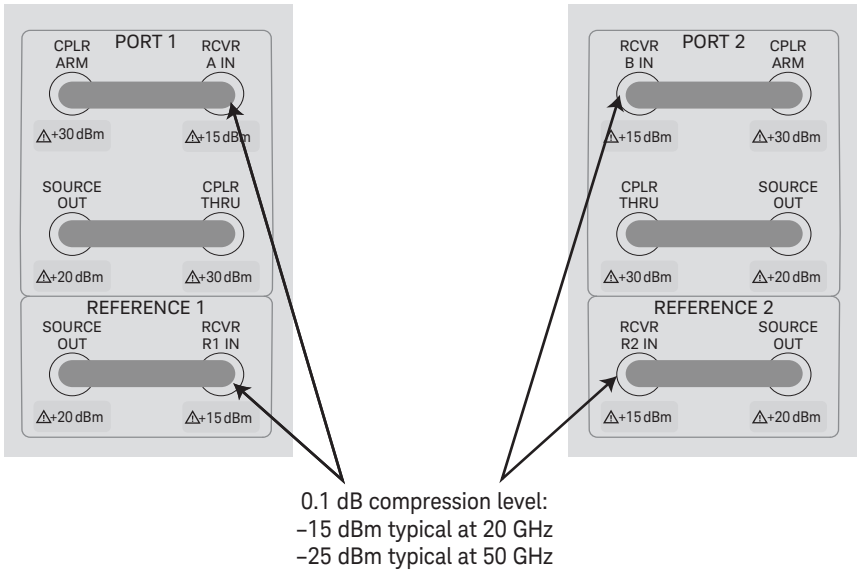
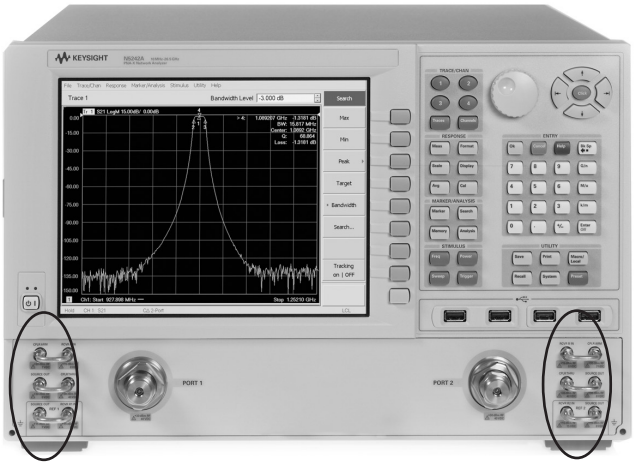


Figure 20. PNA E836xC front panel connectors.

PNA-X N5242A Network Analyzer



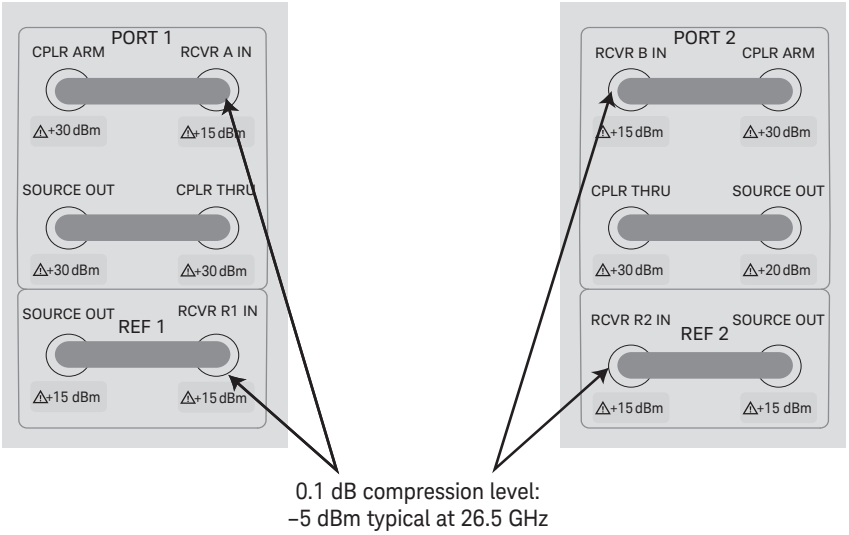
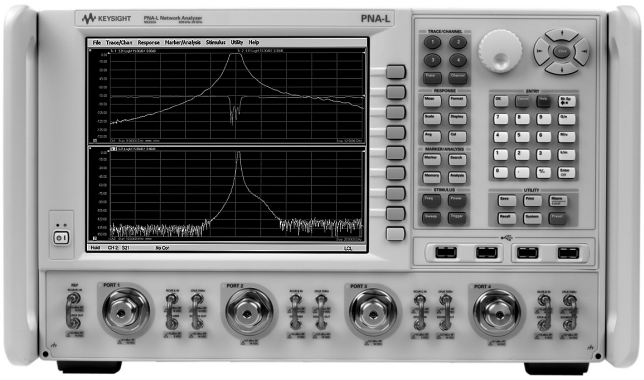
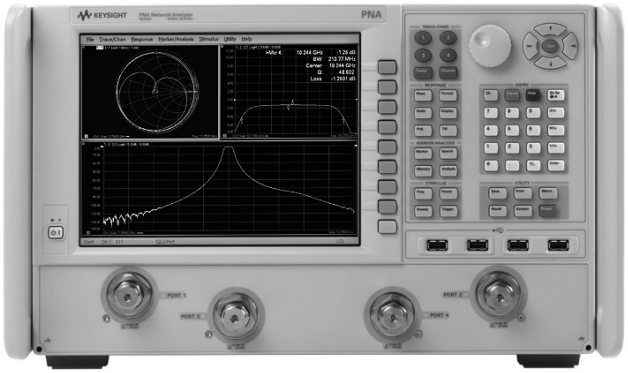


Figure 21. PNA-X N5242A network analyzer front panel connectors.



PNA-L N523xA Network Analyzer



PNA N5222A Network Analyzer

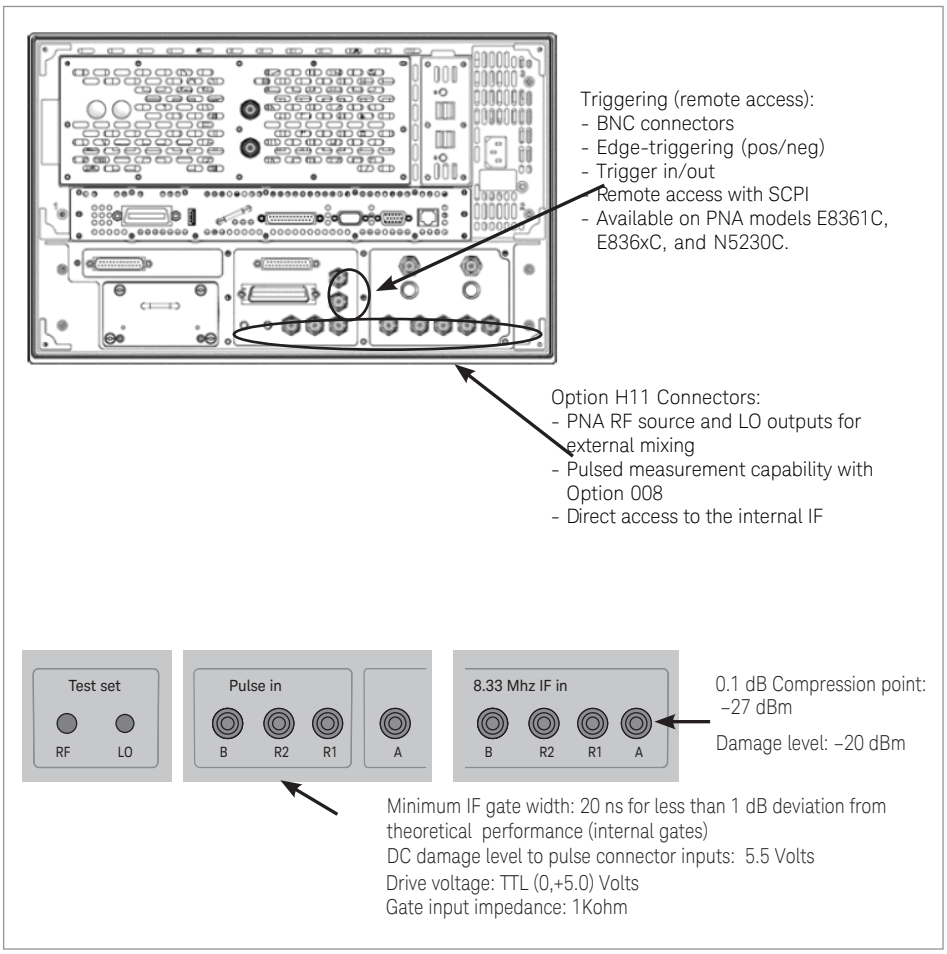


Figure 22. PNA E836xC network analyzer rear connectors.

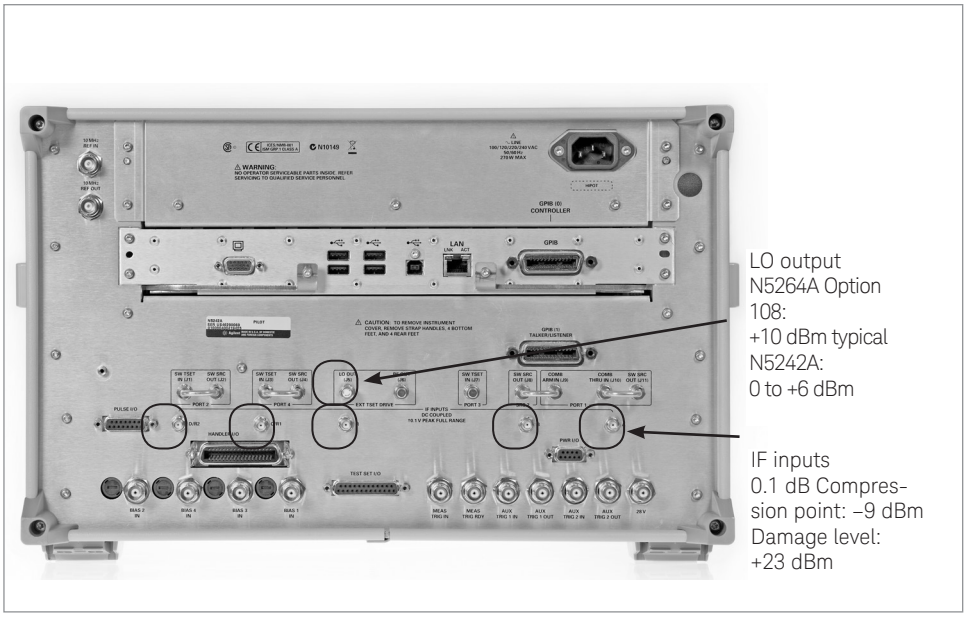


Figure 23. PNA-X N5242A network analyzer and PNA-X N5264A measurement receiver rear connectors.

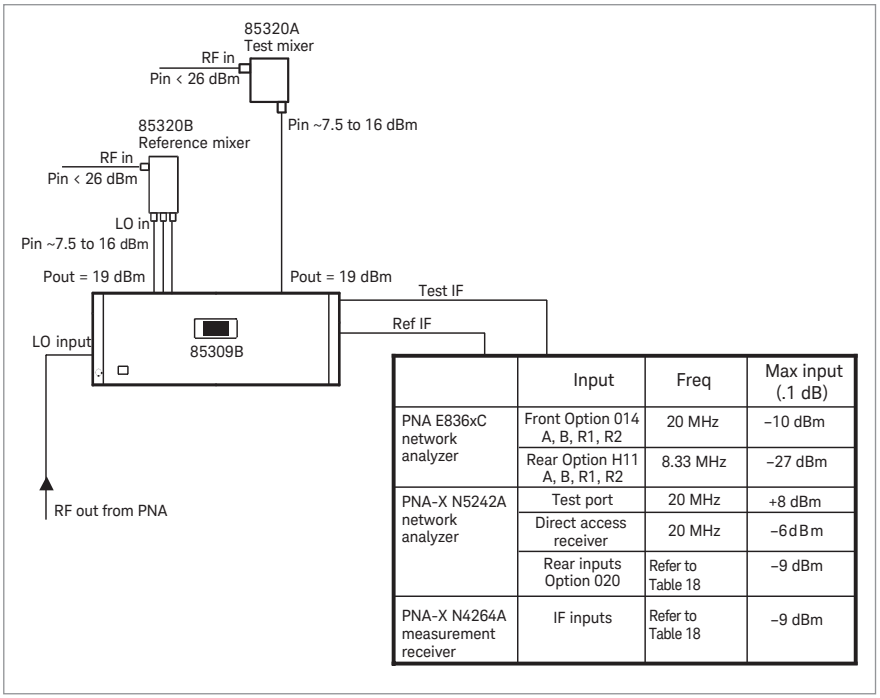
Option H11 – IF access

Option H11 is only available on the PNA network analyzers. Option H11 also requires Options 014, 080, 081 and UNL. Option H11 provides direct access to the first IF down-conversion stage. The external IF input allows 8.33 MHz IF signals from remote mixers to be input directly to the PNA digitizer, bypassing the PNA's RF conversion stage. The test system becomes a distributed network analyzer with a tracking source and a tuned receiver. This shifts the dynamic range curves and increases sensitivity by approximately 20 dB.

Option H11 also provides access to the RF and LO signal sources (from 1.7 to 20 GHz) of the PNA on the rear panel. This dual hybrid source eliminates the need for a separate stand alone synthesizer when remote mixing is used. There is no power control over the rear panel RF and LO signals. Power output ranges vary and external amplifiers may be needed to achieve the power level required by the mixers. Table 2 shows the typical power levels available at the outputs. By removing the necessity of an external RF source the test time is dramatically reduced. This is because the frequency stepping speed is solely a function of the PNA where the settling time is in the uS range as compared to mS range of most sources.

Table 2. Typical values of the RF and LO outputs from the rear panel of the PNA

Rear Panel LO Power (Typical)	
1.7 GHz to 20 GHz	–16 to –7 dBm
Rear Panel RF Power for E8362C (Typical)	
1.7 GHz to 20 GHz	–16 to –5 dBm (at –5 dBm test port power[1])
Rear Panel RF Power for E8363C/E8364C (Typical)	
1.7 GHz to 10 GHz	–12 to –2 dBm (at –5 dBm test port power[1])
10 GHz to 16 GHz	–8 to 0 dBm (at –5 dBm test port power1)
16 GHz to 20 GHz	–1 to +5 dBm (at –5 dBm test port power[1])



	Input	Freq	Max input (.1 dB)
PNA E836xC network analyzer	Front Option 014 A, B, R1, R2	20 MHz	–10 dBm
	Rear Option H11 A, B, R1, R2	8.33 MHz	–27 dBm
PNA-X N5242A network analyzer	Test port	20 MHz	+8 dBm
	Direct access receiver	20 MHz	–6dBm
	Rear inputs Option 020	Refer to Table 18	–9 dBm
PNA-X N4264A measurement receiver	IF inputs	Refer to Table 18	–9 dBm

Figure 24. PNA E836xC network analyzer Option H11 and Option 014 connection diagram and input level requirements.

1. Test port power has to be at a high enough level such that the Drop Cal does not occur. If Drop Cal occurs, then the power out of the rear panel RF connector will drop by about 15 dB.

Option H11 – IF access (continued)

The 85309 LO/IF distribution unit interfaces with the PNA, PNA-X in two different ways, providing either a 20 MHz IF signal for PNA and PNA-X or an 8.33 MHz for PNA, a 7.606534 MHz for PNA-X and PNA-X measurement receiver IF signal. It is important to understand the differences in each configuration before setting up your measurement.

85309B with PNA configured with Options 014 and 080 or PNA-X Option 080

With this setup, the PNA or PNA-X operates in frequency offset mode and the 85309B must create a 20 MHz IF signal. The receiver is set to 20 MHz and the RF and LO sources must be offset by 20 MHz. The test and reference signals are inserted through the front panel links, bypassing the internal coupler. This configuration improves the noise floor by approximately 10 to 38 dB, depending on frequency. However, operation in frequency offset modes results in a decrease of frequency stepping speed.

85309B with PNA configured with Options 014, 080, 081, UNL, and H11

With this setup, the 85309B must create an 8.33 MHz IF signal. The RF and LO sources must be offset by 8.33 MHz. Normal operation of the PNA automatically offsets the internal LO 8.33 MHz from the internal RF. Above 20 GHz the PNA switches to 3rd harmonic mode so that RF – 3 * LO = 8.33MHz. This configuration allows the 85309B IF output to be connected to the PNA H11 rear panel IF inputs, bypassing the first PNA mixer. This configuration provides the best sensitivity.

85309B with PNA-X configure with Option 020 and 080

With this setup, the 85309B must create a 7.605634 MHz IF signal. The RF and LO sources must be offset by 7.605634 MHz. Normal operation of the PNA-X automatically offsets the internal LO 7.605634 MHz from the internal RF. This configuration allows the 85309B IF output to be connected to the PNA-X option 020 rear panel IF inputs, bypassing the first PNA-X mixer. This configuration provides the best sensitivity.

85309B with PNA-X Measurement Receiver

With this setup, the 85309B must create a 7.605634 MHz IF signal. The RF and LO sources must be offset by 7.605634 MHz. PNA-X measurement receiver option 108 automatically offsets 7.605634 MHz from the external RF when operates in couple mode. This configuration allows the 85309B IF output to be connected to the rear panel IF inputs. This configuration provides the best sensitivity and lower cost.

Setting up the PNA LO for an 8.33 MHz IF signal

Note: The following equations are not required for frequencies under 20 GHz. At lower frequencies, the PNA operates in fundamental mixing mode and the LO frequency is automatically offset by 8.33 MHz.

The PNA LO must be set so that an 8.33 MHz IF signal is produced by the mixers for input to the PNA Option H11 inputs. Using the equations below, the appropriate LO frequency can be calculated. (To set up the PNA-X LO for an IF signal, in the procedure below, simply change “8.33 MHz” to “7.605634 MHz “.)

Using the rear panel LO available with Option H11 as the LO input of the 85309B:

We know that for a mixer, IF = N(LO) –RF
where N = external mixer harmonic number

With Option 080 (frequency offset) the frequency out of the rear panel LO port is defined as, $LO = \frac{m}{d}$ (RF) + offset + 8.33 MHz

Substituting for LO in the first equation we have,

$IF = N\left(\frac{m}{d}\right)(RF) + offset + 8.33\ MHz) - RF$

$= \left(\frac{m}{d}\right)N(RF) + N(offset) + N(8.33) - RF$

To create a low side LO, set m = 1 and d = N

Simplifying, IF = RF + N (8.33) + N(offset) – RF
= N(8.33) + N(offset)

Since IF must be equal to 8.33 MHz, then:
8.33 = N(8.33) + N(offset)
(1 – N)8.33 = N(offset)
Therefore, offset (MHz) = $\left(\frac{1-N}{N}\right)$ 8.33

Using the Option 080 dialog box (shown in Figure 25) to set up the LO, enter the offset calculated above, set Multiplier to 1 and Divisor to N (the harmonic number of the external mixer) and select the box next to Frequency Offset on/off, then click OK.

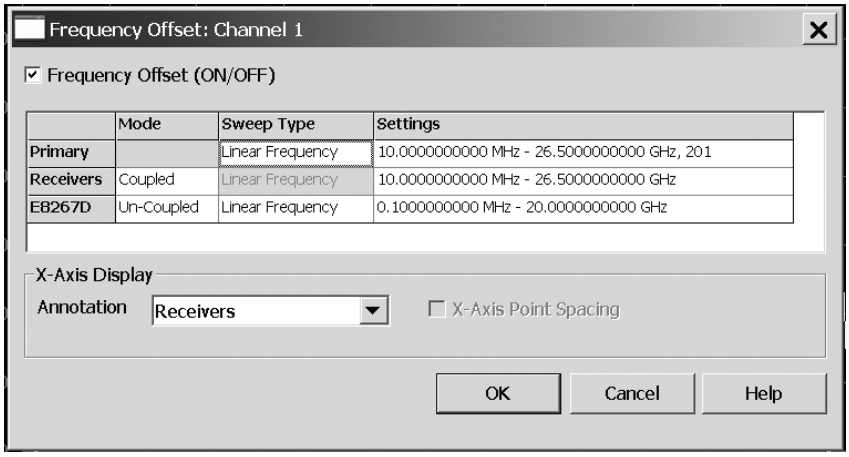


Figure 25. Option 080 dialog box.

Using the PNA E836xC front panel Port 1 Source Out as the LO input for the 85309:

We know that for a mixer, IF= N(LO) – RF
where N = external mixer harmonic number

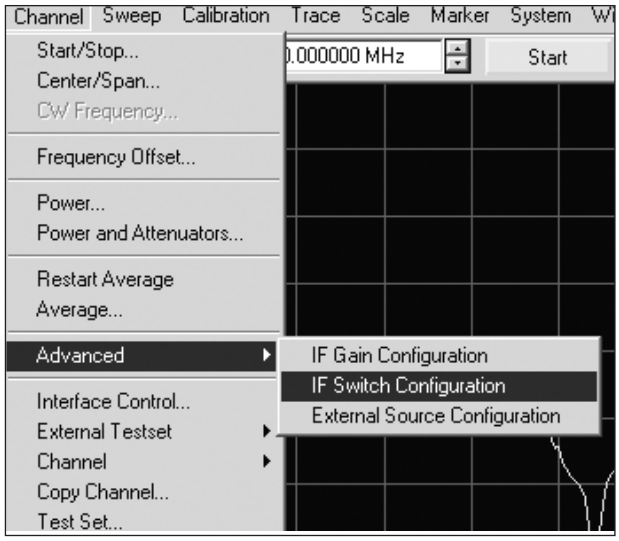
Since IF = 8.33 MHz, then 8.33 = N(LO) – RF
LO (MHz) = (RF + 8.33)/N

To set the LO frequency of the 85309, simply set the RF output on the PNA to the LO frequency calculated above.

Turning on Option H11 with PNA and PNA-X

Although Option H11 is installed, you must assure that the IF switch is set correctly for it to function properly.

For PNA: Select Channel > Advanced > IF Switch Configuration
Then Select External for both IF Inputs



For PNA-X: Select Channel > Hardware Setup > If Switch Config

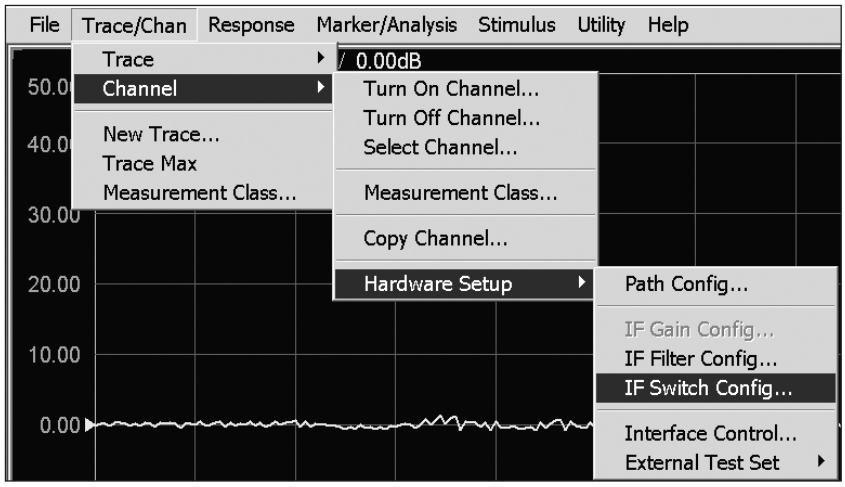


Figure 26. Enabling external IF inputs.

Near-field data collection

Frequency multiplexing during a data scan/acquisition can result in a misalignment of the rectangular near-field grid between forward and reverse data scan directions. This introduces an error into the measured near-field data set which results in a far-field pattern. One way to eliminate this error is to always collect data measurements in the same scan direction, but this would double the data scan acquisition time. Another approach is to scan frequencies in reverse order on reverse scans. Using this reverse sweep in conjunction with correct triggering between forward and reverse passes insures that each frequency set is spatially aligned on the rectangular near-field grid. This technique requires an RF source that supports reverse frequency list mode of operation. The PNA network analyzer includes reverse sweep and edge triggering capability specifically designed for antenna measurements.

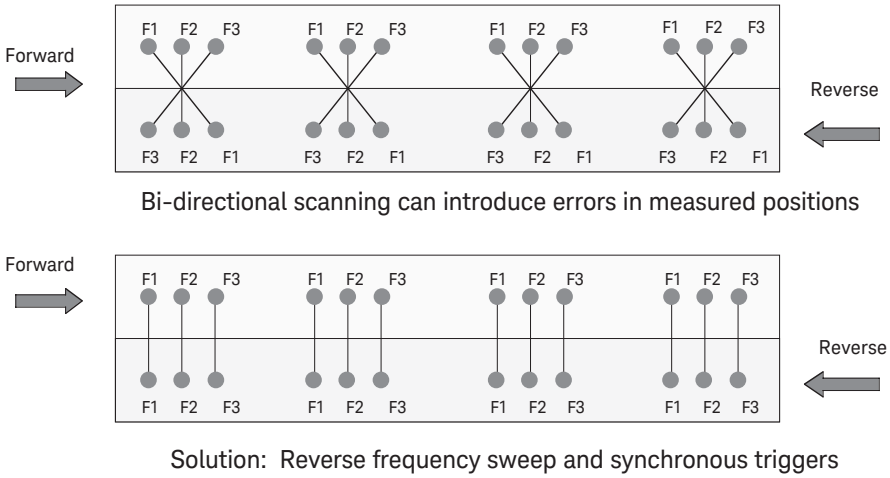


Figure 27. Reverse sweep with synchronous triggers.

Functional test

A software utility is available for the PNA network analyzer that helps verify that a PNA has been correctly configured with an external source for making antenna measurements. The utility configures the PNA as a receiver and communicates with external sources over GPIB. The triggering is done by handshaking the PNA and external sources using the TTL trigger in and trigger out capabilities on the PNA and PSG. The software does not verify specifications, but is useful in determining that a valid connection has been established between the analyzer and the source.

Go to **http://na.tm.keysight.com/pna/antenna** to download the program.

4. Migrating from 8510/8530 to PNA

Migration from 8510/8530 based antenna systems to PNA network analyzer based systems

Table 3 shows the various system components of 8510/8530 based antenna systems and their recommended replacement components. While the components listed are recommended replacements, some interface requirements are different. Refer to the "Antenna measurement design considerations" section on page 22 for interface requirements.

Table 3. Cross reference for 8510/8530 based antenna systems migrating to PNA network analyzer based systems

System Components	Description	Recommended PNA solution	Description
8510C	Network analyzer	Determined by test set	
8510C -008	Network analyzer with pulse capability	Determined by test set	
8514B	45 MHz – 20 GHz test set	E8362C	10 MHz – 20 GHz
8515A	45 MHz – 26.5 GHz test set	N5242A/E8353C	10 MHz – 26.5/40 GHz
8517B	45 MHz – 50 GHz test set	E8364C	10 MHz – 50 GHz
85110A	Pulsed 2 – 20 GHz test set	N5242A Option 021, 025, and 008	10 MHz to 26.5 GHz
85110L	Pulsed 45 MHz – 2 GHz test set	N5242A Option 021, 025, and 008	10 MHz to 26.5 GHz
8530A	Microwave receiver	N5264A measurement receiver	10 MHz to 26.5 GHz
8511A	45 MHz – 26.5 GHz frequency converter	N5280A	26.5 GHz with frequency converter
8511B	45 MHz – 50 GHz frequency converter	N5281A	50 GHz with frequency converter
85105A	mmWave test set controller	N5260A	mmWave test set and external hardware
Q85104A	33 – 50 GHz test set module	E8364C or OML head	10 MHz – 50 GHz
U85104A	40 – 60 GHz test set module	E8361C or OML head	10 MHz – 67 GHz
V85104A	50 – 75 GHz test set module	N5250A or OML head	10 MHz – 110 GHz
W85104A	75 – 110 GHz test set module	N5250A or OML head	10 MHz – 110 GHz
8360 Series	RF Sources	None required	

Engineering services provided for 8510/8530 migration to PNA series network analyzers

For current users of the 8510/8530 Series of network analyzers, Keysight offers a spectrum of engineering services that provide training, code conversion, and/or test plan design.These services allow you to take advantage of the excellent performance of the PNA Series with ease.

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.

Table 4. Recommended consulting services

Transition scenario	Recommended service	Description
Users migrating 8510 network analyzers to new PNA Series solutions	H7215B-203	PNA Series network analyzer operation training course
Test programmers converting automated 8510 network analyzer systems to PNA Series solutions	R1362A-116	8510 to PNA Series test code conversion service
	H7215B-204	PNA programming using SCPI training course
	H7215B-205	PNA programming using COM training course
Test engineers creating a test plan that makes use of the new high performance PNA Series features	R1361A-112	Network analyzer test plan development service

Note: Additional consulting services can be purchased at time of sale or later by ordering part number PS-S20-100.

Migration examples

When migrating from an 8510/8530 to a PNA Series network analyzer, it is important to recognize the differences in power, speed and sensitivity between the analyzers.

In remote mixing configurations, using Option H11, the damage level of the PNA is much lower than the 8510/8530. You must assure that the power going into the analyzer does not exceed –27 dBm by placing attenuators between the 85309B and the H11 inputs. Review section “Option H11 – IF access” earlier in this document for more detailed information.

The internal source of the PNA and PNA-X improves the measurement speed over an external source, however, the internal source is not always feasible to use.

The IF BW setting on the PNA, PNA-L and PNA-X is adjustable, the IF BW of the 8510/8530 was fixed, so sensitivity can be changed by adjusting the IF BW setting on the PNA Series.

For fastest remote control of the PNA and PNA-X, the use of COM programming is recommended. See “Measurement Automation” later in this document. Contact your Keysight Applications Engineer for additional assistance with programming.

The following two examples show conceptually how to migrate from an 8510/8530 to a PNA or PNA-X based antenna system. Since every system is unique, it is not feasible to show every modification necessary for the conversion. Refer to “Antenna measurement design considerations” earlier in this document for additional guidance, or contact your Keysight applications engineer for assistance.

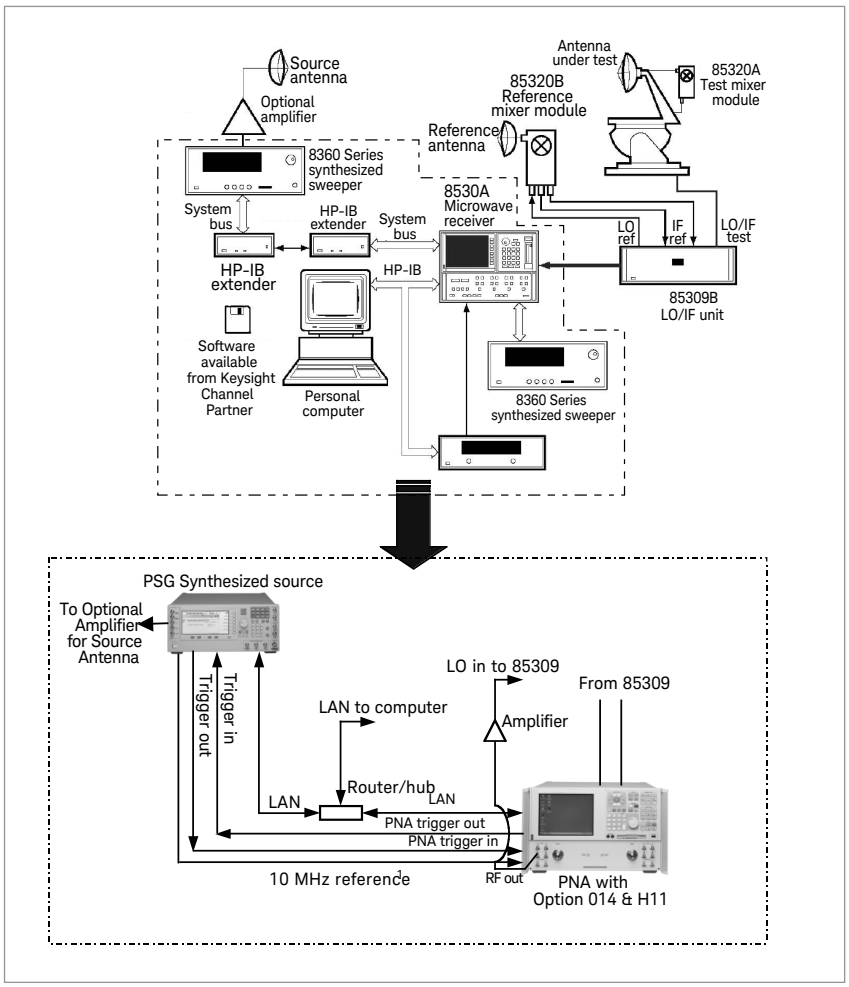


Figure 28. 85301 Far-field system migration to PNA Series.

1. For long distance applications, the use of two GPS receivers to supply the 10 MHz reference may be used.

Migration examples (continued)

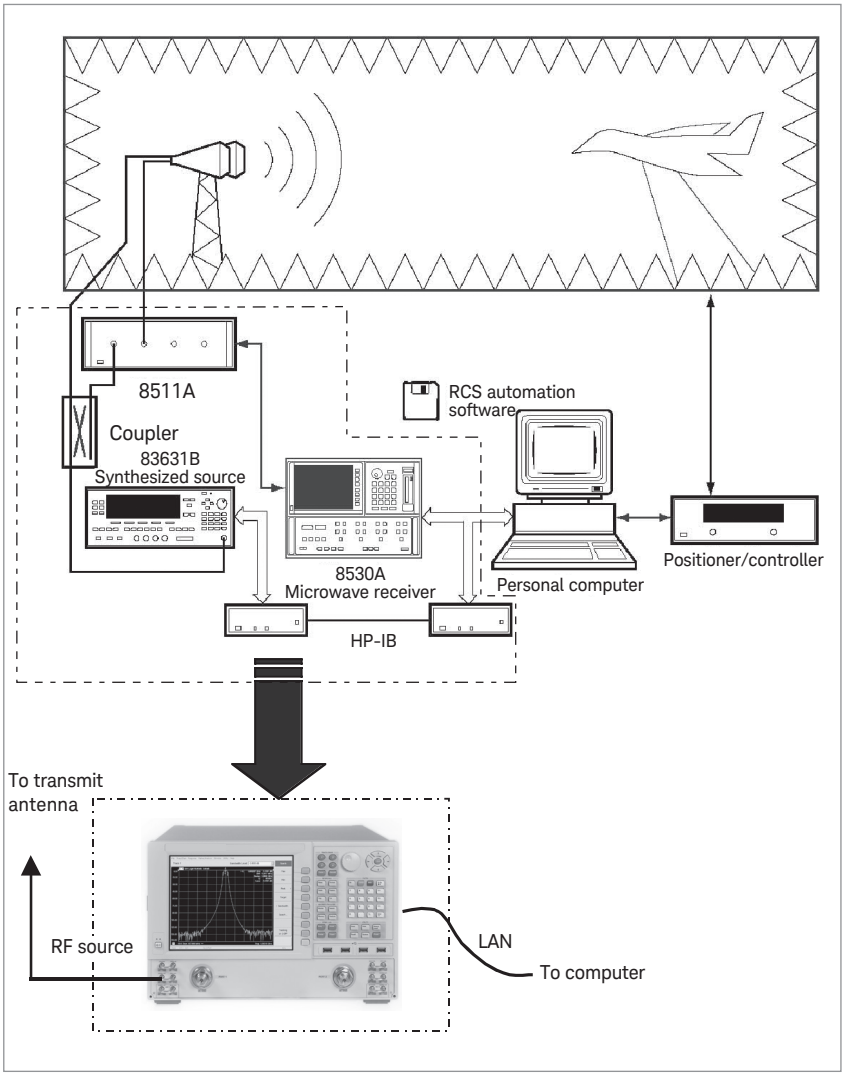


Figure 29. 85301 RCS system migration to PNA-X N5242A network analyzer.

5. Antenna measurement components catalog

Microwave network analyzers

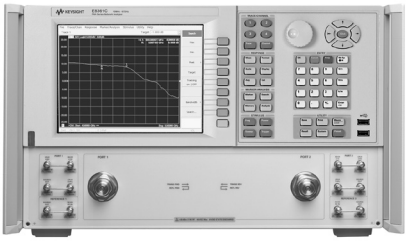


Figure 30. Legacy (E836xC) PNA network analyzer.

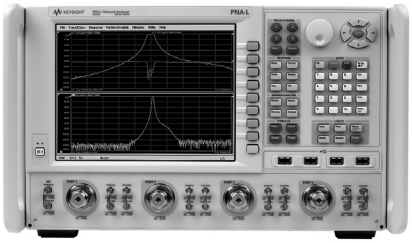


Figure 31. PNA N523xA network analyzer.

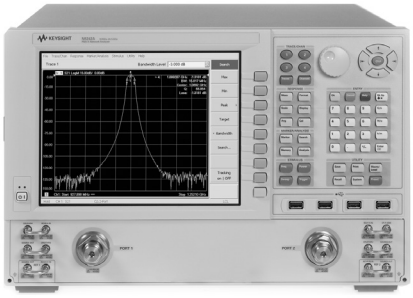


Figure 32. PNA-X N5242A network analyzer.

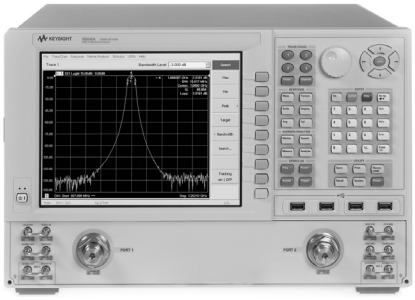


Figure 33. PNA N5222A network analyzer.

PNA Series network analyzers

The microwave PNA Series instruments are integrated vector network analyzers equipped with a built-in S-parameter test set, synthesized sources, hard and floppy disk drives, and an LCD display. They offer fast data acquisition speeds, excellent sensitivity, wide dynamic range, multiple test channels, and frequency agility – without compromising measurement accuracy. Frequency coverage is from 10 MHz to 110 GHz with extensions to 325 GHz.

Features

- Excellent sensitivity due to mixer-based architecture. In addition, the ability to select from a minimum of 29 different IF bandwidths allows the user to optimize the sensitivity versus measurement speed tradeoff.
- Extremely fast data transfer rates are accomplished using the COM/DCOM features.
- Flexibility with 4 simultaneous test receivers and 20,001 data points per trace.
- Pulsed measurement capability for point-in-pulse with pulse widths smaller than 100 ns.
- Removable hard drive ensures the security of the data.

Options

Time-domain capability - Option 010
Optional time-domain capability is available with the PNA Series network analyzer. Time domain is most often used for locating reflections inside anechoic chambers. Time domain displays reflections versus time or distance inside an anechoic chamber. Knowing the distance of a reflection from the source antenna helps the operator locate the reflection source, and helps to identify and mitigate the reflection. Figure 34 shows the time-domain response of a compact antenna test range; the various reflection sources are identified.

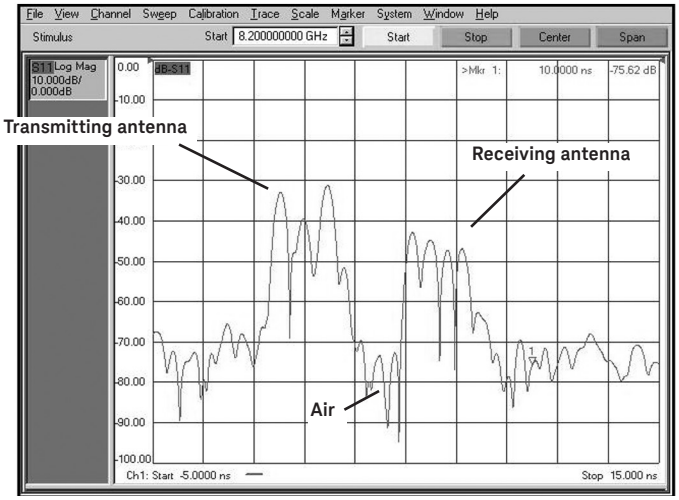


Figure 34. Time-domain plot.

Configurable test set - Option 014[1] PNA E836xC
Provides six front panel access loops. Three access loops are for port one and three for port two. 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. This option improves instrument sensitivity for measuring low-level signals by allowing the user to bypass the internal couplers and enter the test signal directly into the receiver port of the analyzer. (See PNA Series Microwave Data Sheet, literature number 5988-7988EN, for a basic block diagram.)

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. This ability is useful for antenna measurements where the measurement system contains remote mixers and for RCS measurements in pulse mode.

IF access - Option H11 PNA E836xC
Provides IF gating hardware and hardware to enable antenna and broadband millimeter-wave measurements to 110 GHz. For each of the PNA's measurement receivers, IF gates (enabled with pulsed measurement capability, Option 008) and external IF inputs are added. In addition, access to the PNA's internal RF and LO source is provided for remote mixing applications. Option H11 is useful for antenna measurements with external mixers. Use external IF access for up to 20 dB more sensitivity when making antenna measurements with a remote mixer configuration. Pulsed antenna applications also require the Pulse measurement capability (Option 008). Broadband measurements to 110 GHz require an N5260A millimeter-wave test set controller and test heads. Option H11 requires Options 014, 080, 081, and UNL.

1. Up to 67 GHz.

Options (continued)

IF inputs for antenna and millimeter-wave - Option 020 - PNA N522xA and PNA-X N524xA

The PNA-X IF access option provides network analyzer IF signal path access for applications including antenna measurements, and extended frequency coverage beyond 26.5 GHz.

With Option 020 IF access, antenna-test professionals can use an externally generated 10.7 MHz IF, bypassing the PNA-X's internal first converter to achieve maximum sensitivity with remote mixing for antenna measurements. By combining IF access with frequency-offset capability and advanced triggering that supports synchronization with external signal generators, users can attain exceptionally accurate antenna and radar cross section (RCS) measurements faster than previously possible.

When making antenna measurements with a remote mixing configuration, up to 20 dBmore sensitivity is possible. When the PNA-X is equipped with Option 020 and the N5260A millimeter-wave controller, it can be configured for broadband measurements from 10 MHz to 110 GHz.

Pulse modulator for internal 1st source - Option 021 - PNA N522xA and PNA-X N524xA
The PNA-X Option 021 adds an internal pulse modulation capability to the first internal source for pulsed-RF measurements with a frequency range of 10 MHz to 26.5 GHz.

With Option 021, the PNA-X provides pulsed stimuli at test port one that allows forward direction pulse measurements. By combining Option 025 internal pulse generators and Option 008 pulse measurements application, the PNA-X can be a fully integrated, fast and accurate pulse measurement system, which provides full pulse measurement capabilities such as pulse average, point-in-pulse and pulse-profile.

Four internal pulse generators - Option 025 - PNA N522xA and PNA-X N524xA
Option 025 adds four internal pulse generator outputs to control internal or external pulse modulators and IF gates for pulsed-RF measurements, or to set the device conditions.

Each pulse generator can be controlled independently from Option 008 pulse measurement application or through the remote interface. The pulse signals from four generators are available on the Pulse-I/O D-sub connector on the PNA-X rear panel. The N1966A pulse I/O adapter is recommended if using external pulse modulators.

By combining Option 021/022 internal pulse modulators and Option 008 pulse measurements application, the PNA-X can be a fully integrated, fast and accurate pulse measurement system, which provides full pulse measurement capabilities such as pulse average, point-in-pulse and pulse-profiling.

LO source 26.5 GHz - Option 108 - PNA N522xA and PNA-X N524xA The high-output power source option can be used as an LO source for remote mixers or frequency convertors.

Fast CW mode - Option 118 - PNA N522xA and PNA-X N524xA
Fast CW mode provides extremely fast data acquisition speed of 400,000 points per second; with up to five measurement receivers simultaneously.

Pulse measurements (Option 008)[1]

The PNA receiver has optional Pulse measurement capability (Option 008). This option provides software to set up and control pulsed-RF measurements with point-in-pulse and pulse-profile capability.

Keysight has developed a novel way of achieving narrowband detection using wider IF bandwidths than normal, by using a unique “spectral-nulling” technique that lets the user trade dynamic range for speed, with the result almost always yielding faster measurements than those obtained by conventional filtering. The advantage to narrowband detection is that there is no lower pulse-width limit, since no matter how broad the pulse spectrum is, most of it is filtered away anyway, leaving only the central spectral component. The disadvantage to narrowband detection is that measurement dynamic range is a function of duty cycle. As the duty cycle of the pulses gets smaller (longer time between pulses), the average power of the pulses gets smaller, resulting in less signal-to-noise ratio. In this way, measurement dynamic range decreases as duty cycle decreases. This phenomenon is often called “pulse desensitization”. The degradation in dynamic range (in dB) can be expressed as 20*log (duty cycle).

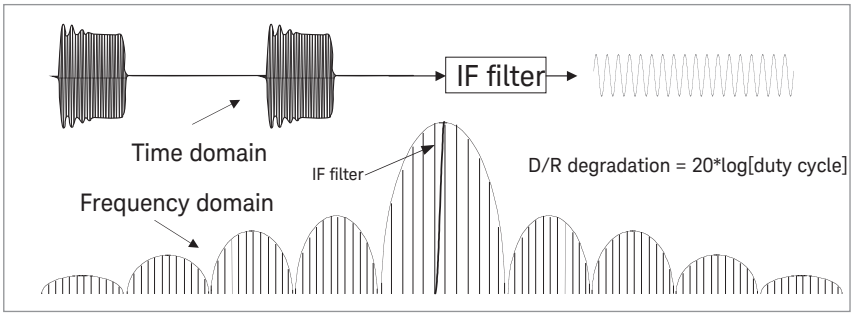


Figure 35. Time domain.

The IF gates supplied with Option H11 can only be used with Option 008. 008 includes all of the proprietary algorithms necessary to implement the spectral nulling technique used with narrowband detection. 008 also controls the pulse generator(s) used in the system, and performs pulse-profile measurements. Option 008 comes with two software components. One is a dynamic-link library (DLL) which acts as a “sub-routine”, and is needed for automated environments. The second portion is a Visual Basic (VB) application that runs on the PNA. This VB application is used for stand-alone, bench-top use. It interacts with the DLL and sends appropriate commands to the PNA and the pulse generator(s). The VB application is assigned to one of the PNA’s macro keys for easy access.

See Table 1 in section 3 for a list of PNA Series network analyzers, their frequency ranges, power and sensitivity. Refer to the PNA data sheet for additional specifications, literature number 5988-7988EN.

For more detailed information regarding pulsed measurement capabilities with the microwave PNA refer to the Keysight Web site **www.keysight.com/find/pna** and download the *PNA Series MW Network Analyzers Configuration Guide for Pulsed Measurements*, literature number 5988-9833EN. Additional information is also available in Application Note 1408-11, literature number 5989-0563EN, and *Pulsed Antenna Measurements Using PNA Network Analyzers*, literature number 5989-0221EN.

1. Up to 67 GHz.

PNA-L Series network analyzers

The PNA-L has many of the same great characteristics of the PNA family but differs in the following ways.

Option H11, IF access, and Option 008, Pulsed-RF measurement capability are not available. The PNA-L cannot be upgraded to millimeter frequencies.

The PNA-L allows even wider IF bandwidth settings than the PNA and has speed advantages over the PNA. It has slightly less sensitivity than the PNA (refer to Table 1 in section 3 for a sensitivity comparison).

For additional information and specifications, refer to the PNA-L data sheet, literature number 5989-0514EN.

ENA

The ENA differs from the PNA in the following ways.

Option H11, IF access, Option 008, Pulsed-RF measurement capability, and Option 014, Configurable test set are not available. The ENA is limited to 8.5 GHz and cannot be upgraded to millimeter-wave frequencies. It also has no security features.

The ENA is the lowest cost solution.

For additional information and specifications, refer to the ENA data sheet, literature number 5988-3780EN.

Sources



Figure 36. PSG sources.



Figure 37. MXG sources.

When selecting a transmit source for an antenna range, frequency range and output power are the primary concerns. Future frequency requirements should also be considered. Keysight offers a variety of signal generators with different frequency ranges and output power. Source frequency switching speed must also be considered for some applications. Keysight sources provide different switching speed capability, with options for setting times less than 1 ms. Depending on individual preference, select a transmit source from Table 5. If the system is to be used for measuring antennas in a pulsed mode of operation, Pulse modulation (Option UNU) or Narrow pulse modulation (Option UNW) must be ordered.

Sources (continued)

Select a transmit source from the following table:

Table 5. Sources

Source	Frequency range	Output power at Fmax	High power (Option 1EA) at Fmax (typical)
PSG analog signal generators			
E8257D-520	250 kHz - 20 GHz	+15 dBm	+23 dBm
E8257D-532	250 kHz - 32 GHz	+11 dBm	+17 dBm
E8257D-540	250 kHz - 40 GHz	+11 dBm	+17 dBm
E8257D-550	250 kHz - 50 GHz	+5 dBm	+14 dBm
E8257D-567	250 kHz - 67 GHz	+5 dBm	+14 dBm
MXG analog signal generators			
N5183A-520	100 kHz - 20 GHz	+11 dBm	+18 dBm
N5183A-532	100 kHz - 32 GHz	+7 dBm	+12 dBm
N5183A-540	100 kHz - 40 GHz	+7 dBm	+12 dBm
PSG vector signal generators			
E8267D-520	250 kHz - 20 GHz	+18 dBm (+22 dBm)	NA
E8267D-532	250 kHz - 32 GHz	+14 dBm (+18 dBm)	NA
E8267D-544	250 kHz - 44 GHz	+10 (+13 dBm)	NA

For more information on MXG and PSG signal generators visit:
www.keysight.com/find/N5183A
www.keysight.com/find/PSG

For data sheets and additional details visit: www.keysight.com/find/na

Frequency converters



Figure 38. 85309 LO/IF distribution unit and 85320A/B mixer modules.

The 85309B LO/IF distribution unit and the 85320A/B mixers downconvert a microwave signal to an IF signal that can be measured by the PNA. The distributed frequency converter uses external mixers for microwave downconversion. These mixers can be located directly at the antenna under test. The frequency of operation depends upon the frequency range of the external mixers selected.

Features

- Allows mixers to be located at the antenna under test, minimizing RF cable loss
- Allows fundamental mixing to 18 GHz for best sensitivity
- Provides best rejection of unwanted spurious signals

Description

The 85309B LO/IF distribution unit contains LO signal amplifiers, which amplify LO drive power through RF cables to the mixers. The high output power allows the mixers to be located more than seven meters from the 85309B. Since the 85309B uses a separate LO amplifier for each channel, channel-to-channel isolation of 100 dB is achieved, minimizing signal leakage from the reference to the test channel and improving the accuracy of the measurement. There are also IF amplifiers located in the 85309B, which serve as a preamplifier for the receiver, reducing the overall system noise figure significantly.

A leveling detector in the reference mixer is used to provide the proper LO drive to the mixers. It is important to use equal length cables to both the reference and test mixers to ensure the same cable loss, and provide the same LO drive power to both mixers.

An internal filter in the reference IF channel is designed to pass frequencies below 20 MHz. This allows the proper IF signal to be passed for both PNA Option 014 and PNA Option H11.

Specifications

Table 7. 85309B specifications

85309B Options 40x Output Power Limits for HIGH Band

LO Output Power (+6 dBm Input)	
Frequency Range	**Power Level**
0.3 – 0.5 GHz	> +21.3 dBm
0.5 – 3 GHz	> +22.4 dBm
3 – 6.2 GHz	> +24.4 dBm
6.2 – 18 GHz	> +22 dBm
LO Output Power (0 dBm Input)	
0.3 – 0.5 GHz	> +21.3 dBm
0.5 – 3 GHz	> +22.4 dBm
3 – 6.2 GHz	> +24.4 dBm
6.2 – 18 GHz	> +22 dBm

85309B Standard or Options 001 or 002 Output Power Limits

LO Output Power (+6 dBm Input)	
Frequency Range	**Power Level**
0.3 – 0.5 GHz	> +21.6 dBm
0.5 – 3 GHz	> +24.1 dBm
3 – 6.2 GHz	> +26.3 dBm
6.2 – 18 GHz	> +23.5 dBm
LO Output Power (0 dBm Input)	
0.3 – 0.5 GHz	> +21.6 dBm
0.5 – 3 GHz	> +23 dBm
3 – 6.2 GHz	> +25 dBm
6.2 – 18 GHz	> +23 dBm

85309B Options 40x Output Power Limits for LOW Band

LO Output Power (+6 dBm Input)	
Frequency Range	**Power Level**
0.1 – 1 GHz	> +14 dBm
LO Output Power (0 dBm Input)	
0.1 – 1 GHz	> +13 dBm

Remote mixer distances

Mixers require a certain LO drive power level; the output power of the 85309B LO/IF distribution unit and the RF loss of the cables will determine the maximum allowable cable lengths. Maximum cable lengths can be calculated using the following equations:

Cable (source to 85309B) length (meters) = (P_{OUT} source – P_{IN}85309B)/(cable loss/meter at frequency)

Cable (85309B to mixers) length (meters) = (P_{OUT} 85309B – P_{IN}mixer)/(cable loss/meter at frequency)

The following diagram shows the power levels for the various mixer configurations.

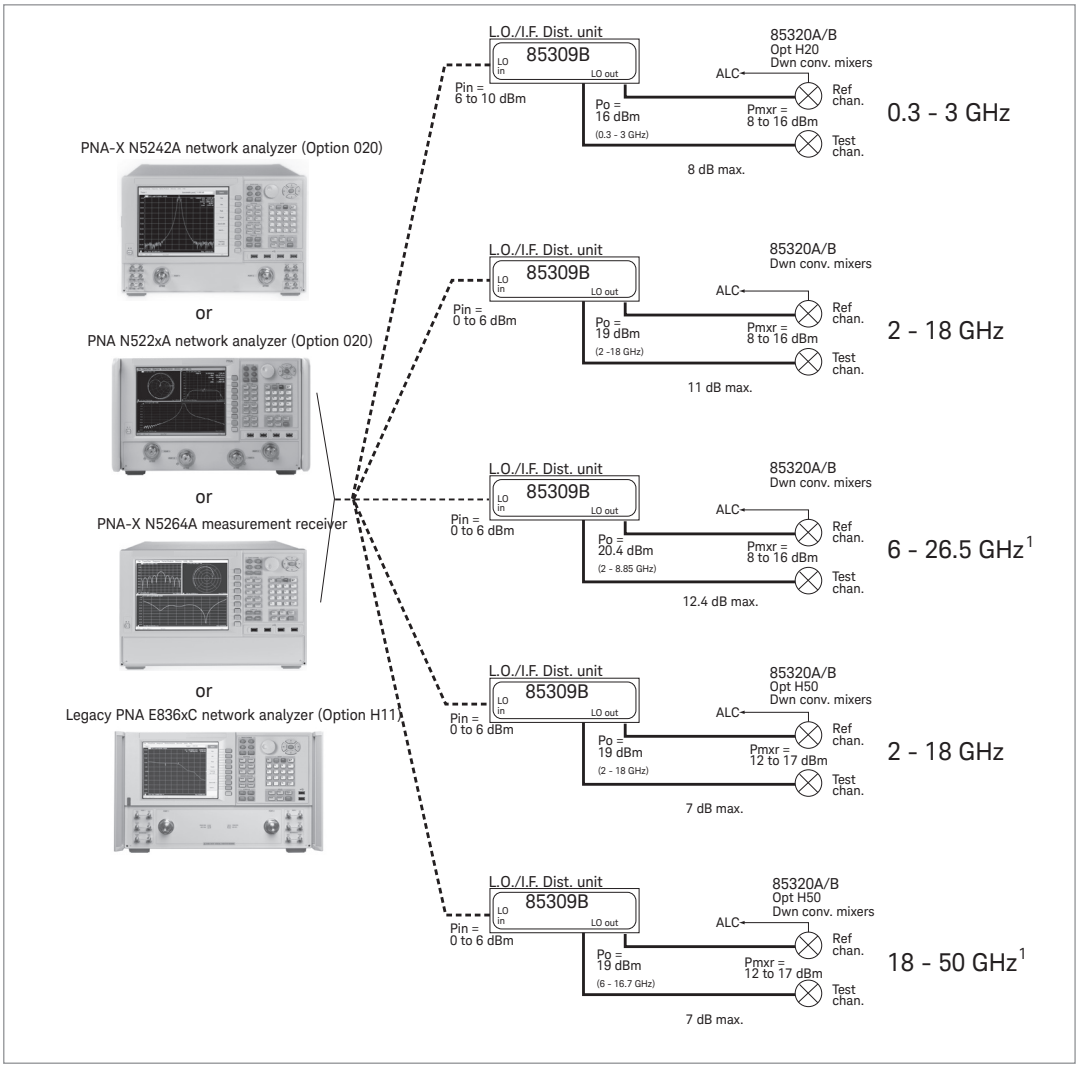


Figure 39. 85309B external mixer configurations.

85309B options	
85309B Standard	Provides one test channel and one reference channel
85309B Option 001	Adds one additional test channel; provides a total of two test channels and one reference channel.
85309B Option 002	Adds two additional test channels; provides a total of three test channels and one reference channel.
85309B Option 400	Low and high frequency bands; one test channel0.1 to 1 GHz low frequency band; 0.3 to 18 GHz high frequency band.Provides a total of one test channel and one reference channel.
85309B Option 401	Low and high frequency bands, two test channels0.1 to 1 GHz low frequency band; 0.3 to 18 GHz high frequency band. Adds one additional test channel. Provides a total of two test channels and one reference channel.
85309B Option 402	Low and high Frequency bands, three test channels
Option 1CM	Rack mount kit without handles
Option 1CP	Rack mount kit with handles

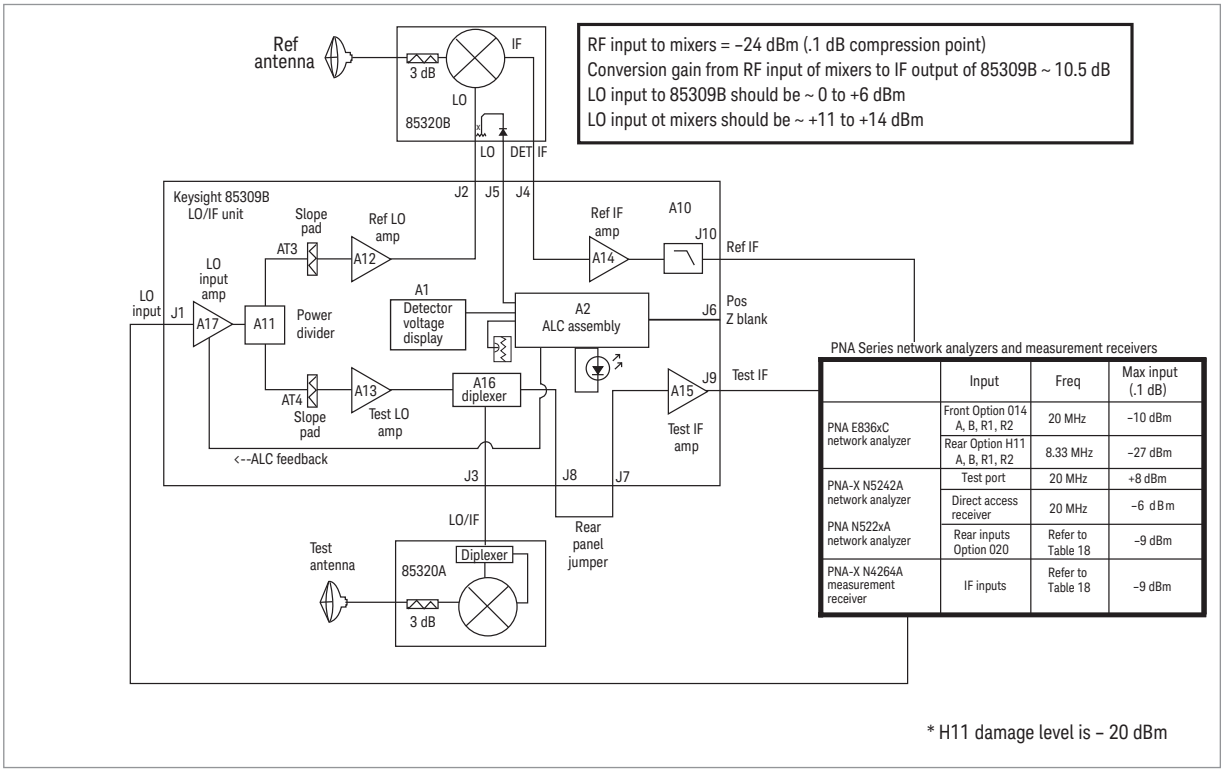
1. Mixers are operated in the 3rd harmonic mode.

Special options

Occasionally an application requires locating the mixers at a distance greater than is possible with a standard 85309B. Greater distances require additional LO output power from the 85309B. Several special options that increase the output power of the 85309B are available. Refer to the 85309B-H30 section in this document.

Other information

Connectors	type-N female
Environmental	operating conditions: 0 to 55 °C
Non-operating conditions	–40 to 75 °C; 5 to 90% relative humidity, non-condensing.
Power consumption	47.5 to 66 Hz, 100-120 or 220-240 VAC (±10%); 125 VA maximum.
Weight	15.5 kg (34 lb)
Size	460 mm (18.1 in) W x 133 mm (5.25 in) H x 533 mm (21 in) D



	Input	Freq	Max input (.1 dB)
PNA E836xC network analyzer	Front Option 014 A, B, R1, R2	20 MHz	–10 dBm
	Rear Option H11 A, B, R1, R2	8.33 MHz	–27 dBm
PNA-X N5242A network analyzer	Test port	20 MHz	+8 dBm
	Direct access receiver	20 MHz	–6 dBm
PNA N522xA network analyzer	Rear inputs Option 020	Refer to Table 18	–9 dBm
PNA-X N4264A measurement receiver	IF inputs	Refer to Table 18	–9 dBm

Figure 40. 85309B LO/IF distribution unit block diagram.



85320A/B mixer modules

Figure 41. 85320A/B mixer module.

The 85320A/B, 85320A/B-H20, and 85320A/B-H50 mixer modules are designed for use with the 85309B LO/IF distribution unit. Each antenna range should have one reference mixer (B model numbers) and one to three text mixers (A model numbers). In conjunction with the 85309B, the mixers serve to downconvert microwave frequencies to an IF signal for measurement by the PNA network analyzer.

Features

The mixer modules are broadband with various operating frequencies which are designated by option number. The 85320A/B-H20 are low frequency modules that operate from 300 MHz to 3 GHz in fundamental mixing mode. The 85320A/B operate in fundamental mixing mode from 1 to 18 GHz and third-harmonic mixing can be used for the frequency range of 6 to 26.5 GHz. The 85320A/B-H50 operates in fundamental mixing mode from 2 to 18 GHz and in third-harmonic mode from 18 to 50 GHz. Fundamental mixing mode provides the lowest conversion loss and best sensitivity.

85320A test mixers

The 85320A, 85320A-H20 and 85320A-H50 contain a diplexer that combines the LO input and IF output onto a single coaxial connector, which is useful for systems using a rotary joint.

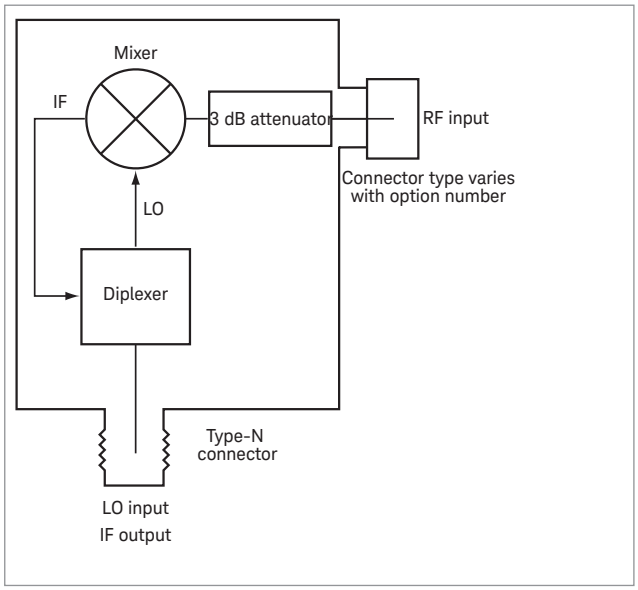


Figure 42. 85320A test mixer.

85320B reference mixers

The 85320B, 85320B-H20, 85320B-H50 contain a leveling coupler/detector that provides a leveling signal to the 85309B LO/IF distribution unit, ensuring leveled LO drive power to the mixer.

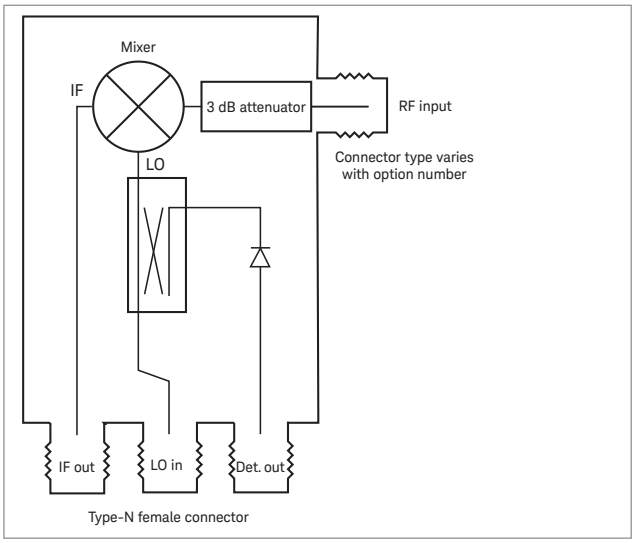


Figure 43. 85320B reference mixer.

Specifications

Frequency range		
85320A/B-H20	Fundamental mixing mode	300 MHz to 3 GHz
85320A/B	Fundamental mixing mode	1 to 18 GHz
85320A-H50	Fundamental mixing mode	2 to 18 GHz
85320A-H50	Third-harmonic mode	18 to 50 GHz

Maximum input levels	
Maximum DC voltage at input	10 volts
Maximum signal level at RF or LO inputs	+20 dBm (Option H20) +26 dBm (standard, Option H50)

Optimum input levels (when connected to 85309B LO/ IF Distribution Unit)	
LO input power	+11 to +14 dBm
RF input power	< –24 dBm

Table 9. LO signal power

	LO frequency	**Minimum power**	**Typical power**	**Maximum power**
85320A/B-H20	0.3 to 3 GHz	+8 dBm	+10 dBm	+16 dBm
85320A/B	1 to 18 GHz	+7.5 dBm	+11 dBm	+16 dBm
85320A/B-H50	2 to 18 GHz	+12 dBm	+14 dBm	+17 dBm

Table 10. Conversion loss

	Frequency range	**LO harmonic**	**Typical loss**	**Maximum loss**
85320A/B-H20	300 MHz to 3 GHz	1	–10 dB	–14 dB
85320A/B	1 to 2 GHz	1	–18.0 dB	–22 dB
	2 to 3 GHz	1	–12.0 dB	–16 dB
	3 to 5 GHz	1	–11.0 dB	–15 dB
	5 to 18 GHz	1	–14.7 dB	–17 dB
	6 to 8 GHz	3	–23.8 dB	–26 dB
	8 to 16 GHz	3	–26.5 dB	–28 dB
	16 to 26.5 GHz	3	–28.5 dB	–33 dB
85320A/B-H50	2 to 18 GHz	1	–12 dB	
	18 to 50 GHz	3	–28 dB	

Specifications (continued)

Connector types	
RF input	type-N female (Option H20) 3.5 mm male (standard) 2.4 mm male (Option H50)
All other connectors	type-N female
Environmental characteristics	
Operating conditions	0 to +55 °C 0 to +45 °C (Option H50)
Non-operating conditions	–40 to +75 °C; 5 to 90% relative humidity, non-condensing.
Size	
85320A (excluding connectors)	97 mm (3.8 in) W x 122 mm (4.8 in) L x 34 mm (1.3 in) D (Option H20, H50) 83 mm (3.25 in) W x 122 mm (4.8 in) L x 33 mm (1.3 in) D (standard)
85320B (excluding connectors)	97 mm (3.8 in) W x 186 mm (7.3 in) L x 31 mm (1.2 in) D (Option H20, H50) 92 mm (3.6 in) W x 185 mm (7.3 in) L x 25 mm (1.0 in) D
	92 mm (3.6 in) W x 185 mm (7.3 in) L x 25 mm (1.0 in) D
Weight	
85320A-H20	700 g (1.52 lb)
85320A	615 g (1.35 lb)
85320A-H50	794 g (1.75 lb)
85320B-H20	840 g (1.85 lb)
85320B	840 g (1.85 lb)
85320B-H50	1021 g (2.25 lb)

N5280/1A Frequency converter



Figure 44. N5280A frequency converter front and rear panels.

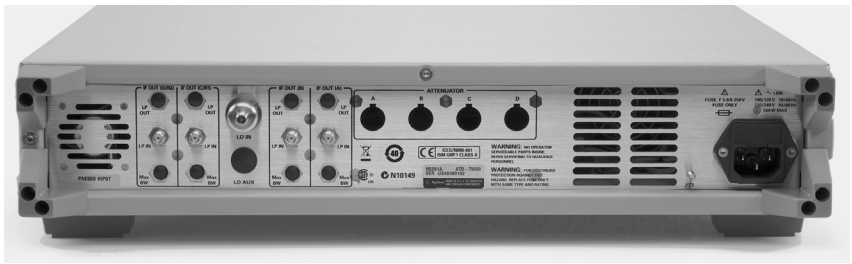


Figure 45. N5281A frequency converter rear panel detail.

Description

The Keysight N5280/1A is a four channel frequency converter test set. This test set is used with the Keysight N5242A 2-port or 4-port PNA-X network analyzer, and a N5264A measurement receiver. It can be operated with other microwave accessories (couplers, power splitters). The N5280/1A provides a convenient means of customizing a test configuration for a variety of applications within a frequency range of 10 MHz to 26.5 GHz and 10 MHz to 50.0 GHz, respectively.

Features

- Four measurement inputs
- Exceptional low noise floor with fundamental mixing
- Wide IF frequency, 0.007 to 20 MHz (with jumper) or 0.007 to 1.5 GHz (without jumper)
- N5281A IF frequency 7 MHz

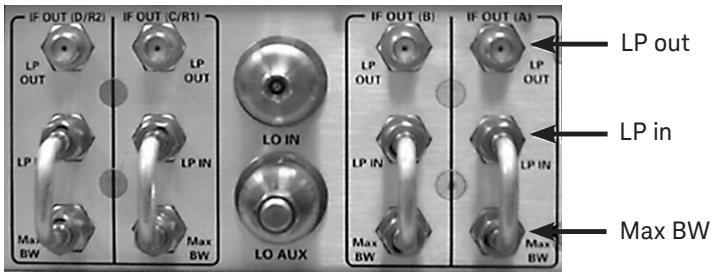


Figure 46. N5280A frequency converter rear panel detail.

N5280/1A Test set options:

The N5280/1A has two available options:

- Standard – There are no attenuators in the RF input paths.
- Option 001 – There are four 35 dB attenuators in the RF paths to reduce the power levels.

N5280/1A instrument dimensions

Weight: 11.4 kg (25 lb)
Height: 8.9 cm (3.5 in)
Width: 42.5 cm (16.7 in)
Depth: 48.3 cm (19 in)

Table 11. N5280/1A frequency range and connectors

Port	Frequency range	Connectors
RF port	0.01 to 26.5 GHz/0.01 to 50 GHz	3.5 mm (f)/2.4 mm (f)
LO port	0.01 to 26.5 GHz/0.01 to 26.5 GHz	3.5 mm (f)/3.5 mm (f)
IF port	0.007 to 20 MHz (with jumper)/7 MHz 0.007 to 1.5 GHz (without jumper)/7 MHz	SMA (f)/SMA (f)

Table 12. N5280/1A maximum power levels

RF maximum input levels	
RF port	+18 dBm/+18 dBm
Lo port	+5 dBm/+5 dBm
IF output level at max RF input at 0.1 dB typical compression	
Ports A-D, 20 MHz filter port	–21 dBm
Ports A-D, Maximum bandwidth	–1 dBm
N5242A, N5264A at 0.1 dB typical	–21 dBm
IF compression	

Table 13. N5280/1A RF receiver tracking

RF port magnitude tracking	
Frequency	Value
10 MHz to 20 GHz	±1.0 dB/±2.0 dB
20 MHz to 22 GHz	±1.5 dB/±3 dB (20 to 30 GHz)
22 MHz to 26.5 GHz	±3.5 dB/±4.0 dB (30 to 50 GHz)

Table 14. N5280/1A port match

RF port match	
Frequency	Value
10 MHz to 500 GHz	< –15 dB
500 MHz to 10 GHz	< –15 dB
10 GHz to 20 GHz	< –12 dB
20 GHz to 30 GHz	< –10 dB
30 GHz to 50 GHz	< –5 dB
LO Port Match	
10 MHz to 26.5 GHz	< –8 dB
500 MHz to 10 GHz	n/a

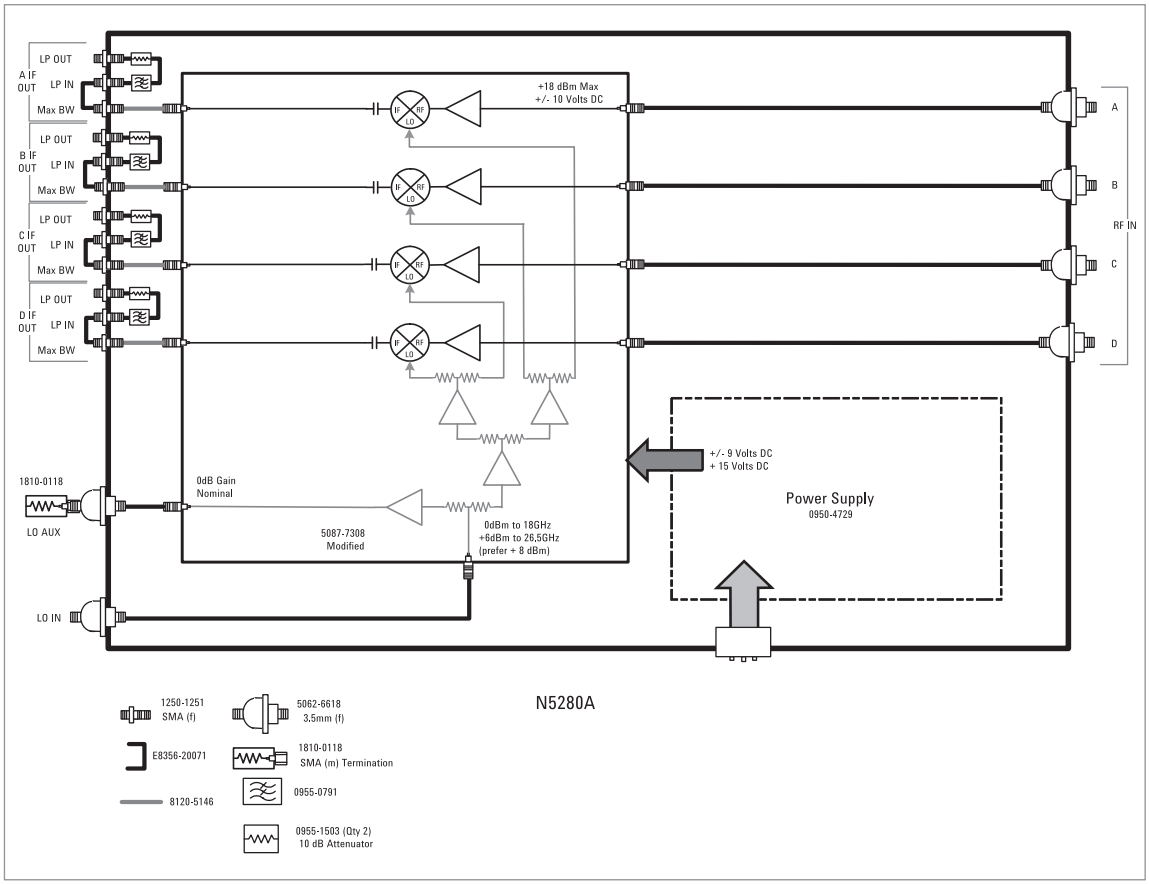


Figure 47. N5280A block diagram (Standard 700)

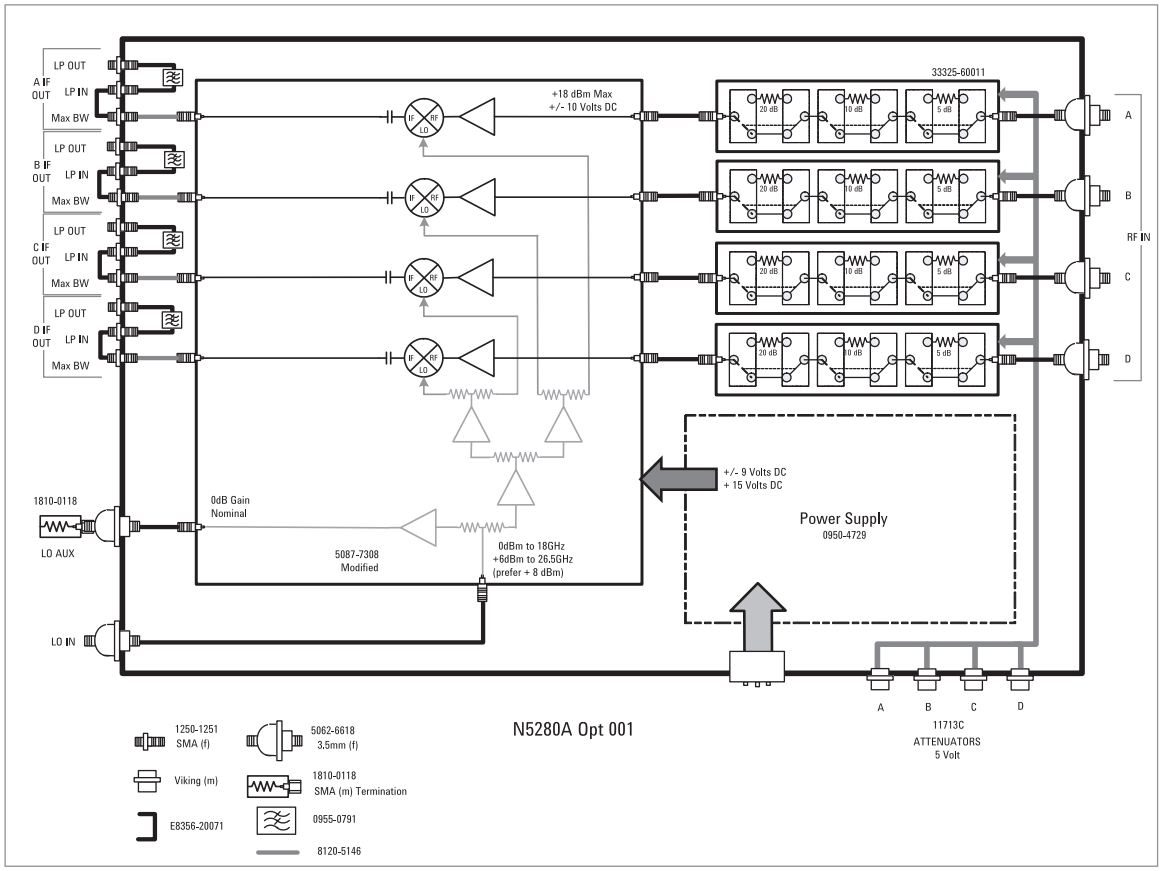


Figure 48. N5280A block diagram (Option 001)

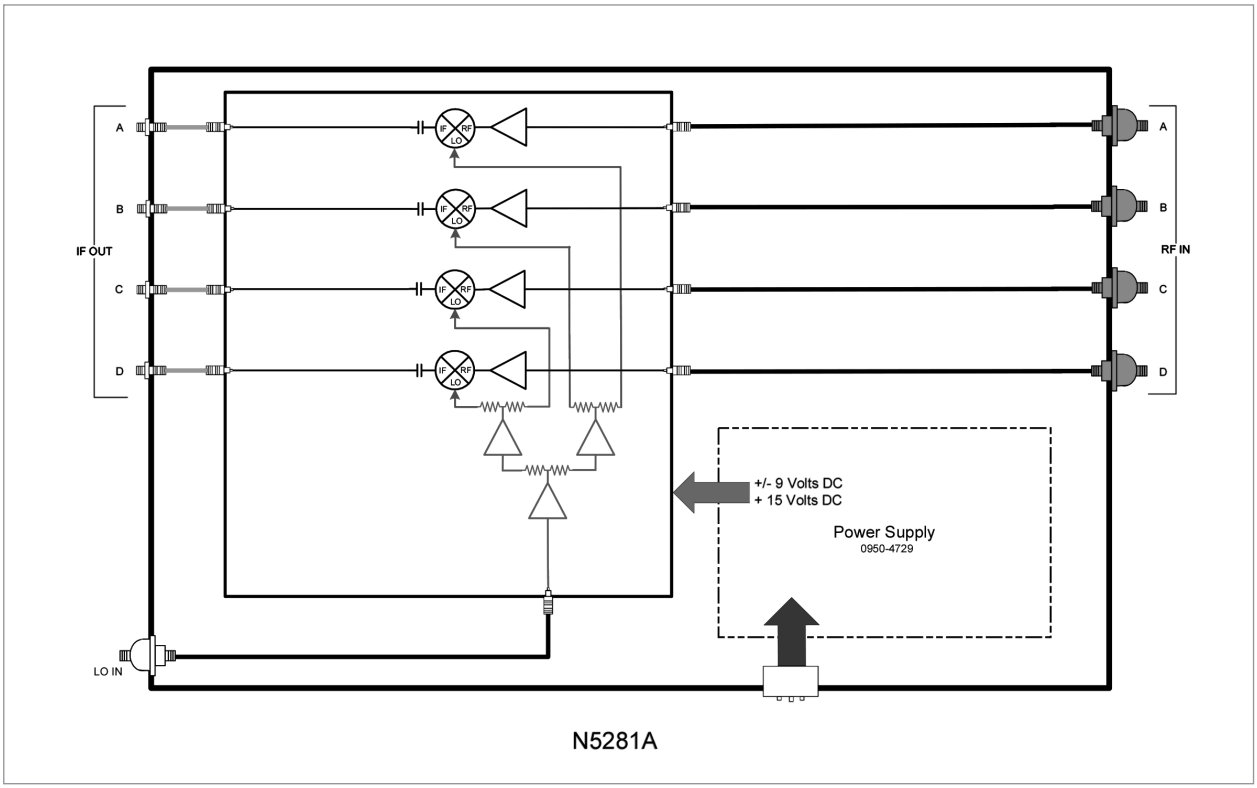


Figure 49. N5281A block diagram (Standard 700)

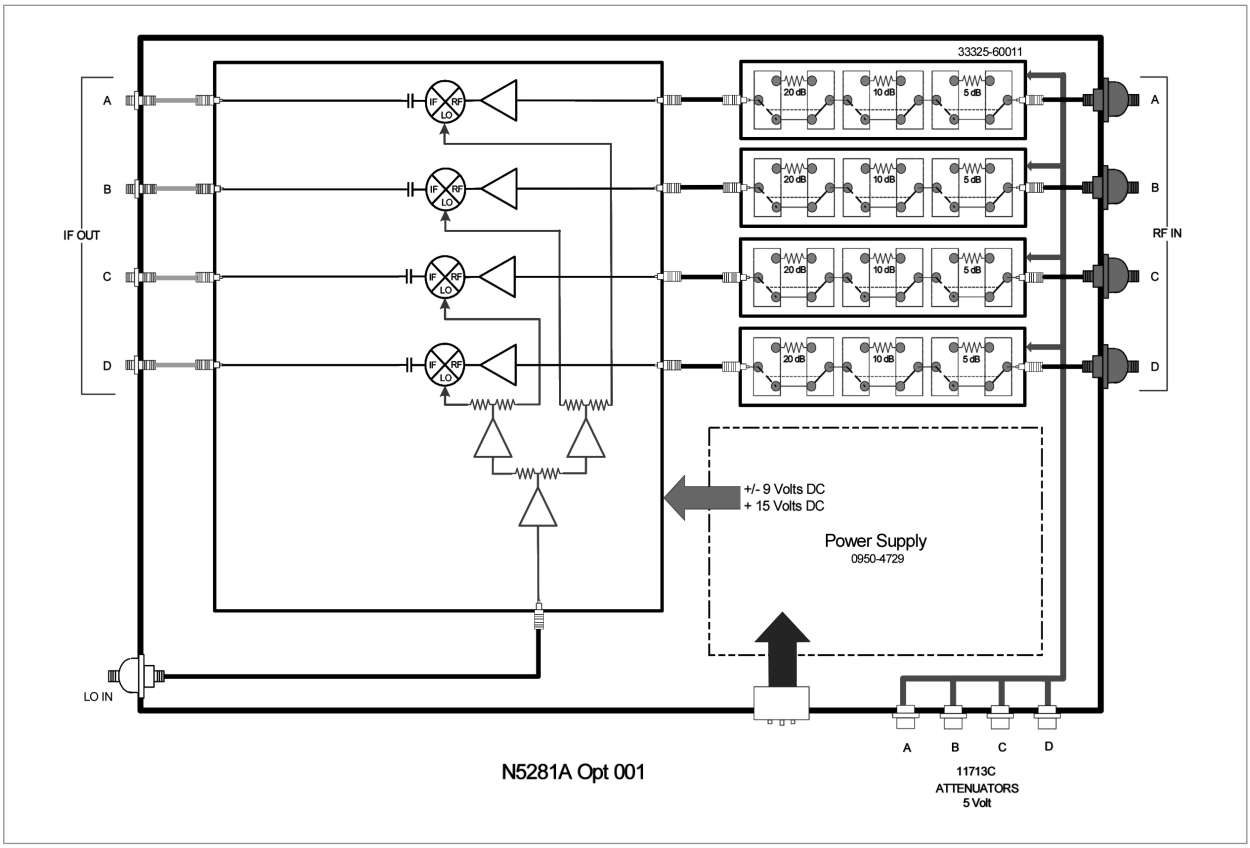


Figure 50. N5281A block diagram (Option 001)

Amplifiers



Figure 51. Amplifiers.

Keysight Technologies, Inc. has a variety of amplifiers that find applications on antenna and RCS ranges. These amplifiers are small and compact, with high gain and output power. An external power supply is required for these amplifiers. Refer to Keysight's *83000A Series Microwave System Amplifiers*, literature number 5963-5110E, for complete information on amplifiers. Also refer to *Keysight 87415A Technical Overview*, literature number 5091-1358E, *Keysight 87405A Data Sheet*, literature number 5091-3661E.

Table 15. Amplifier specifications

Model	Frequency (GHz)	Output power at P_{sat} (dBm/mW)	Output power at P_{1dB} (dBm/mW) (min)	Gain (dB) (min)	Noise figure (dB) (typ)	Detector [1] output/dc connector	RF bias (nom)	Connectors (input/output)
83006A	0.01 to 26.5	+18/64 typ. to 10 GHz +16/40 typ. to 20 GHz +14/25 typ. to 26.5 GHz	+13/20 to 20 GHz +10/10 to 26.5 GHz	20	13 to 0.1 GHz 8 to 18 GHz 13 to 26.5 GHz	No	+12 V at 450 mA –12 V at 50 mA	3.5 mm (f)
83017A	0.5 to 26.5	+20/100 typ. to 20 GHz +15/32 typ. to 26.5 GHz	+18/64 to 20 GHz (18 – 0.75Æf) dBm[2] (64 – 7.8Æf) mw[2] (20 ² f ² 26.5 GHz)	25 13 to 26.5 GHz	8 to 20 GHz	Yes/BNC (f)	+12 V at 700 mA –12 V at 50 mA	3.5 mm (f)
83018A	2 to 26.5	+24/250 min to 20 GHz +21/125 min to 26.5 GHz	+22/160 to 20 GHz +17/50 to 26.5 GHz	27 to 20 GHz 23 to 26.5 GHz	10 to 20 GHz 13 to 26.5 GHz	Yes/BNC (f)	+12 V at 2 A –12 V at 50 mA	3.5 mm (f)
83020A	2 to 26.5	+30/1000 min to 20 GHz (30 – 0.7Æf) dBm min2 (1000 – 65Æf) mw min[2] (20 ² f ² 26.5 GHz)	+27/500 to 20 GHz +23/200 to 26.5 GHz	30 to 20 GHz 27 to 26.5 GHz	10 to 20 GHz	Yes/BNC (f) 13 to 26.5 GHz	+15 V at	3.2 A 3.5 mm (f) –15 V at 50 mA
83050A	2 to 50	+20/100 min to 40 GHz (19 – 0.2Æf) dBm3 (80 – 3.1Æf) mw3 (40 < f ² 50 GHz)	+15/32 to 40 GHz +13/20 to 50 GHz	23	6 to 26.5 GHz 10 to 50 GHz	No	+12 V at 830 mA –12 V at 50 mA	2.4 mm (f)
83051A	0.045 to 50	+12/16 min to 45 GHz min +8/6 to 45 GHz +10/10 min to 50 GHz min +6/4 to 50 GHz	23	12 to 2 GHz 6 to 26.5GHz 10 to 50 GHz	No	+12 V at 425 mA –12 V at 50 mA	2.4 mm (f)	
87405A	0.01 to 3	+26/400 typ.	+4/2.5	22 min 27 max	6.5 to 2 GHz 7.5 to 3 GHz	No	+15 V at 80 mA	N (f) N (m)
87415A	2 to 8	+26/400 typ.	+23/200	25	13	No	+12 V at 900 mA	SMA (f)

1. Detector output can be used for leveling output power at the test port.
2. Æ f = f (GHz) – 20
3. Æ f = f (GHz) – 40

A 2-meter power cable with a connector on one end and bare wires on the other is shipped with all amplifiers.

Recommended power supplies

The 87422A is the recommended power supply for the 83020A amplifier. For all other amplifiers, the recommended power supply is the 87421A. A 2-meter power cable with connectors to connect between amplifier and power supply is provided with all power supplies.

Table 16. Power supply specifications

Model	ac imput voltage	dc output (nom)	Output power	Sizew (H,W,D)
87421A	100 to 240 VAC 50/60 Hz	+12 V at 2.0 A, –12 V at 200 mA	25 W max	57, 114, 176 mm 2.3, 4.5, 6.9 in
87422A[1]	100 to 240 VAC 50/60 Hz	+15 V at 3.3 A, –15 V at 50 mA +12 V at 2.0 A, –12 V at 200 mA	70 W max	86, 202, 276 mm 3.4, 8.0, 10.9 in

1. The ±15V output is designed to power the 83020A; the ±12V output can be used to power an additional amplifier.

Multiple-channel measurements



Figure 52. 2 and 4-port PIN switches.

85331B 1P2T PIN switch (0.045 to 50 GHz)

85332B 1P4T PIN switch (0.045 to 50 GHz)

The 85331B and 85332B PIN switches offer the ability to switch between test channels quickly. These high-performance PIN switches have 90 dB of isolation, low loss, and a 45 MHz to 50 GHz bandwidth. They are absorptive, providing a good impedance match, which is key to achieving accurate measurements. The switches are small in size and weather resistant. Figure 52 shows a typical configuration with the PIN switches connected to the source antenna and AUT.

Note: The 85331B and 85332B do not contain a switch control unit. If your system is configured with an 85330A multiple channel controller, the switch control unit must be ordered separately (Keysight part number 85331-60061)

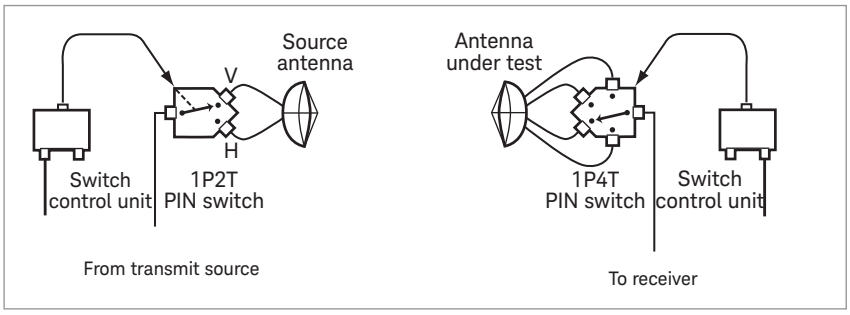


Figure 53. A typical multiple-channel, multiple-frequency system configuration.

Application flexibility

Far-field antenna measurements

These products are ideally suited for antennas with multiple test ports, or applications that require measuring the co- and cross-polarization response. One PIN switch can switch transmit polarization, and a second PIN switch can switch between the separate test ports of the antenna. With this technique, the co- and cross-polarization response of each test port can be measured in one rotation of the antenna.

Near-field antenna measurements

For near-field applications, both the co- and cross-polarized response of an antenna can be measured at multiple frequencies in a single scan across the antenna. For the dual polarized response, a PIN switch can be used to rapidly switch between the two probe polarizations.

Radar cross-section measurements

For Radar cross-section (RCS) applications, the ability to rapidly switch transmit and receive polarization allows full polarimetric RCS measurements to be made quickly and easily.

Complex switch configurations

Complex PIN switch trees with multiple outputs can be easily configured. Figure 54 shows conceptually how multiple PIN switches can be configured. Configurations such as these are used in making phased-array antenna measurements.

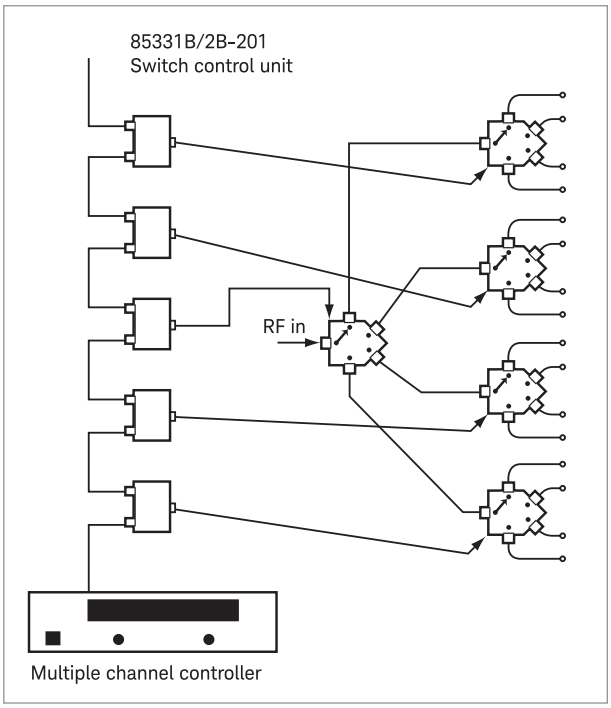


Figure 54. Example 1P16T switch configuration constructed from modular components.

Switch specifications

Table 17. 85331/32B specifications

Model number	Frequency range (GHz)	ON S21 (db)	OFF S21 (db)	OFF S22 (db)	ON S22 (db)	ON S11 (db)	Max power (dBm)
85331B 1P2T	0.045 to 0.5 0.5 to 18 18 to 26.5 26.5 to 40	–2.0 –4.5 –6.0 –10.0	–85 –90 –90 –85	–19.0 –19.0 –12.5 –10.0	–10.0 –10.0 –6.0 –6.0	–10.0 –10.0 –5.5 –4.5	+27 +27 +27 +27
85332B 1P4T	0.045 to 0.5 0.5 to 18 18 to 26.5 26.5 to 40	–2.0 –4.5 –7.0 –12.0	–85 –90 –90 –85	–19.0 –19.0 –12.5 –10.0	–9.0 –9.0 –5.0 –4.5	–10.0 –10.0 –5.5 –4.0	+27 +27 +27 +27

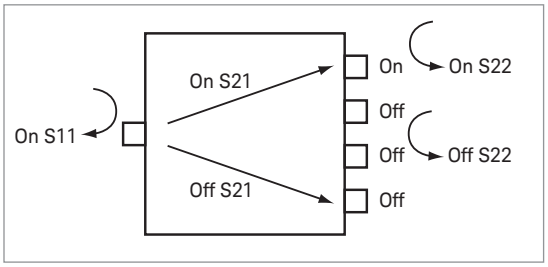


Figure 55. Switch port match definitions for switch on/off states.

Other information

Connectors on PIN switch

All RF ports are 2.4 mm female (a 2.4 mm male to 3.5 mm female adapter is provided for all RF ports). The bias connector mates with LEMO 7 pin plug #FGG.1K.307.CLAC60.

Drive levels

Refer to Figure 56 for pin locations. Note the notch and red mark on the bias connector outer ring are used for reference.

To turn ON a port, supply a –7VDC (± 0.35V) bias voltage.
Current is approximately 41 mA.
To turn OFF a port, supply a +6.3VDC (± 0.32V) bias voltage.
Current is approximately 95 mA.

Only one port can be turned on at a time, or all ports can be off.

The total current is approximately 400 mA for 85332B, 200 mA for 85331B with all ports off.

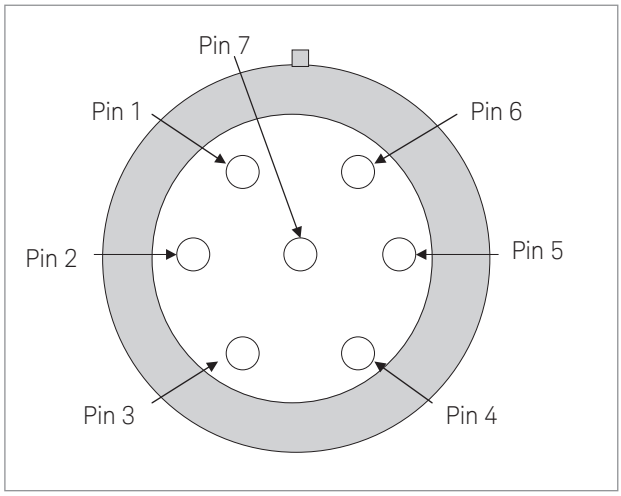


Figure 56. Bias connector pin locations (enlarged).

Pin 1 = Port 1 on/off bias
Pin 2 = Port 2 on/off bias
Pin 3 = Port 3 on/off bias (not connected for 85331B)
Pin 4 = Port 4 on/off bias (not connected for 85331B)
Pin 5 = Common/ground (0VDC)
Pins 6,7 = Not Connected

Note: Keysight channel partners can provide the control, interface and timing required for these PIN switches.

Size and weight

65 mm (2.6 in) x 70 mm (2.75 in) x 70 mm (2.75 in)
Approximately 0.35 kg (0.7 lbs)

Environmental

Operating conditions		
	Temperature	–20 to 55 °C (–4 to 131 °F)
	Humidity	5 to 95% at 40 °C or less (non-condensing)
Non-operating conditions		
	Temperature	–40 to 70 °C (–40 to 158 °F)
	Humidity	5 to 95% at 65 °C or less (non-condensing)

Power

Supplied by external controller

Measurement automation

Keysight's PNA network analyzers provide several interface methods for automating antenna measurements. Applications can be run using external computers or controllers. User loaded applications can be executed directly from the PNA's internal Microsoft Operating System. Measurement automation allows the user to quickly and easily control the PNA for operations such as frequency sweeps and making antenna pattern measurements.

The PNA Series network analyzers have two connections for communicating with external software, GPIB and LAN. The protocol used to communicate with the analyzer determines which physical connection will be used.

There are two methods available to remotely control the PNA: Component object model (COM) and Standard Commands for Programmable Instrumentation (SCPI). The COM protocol requires a LAN connection. SCPI protocol can be used directly over GPIB or you can use the Standard Instrument Control Library (SICL) I/O libraries with a LAN connection.

COM uses a binary protocol, allowing the user to directly invoke a PNA feature. This is more efficient than SCPI, a text based instrument language. COM typically executes faster than SCPI and is generally easier to use.

With SCPI a text string is sent to the PNA, the PNA SCPI parser must first decode the text string to determine that the user has asked for specific information, then the parser calls the routine to get the information.

With either COM or SCPI, the best throughput is attained by using the PNA's internal PC to execute your test code. However, if your test code uses too much of the system resources (CPU cycles and/or memory), it will slow the PNA's performance.

For additional information refer to the PNA internal help file, or download the file from **www.keysight.com/find/pna**. Additional COM/DCOM information can be found in *Application Note 1408-13*, Keysight literature number 5980-2666EN.

Customers can either develop their own software or work with one of Keysight Technologies' channel partners to develop the code. Keysight channel partners have software available for PNA drivers.

IF input frequencies

The IF input frequencies are different depending on the DSP version.

With DSP version 4:

* RF or Transmitting frequency < 53 MHz: IF = 2.535211 MHz [3 x (60e6 / 71)]
* RF or Transmitting frequency > 53 MHz: IF = 7.605634 MHz [9 x (60e6 / 71)]

With DSP version 5, the IF frequency is dependent on the RF or transmitting frequency and current IFBW setting:

Table 18
* All RF or transmitting frequency; IF bandwidth > 1 MHz

IFBW setting	IF frequency
1 MHz	7.692 MHz
1.5 MHz	7.368 MHz
2 MHz	8.450 MHz
3 MHz	8.163 MHz
5 MHz	6.897 MHz
7 MHz	10.53 MHz
10 MHz	15.38 MHz
15 MHz	22.22 MHz

* IF bandwidth <= 600 kHz:
    * RF or transmitting frequency < 53 MHz; IF = 2.479339 MHz [(3 x (100e6 / 121)]
    * RF or transmitting frequency > 53 MHz; IF = 7.438017 MHz [(9 x (100e6 / 121)]

Manually change the IF frequency

The IF frequency can be changed to any value between +14.9999 MHz and – 14.9999 MHz using SENS:IF:FREQ (SCPI) or IFFrequency (COM) commands.

* With DSP Version 4 through 34 and above, min and max IF frequencies up to + 20.1 MHz are available.
* With DSP Version 5, min and max IF frequencies up to + 38 MHz are available.
* Performance is degraded drastically above + 14.999 MHz.

Appendix 1: PNA Series security features

Terms and definitions

Clearing

The process of eradicating the data on media before reusing the media so that the data can no longer be retrieved using the standard interfaces on the instrument. Clearing is typically used when the instrument is to remain in an environment with an acceptable level of protection.

Sanitization

The process of removing or eradicating stored data so that the data cannot be recovered using any known technology. Instrument sanitization is typically required when an instrument is moved from a secure to a non-secure environment such as when it is returned to the factory for calibration. (The instrument is declassified.) Keysight memory sanitization procedures are designed for customers who need to meet the requirements specified by the US Defense Security Service (DSS). These requirements are outlined in the *"Clearing and Sanitization Matrix"* issued by the Cognizant Security Agency (CSA) and referenced in *National Industrial Security Program Operating Manual* (NISPOM) DoD 5220.22M ISL 01L-1 section 8-301.

Security erase

Refers to either the clearing or sanitization features of Keysight instruments.

Instrument declassification

Procedures that must be undertaken before an instrument can be removed from a secure environment such as is the case when the instrument is returned for calibration. Declassification procedures will include memory sanitization and or memory removal. Keysight declassification procedures are designed to meet the requirements specified by the DSS NISPOM security document (DoD 5220.22M chapter 8).

PNA Series memory

This section contains information on the types of memory available in your PNA. It explains the size of memory, how it is used, its location, volatility, and the sanitization procedure.

Table 19.

Memory type	Writable during normal operation?	Data retained when powered Off?	Purpose/contents	Data input method	Location in instrument and remarks	Sanitization procedure
main memory (SDRAM)	yes	no	Firmware operating memory	Operating system (not user)	CPU board	Cycle power
hard disk drive	yes	yes	User files, including calibrations and instrument states	User-saved data	Removable from rear panel	
EEPROM	no	yes	Instrument information such as serial number, installed options, correction constants	Factory or authorized personnel only	1,2, or 3 EEPROMs contained on most PC Boards	

Memory clearing, sanitization and/or removal procedures

This section explains how to clear, sanitize, and remove memory from your PNA for all memory that can be written to during normal operation and for which the clearing and sanitization procedure is more than trivial such as rebooting your instrument.

Table 20.

Description and purpose	Hard disk drive
Memory clearing	Delete user files and empty recycle bin
Memory sanitization	Remove hard disk drive and replace with a new or unused hard disk drive. See the PNA Service Manual for details.
Memory removal	Remove hard disk drive
Write protecting	N/A

User and remote interface security measures

Screen and annotation blanking

You can prevent frequency information from appearing on the PNA screen and printouts. To set security levels from the PNA menu, click System, then Security. When the security level is set to Low or High, frequency information is blanked from the following:

- Display annotation
- Calibration properties
- All tables
- All toolbars
- All printouts
- GPIB console – When set to None or Low, nothing is blanked. When set to High, the GPIB console is inactive.

Frequency information is NOT blanked from the following regardless of security level:

- The frequency converter application (Option 083) dialog box information or printouts.
- Service programs.
- Your COM or SCPI programs.

USB mass storage device security

To prevent USB write capability on XPSP2, create a new registry key of: HKLM\System\CurrentControlSet\Control\StorageDevicePolicies.

Then create a REG_DWORD entry in it called WriteProtect. Set it to “1” and you’ll be able to read from USB drives but not write to them.

Remote access interfaces

The user is responsible for providing security for the I/O ports that allow remote access by controlling physical access to the I/O ports. The I/O ports must be controlled because they provide access to all user settings, user states and the display image.

The I/O ports include RS-232, GPIB, and LAN.

The LAN port provides the following services, common to all Windows-based computers, which can be selectively disabled:

- http
- ftp
- sockets
- telnet

There is also a ‘ping’ service, which cannot be selectively disabled. This makes it possible to discover IP addresses of connected instruments and allows you to query their setups over the internet, but it can also be used to break into the code.

Procedure for declassifying a faulty instrument

When shipped from the factory, all PNAs have PNA-specific files stored on the hard disk drive. When replacing a hard disk drive, in order to achieve specified performance, the PNA-specific files must be copied to the new hard drive. These files all begin with mxcalfiles_ and are located in the directory:
C:\Program Files\Keysight\Network Analyzer.

Perform the following procedure to declassify a PNA if it needs to be removed from a secure area.

1. When a new PNA is received, or if this step has not yet been done, copy files that begin with “mxcalfiles_ “ from the hard disk drive to a floppy disk. This disk should be maintained in a non-secure area.
2. Purchase the appropriate spare hard drive and keep it with the floppy disk. Clearly mark this hard drive as “Unsecured”.
3. Remove the secure hard drive from the PNA and keep it in the secured area.
4. Remove the PNA from the secured area and install the “unsecured” hard drive.
5. If not previously done, copy the mxcalfiles from the floppy disk to the unsecured hard drive into the directory listed above.

Perform the following procedure when the PNA needs to be returned to the secure area. Any servicing of the PNA may include the regeneration of correction constants. Most of these are contained in the onboard EEPROMs, so no action is necessary. The only exception is with the mxcalfiles. See below.

1. If the PNA was sent out for servicing, check to see if any of the mxcalfiles have been updated (check the last-modified date.) If so, these updated files should be copied to a floppy disk so that they can be updated on the secured hard drive.
2. Remove the unsecured hard drive, transport the PNA to the secure area, and re-place he hard drive with the secure version.
3. If the mxcalfiles have changed, copy all new files saved to the floppy disk to the directory. C:\Program Files\Keysight\Network Analyzer

Note: Keysight maintains a security page for all instruments at www.keysight.com/find/security. Visit this site for current information on security issues.

Appendix 2: How to select PNA Series (PNA/ PNA-X) IF BW with performance comparable to 8510

Averaging on an 8510 is similar to the IF BW filtering of the PNA, both are like a DSP filter. The IF BW of the PNA is similar to point averaging on the 8510. Increasing the averaging factor of the 8510 reduces the noise level. Each point on an 8510 receives the same weight in the averaging function. The IF BW on a PNA reduces noise in the same way. The 8510 uses either point or trace averaging depending on many factors including the hardware and software setup. On the PNA, you always want to use IF BW reduction instead of trace averaging because it is faster.

It is difficult to easily see how PNA IF BW and 8510 averaging are the same. It is especially difficult to see because the 8510 dynamic range performance rolls off quicker than the PNA and the 8510 and PNA define specs differently; noise floor on 8510 is specified as peak noise; on PNA it is specified as RMS noise floor. The difference is 10.4 dB. So you have to improve the 8510 noise floor by 10.4 dB to compare it to PNA values. It is easiest to simply measure and adjust.

There are two steps in determining the equivalent PNA IF BW:

1. Measure 8510 noise level
2. Determine Equivalent PNA IF BW
   (Adjust PNA IF BW to match 8510 noise level)

1. Measure 8510 noise level

a. Set 8510 up for desired measurement.
b. Turn calibration off.
c. Place marker at desired point.
d. Select log mag.
e. Set center frequency = marker.
f. Set span to 0 Hz.
g. Set 801 points.
h. Turn smoothing off.
i. Place reference in center of screen.
j. Set reference value = marker.
k. Select single sweep. Continue when sweep is complete.
l. Adjust reference value until noise envelope is centered on screen.
m. Adjust scale until noise spreads across 6 grid lines.
   - Three noise spikes should pass through either grid 2 or 8
   - Scale (roughly) equals rms trace noise:
   - TN = scale:____;____;____;____;____ ; Average TN = ____
   - Repeat from step k. at least three times. Average result above.

2. Determine equivalent PNA IF BW

a.....Set PNA up for desired measurement.
b..... Turn calibration off.
c.....Place marker at desired point.
d.....Select log mag.
e..... Set center frequency = marker.
f..... Set span to 0 Hz.
g.....Set 801 points.
h.....Turn trace statistics on.
i.....Read rms noise (Std. Dev.) from marker data.
j.....Adjust PNA IF BW until Std. Dev. = Average TN (from step 1m).

Appendix 3: How to configure an external source for use with a PNA Series

Connect the PNA-X, PNA or PNA-L to PSG, ESG, or MXG source as shown in Figure 57. There is a LAN or GPIB interface available on the rear of the instrument to connect external sources. Below is an example setup for the GPIB interface.

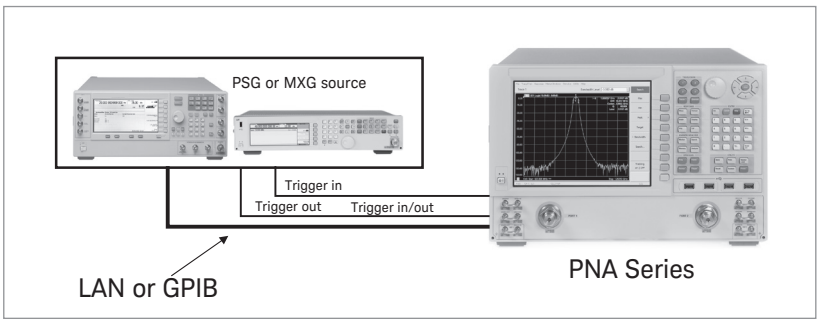
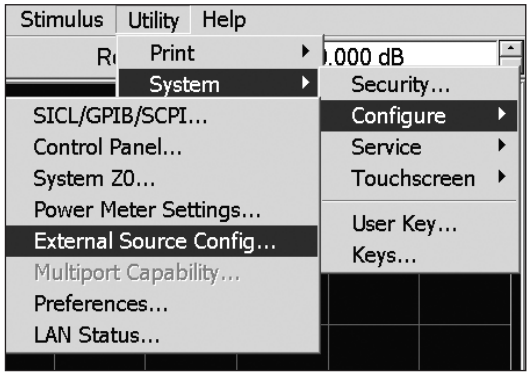


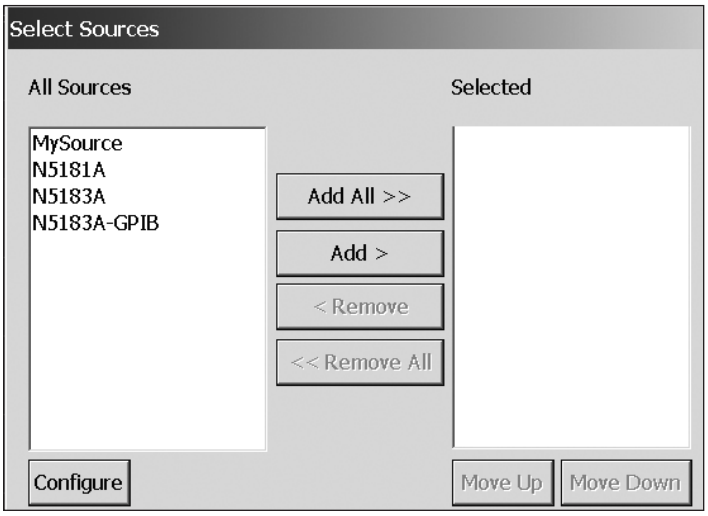
Figure 57. Configuring an external source.

1. Setting up a source:
   a) Obtain GPIB addresses of your sources.

2. Setting up PNA Series network analyzers and measurement receivers:
   a) Select External Source Config...> Utility > System > Configure as shown in the menu below.



The Select Sources dialog box will appear.

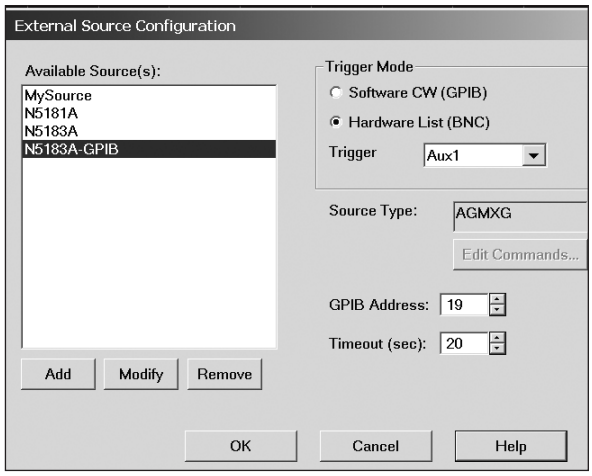


This shows all sources that were previously added.

b) Select Configure if a new source needs to be added.

The External Source Configuration dialogue box will appear.

c) Select Add to add another source.

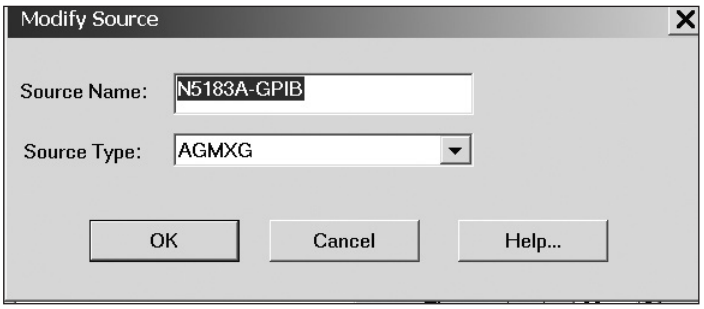


d) From the Modify Source dialogue box:

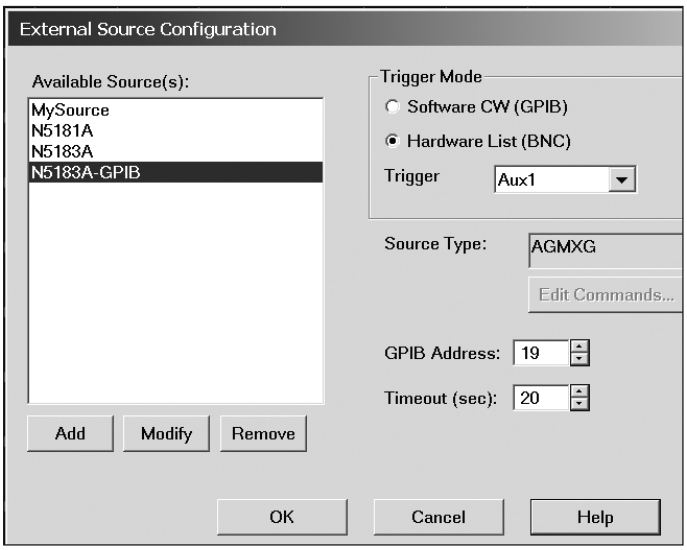
i) Type in source name.

ii) Select source type from drop-down menu.

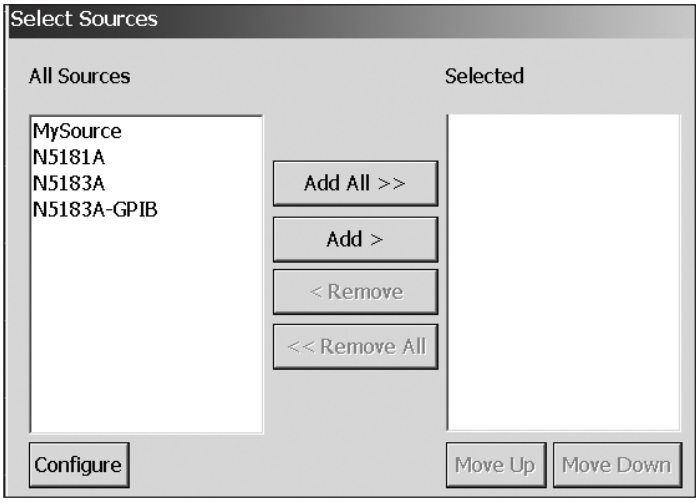
iii) Select OK.



e) From the External Source Configuration dialogue box select the trigger mode.
Note: Hardware trigger is TTL and is faster than Software trigger. To learn more, select the Help button.



f) From the Select Sources dialogue box:
i) Highlight source name.
ii) Select Add.
iii) Select OK.

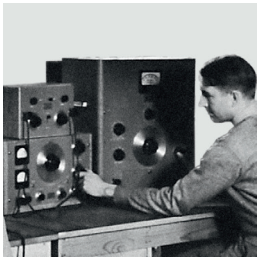


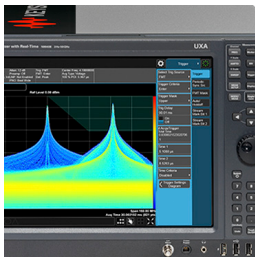
If all of your sources have been setup properly then the external sources should start to sweep.

3. Verify operation:
a) Go to Frequency Offset dialog box and you should see the external source listed.

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