

Keysight Technologies N5241/42AS Option H85

User's and Service Guide

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N5241AS and N5242AS
PNA-X Series High Power
Configurable Test Sets

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WARNING

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Table of Contents

N5241/42AS Option H85	
Introduction	2
Verifying the Shipment	2
Description	3
What you need to Know About Your N524xAS PNA-X	4
N5241/42AS Option H85 Ordering Configuration (serial tag options)	4
N5241/42A Option H85 Shipped Configuration (about network analyzer option fields)	5
Operation	6
Specifications: Front Panel Jumpers and Test Ports	22
Example: Making High Power Measurements with Option H85	26
Typeface Key Conventions	26
Initial Setup	27
Determining Power Levels	28
Additional Setup	31
Selecting Power Ranges and Attenuator Settings	32
Final Setup	37
Specifications	40
Definitions for Specifications	40
Service Information	40
Replaceable Parts	41
Safety and Information	43
Introduction	43
Safety Earth Ground	43
Declaration of Conformity	43
Statement of Compliance	43
Before Applying Power	44
Connector Care and Cleaning Precautions	45
Regulatory Information	46
Instrument Markings	46
Battery Collection	47
Electrical Safety Compliance	47
EMI and EMC Compliance	47
Keysight Support, Services, and Assistance	48
Service and Support Options	48
Contacting Keysight	48
Shipping Your Product to Keysight for Service or Repair	48

Table of Contents

N5241/42AS Option H85

Introduction

This document describes the differences between the standard N5241/42A and the N5241/42AS Option H85 PNA-X Series Network Analyzer. For more technical information refer to Keysight 2-Port and 4-Port PNA-X Network Analyzers Data Sheet and Technical Specifications (N5242-90007).

Information can be viewed or printed regarding the N5241/42A PNA-X Series Network Analyzer Data sheets, white papers, or manuals by visiting our web site at <http://www.keysight.com/find/pna>, or by typing N5241A or N5242A in the search field.

This document is to be used in conjunction with the network analyzers on-line Help System and Application note 1408-10.

Verifying the Shipment

To verify the contents shipped with your product, refer to the “Box Content List” included with the shipment.

Inspect the shipping container. If the container or packing material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is physical damage refer to **“Contacting Keysight” on page 48**. Keep the damaged shipping materials (if any) for inspection by the carrier and an Keysight Technologies representative.

Description

The Keysight N5241/42AS Option H85 is a modified version of the standard N5241/42A PNA-X Series Network Analyzer. Option H85 is designed to permit insertion of high power amplifiers, and other signal conditioning equipment to allow high power network measurements at RF levels up to 20 Watts (+43 dBm) from 10 MHz to 26.5 GHz. The Option H85 modification supplies extended power range attenuators *without* bias tees. The N5241/42AS Option 285 (add extended power range to 2-Port analyzer, no bias-tees) replaces the standard N5241/42A Option 219 (add extended power range and bias-tees to 2-Port analyzer). The N5241/42AS Option 485 (add extended power range to 4-Port analyzer, no bias-tees) replaces the standard N5241/42A Option 419 (add extended power range and bias-tees to 4-Port analyzer).

The Option H85 does not increase the output power of the N5241/42A analyzer. This option only allows the N5241/42A analyzer to make high power measurements. The user must supply their own amplifier(s) and external components such as high power couplers, attenuators and isolators to configure the analyzer for high power. These components are not supplied, or included with the Option H85. The user is responsible to ensure that these components meet their DUT requirements, and also protect the PNA-X from damage. Therefore, it is very important that you read this document thoroughly and follow the power level guide lines in [Table 1 on page 23](#).

NOTE The Bias Tee's are removed from the Option H85 to allow high power operation. Specifications for the Keysight N5241/42AS Option H85, when configured in Standard Configuration, are the same as those of an N5241/42A PNA-X Series Network Analyzer with Options N5241/42A-219, or N5241/42A-419.

The instrument is shipped from the factory with jumper cables installed on the front panel in what is referred to as the "Standard Configuration." Refer to [Figure 9 on page 10](#) through [Figure 11 on page 11](#). This configuration will allow the instrument to operate as a standard N5241/42A PNA-X Series Network Analyzer with Options N5241/42A-219 or N5241/42A-419.

What you need to Know About Your N524xAS PNA-X

Your N524xAS PNA-X network analyzer was setup as an ordering convenience to respond to customer application and test needs requiring modification or enchantment to the standard N524xA PNA-X. All AS models are tested to the performance closest matching their configuration. Test and environmental specifications, characteristics, or typical values, are based, leveraged or derived from the performance of the standard N524xA PNA-X network analyzers and their options.

Ordering configurations and rear panel serial tags will differ from the standard model number and options indicated on the network analyzer front panel, and option field window of the instrument. When ordering and enabling Option H85, Options 219/419 become Options 285/485.

N5241/42AS Option H85 Ordering Configuration (*serial tag options*)

Figure 1 Serial Tag



2-Port Configuration Includes the Following Options:

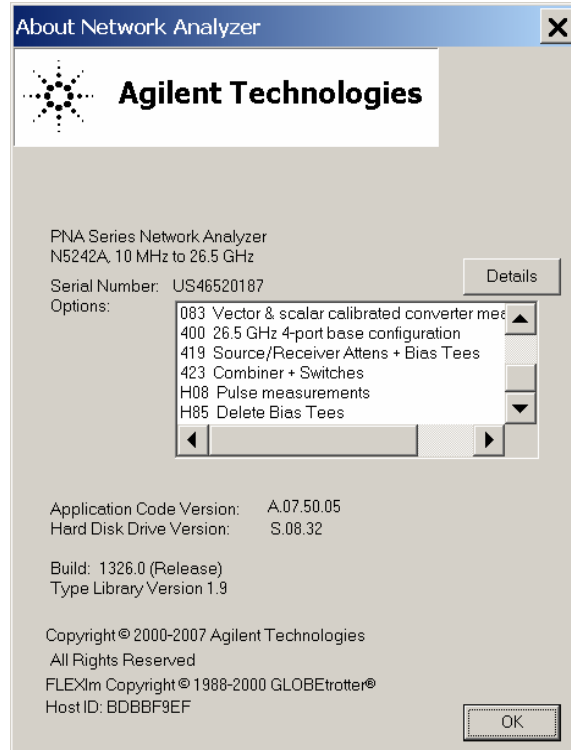
- 200 2-Ports, single source
- 285 Add extended power range to 2-Port analyzer (no bias tees)
- H85 High Power Configurable

4-Port Configuration Includes the Following Options:

- 400 4-Ports, dual source
- 485 Add extended power range to 4-Port analyzer (no bias tees)
- H85 High Power Configurable

N5241/42A Option H85 Shipped Configuration (*about network analyzer option fields*)

Figure 2 About Network Analyzer



2-Port Configuration Shown in PNA-X Option Fields:

- 200 26.5 GHz 2-Ports base configuration¹
- 219 Source/Receiver Attens + Bias Tees
- H85 Delete Bias Tees

4-Port Configuration Shown in PNA-X Option Fields:

- 400 26.5 GHz 4-Ports base configuration¹
- 419 Source/Receiver Attens + Bias Tees
- H85 Delete Bias Tees

¹ The frequency is dependant on the PNA-X model.

Operation

The Keysight Option H85 can be configured differently for many applications. Included in this manual are five typical configurations:

- [Figure 12, “2-Port Two Way High Power Configuration.”](#)
- [Figure 14, “4-Port Four Way High Power Configuration.”](#)
- [Figure 16, “2-Port One Way High Power Configuration.”](#)
- [Figure 18, “4-Port One Way High Power Configuration.”](#)
- [Figure 20, “2-Port Forward DUT Configuration.”](#)

NOTE The internal firmware of the PNA-X has not been modified for this option. The power levels indicated on the Keysight N5241/42AS Option H85 may differ depending on the user configuration that is chosen.

Refer to the configuration diagrams for external component connections and/or operating constraints when utilizing the high power capability of the Keysight N5241/42AS Option H85. External components are not supplied with this option.

When using the Keysight N5241/42AS Option H85 in the high power configuration (flow through R1 Loop), the analyzers R1 Input path must be set to External. In the **Trace/Chan** drop-down menu select **Channel** > **Hardware Setup** > **Path Config**. See [Figure 31 on page 35](#). In the path configuration dialog box, select **Port 1 Reference Mixer Switch** > **External** and select **OK** to activate the R1 Input path. See [Figure 32 on page 36](#).

CAUTION The maximum attenuator power setting for the receiver attenuator is 35 dB. The PNA-X Receiver Step Attenuators reduce the power to the A, B, C and D receivers. Power measurements to Test Ports 1, 2, 3 and 4 above +35 dBm will require additional attenuation. Add the appropriate amount of attenuation that will keep the coupler arm output power below the maximum receiver inputs. Refer to [Table 1 on page 23](#).

CAUTION Prior to powering-up the booster amplifier, it is highly recommended that the user verify the RF power levels seen by the various elements of the test setup. At high power levels an incorrect power level could permanently damage the instrument. Refer to [Table 1 on page 23](#).

CAUTION To reduce risk of damaging the PNA-X or your device, reduce the power and set the initial power setting to -65 dBm at the test port. The microwave PNA-X has 36 frequency bands. The firmware turns off the RF power level during band-crossings. If you are testing a high-gain device with an ALC when the PNA-X switches bands, the power shuts down and the DUT ALC attempts to increase the gain. Microseconds later, the PNA-X power returns. However, in the short time frame the DUT or the VNA may be damaged. The Band Crossings are listed in [Table 3 on page 25](#).

Figure 3 N5241/42AS Option 200 and H85 2-Port RF Block Diagram

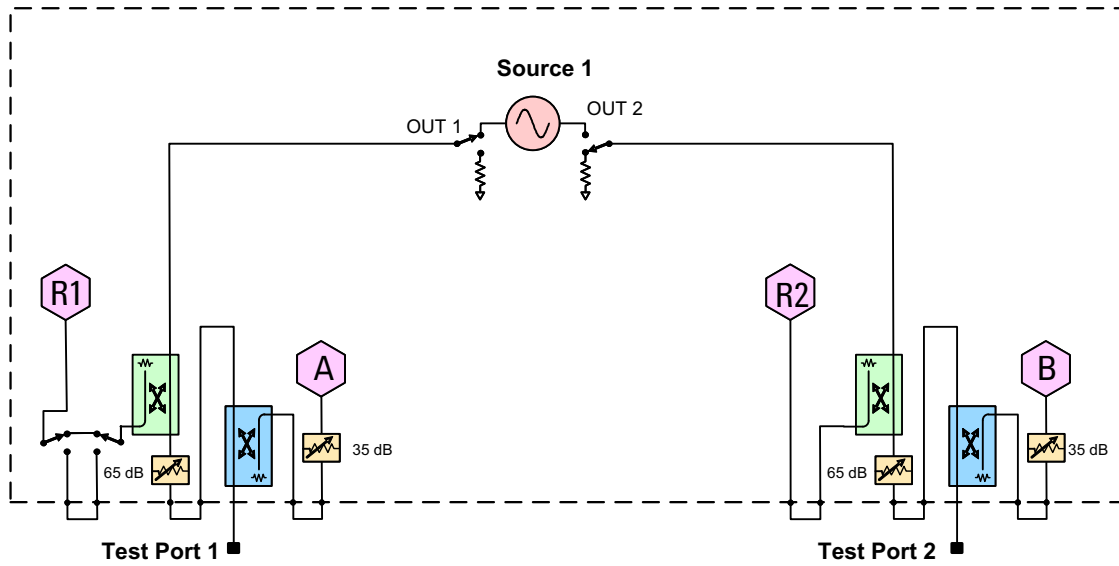


Figure 4 N5241/42AS Option 200, 224 and H85 2-Port RF Block Diagram

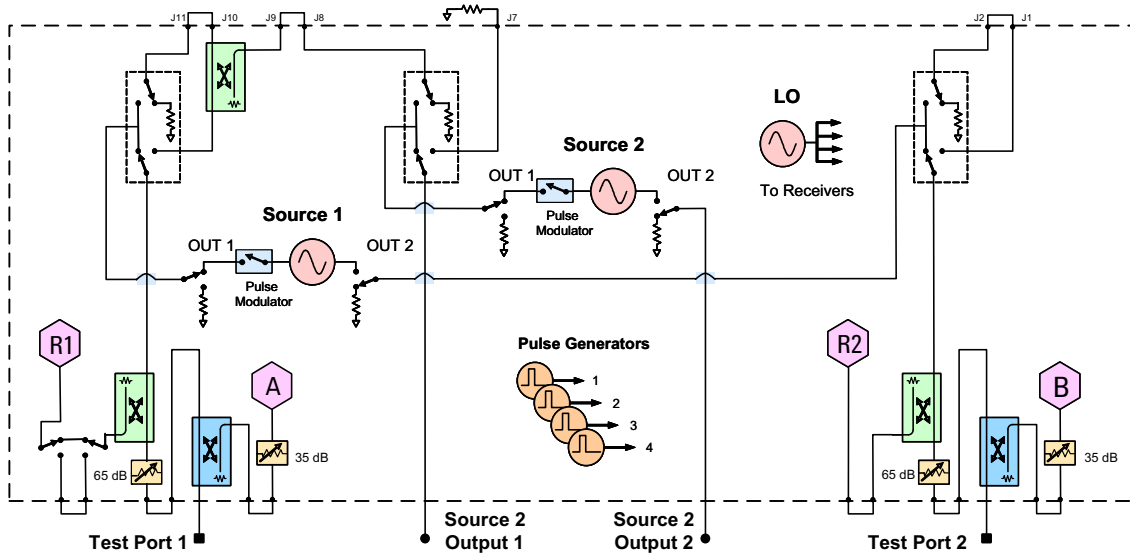


Figure 5 N5241/42AS Option 200, 224, 029 and H85 2-Port RF Block Diagram

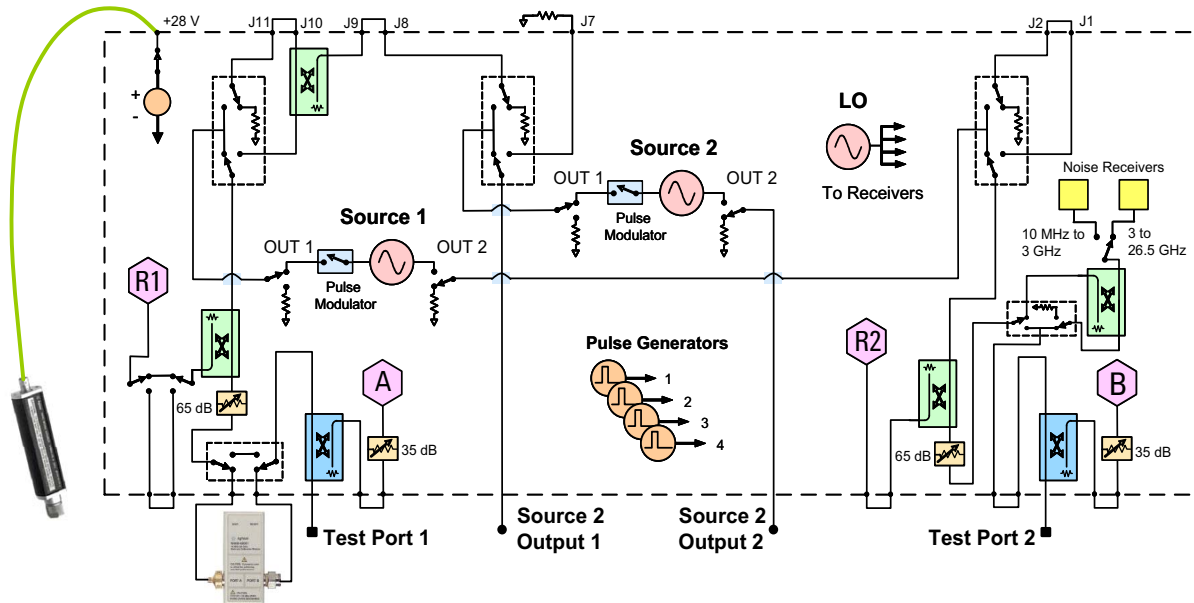


Figure 6 N5241/42AS Option 400 and H85 4-Port RF Block Diagram

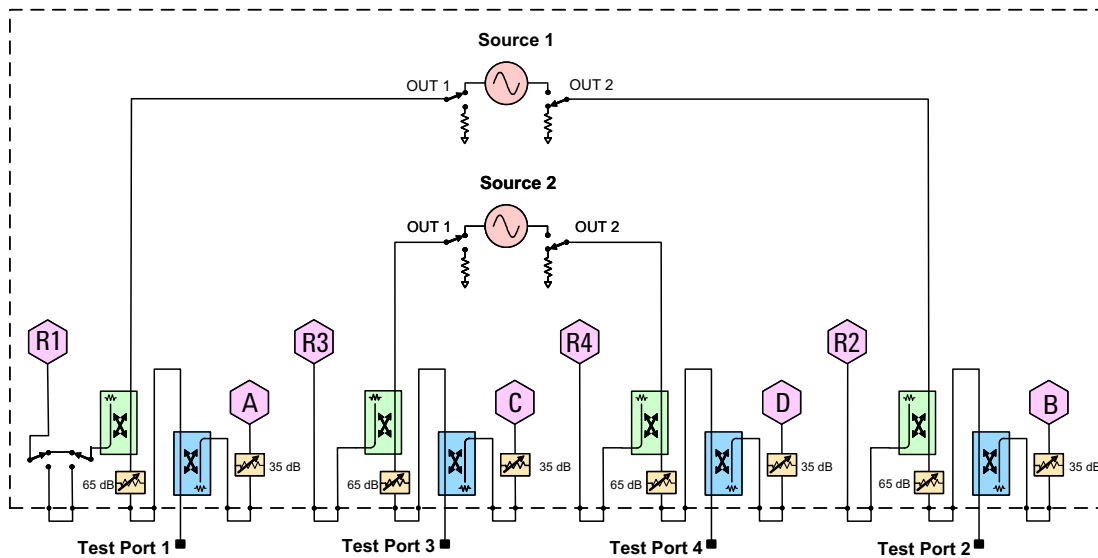


Figure 7 N5241/42AS Option 400, 423 and H85 4-Port RF Block Diagram

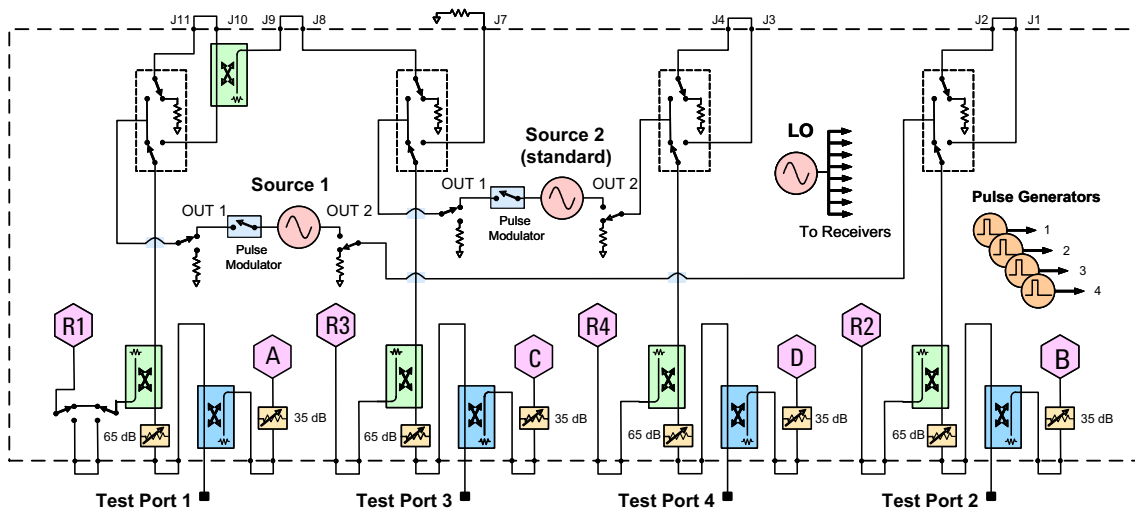


Figure 8 N5241/42AS Option 400, 423, 029 and H85 4-Port RF Block Diagram

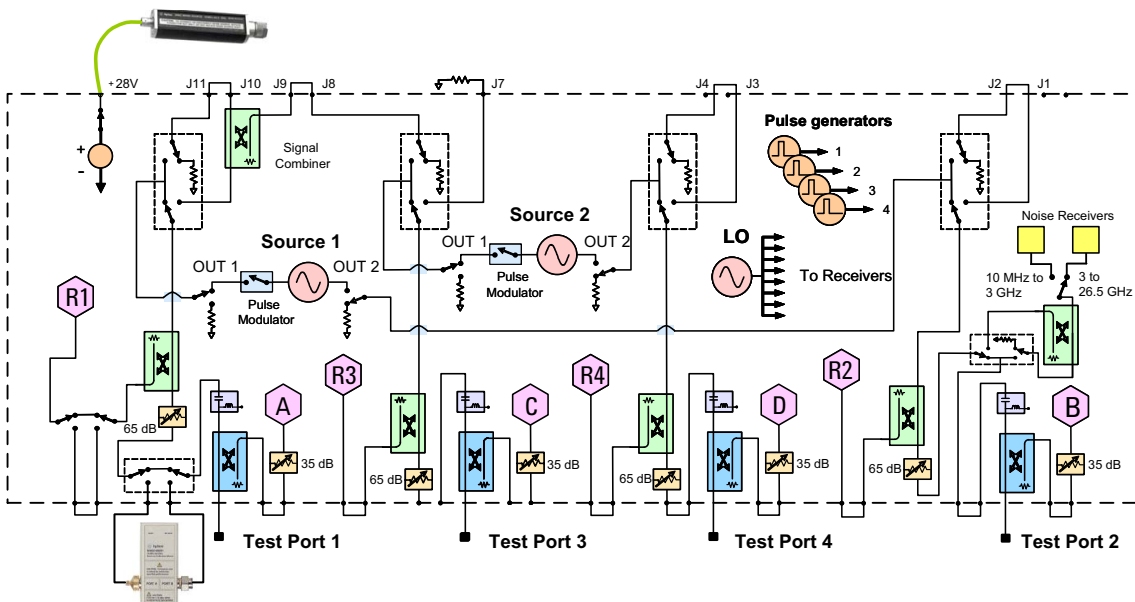


Figure 9 Standard 2-Port Front Panel

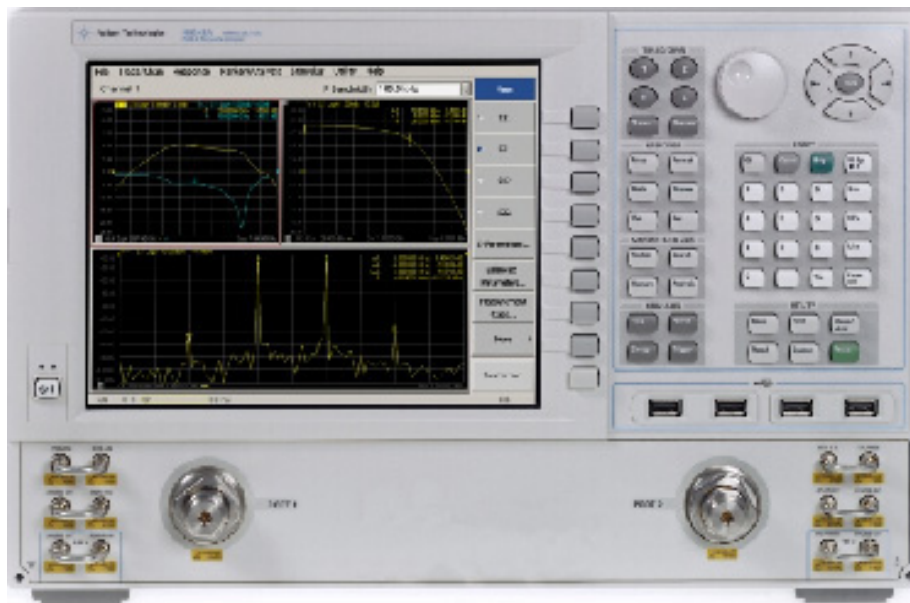


Figure 10 2-Port Front Panel with Internal Second Source

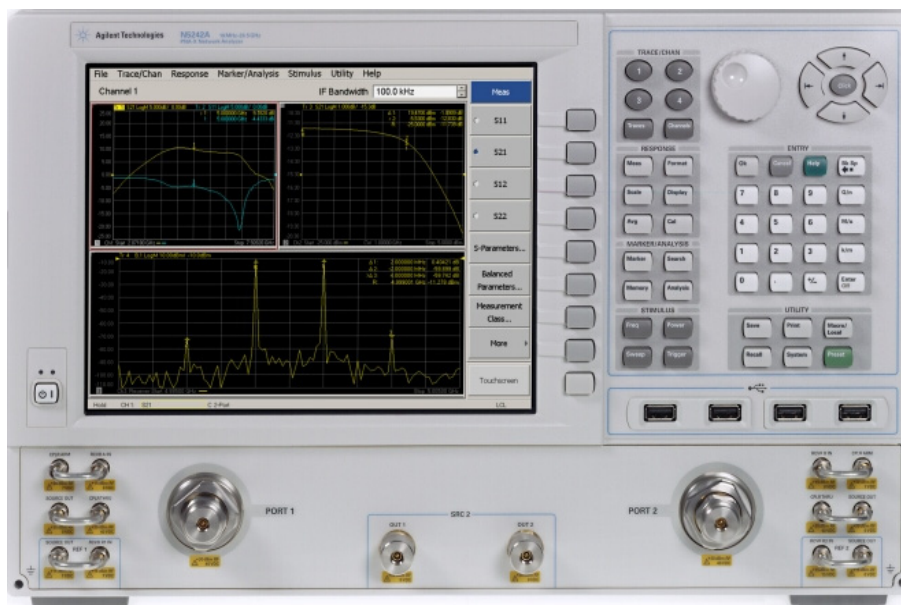
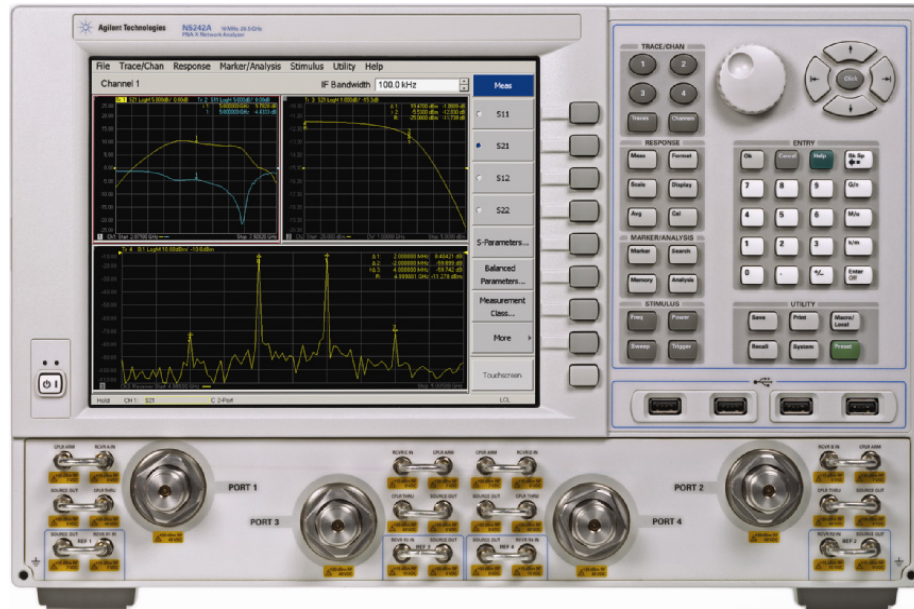


Figure 11 Standard 4-Port Front Panel



Ports 1 and 2 are configured to allow the user to stimulate each port with high power. Each port must have a high power amplifier and high power coupler. The isolators, reference and measured receiver attenuators are optional. They are dependent on the high power couplers coupling factor, amplifiers reverse isolation and power required to test the device. The attenuator, located at the high power coupler arm, may not be required if the coupling factor attenuates the signal adequately for the reference receiver channel. The same is also true for the measure receiver channels. The measure receiver attenuators for A IN and B IN may have sufficient range to compensate for the users desired power level. The isolators maybe eliminated if the amplifier reverse isolation is high. Refer to [Figure 12](#) and [Figure 13 on page 13](#).

Figure 12 2-Port Two Way High Power Configuration

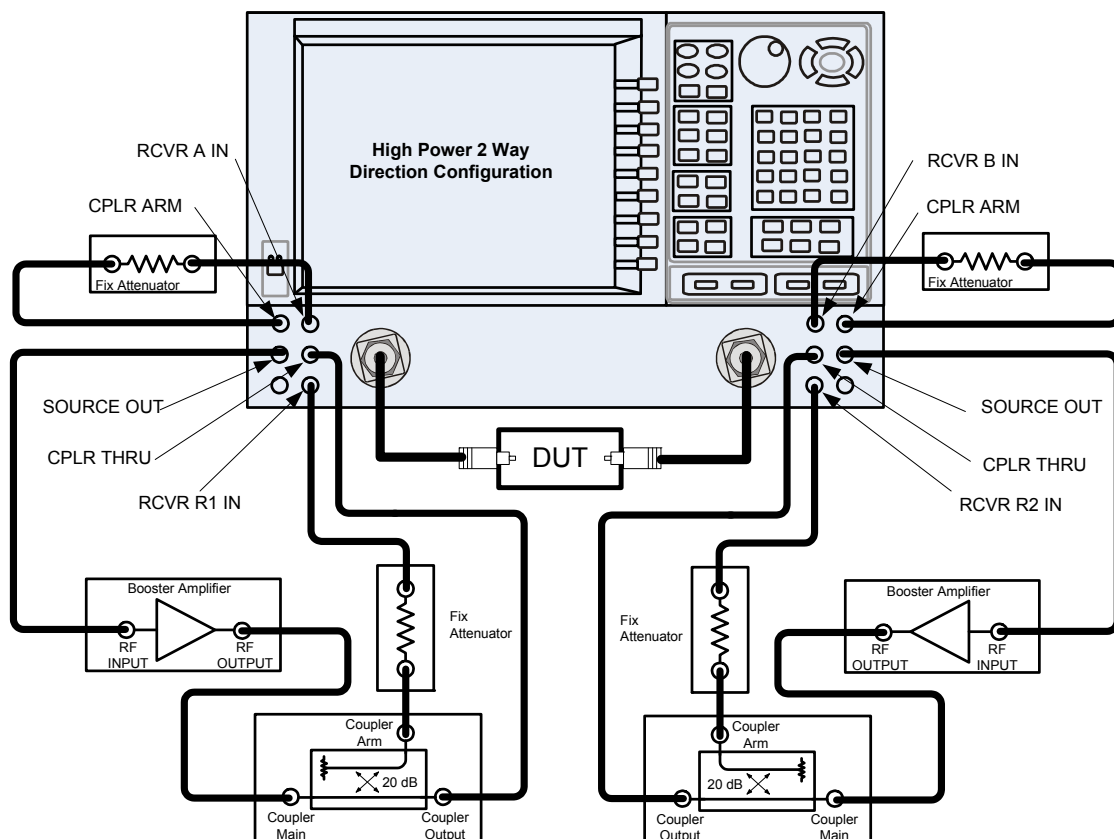
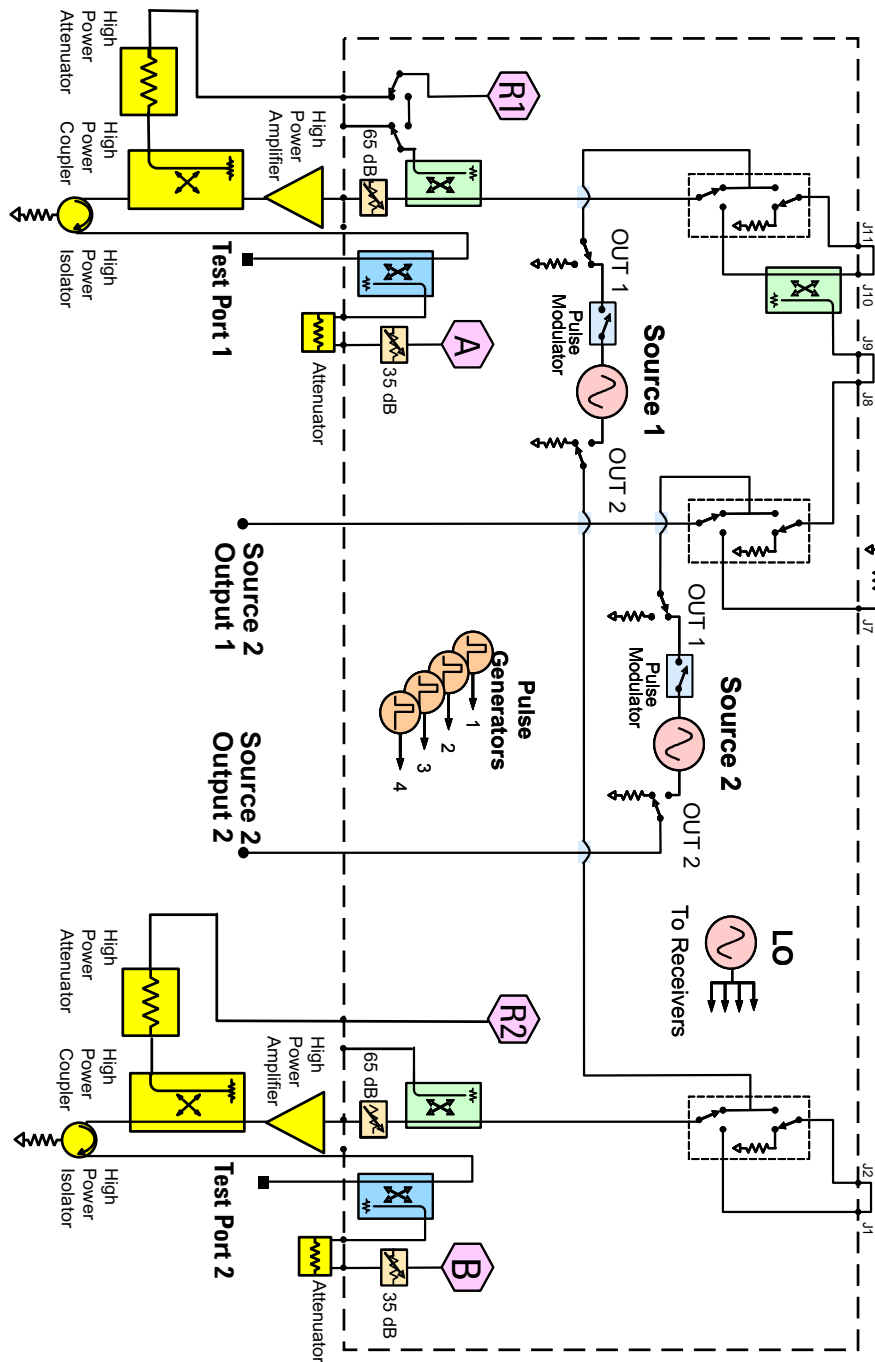


Figure 13 2-Port Two Way High Power Block Diagram



This configuration is similar to the 2-Port Two Way Configuration with the exception that Ports 1, 2, 3 and 4 are configured to allow the user to stimulate each port with high power. Each port must have a high power amplifier, high power coupler, isolator and attenuators. The isolators, reference and measured receiver attenuators are optional. They are dependent on the high power couplers coupling factor, amplifiers reverse isolation and power required to test the device. The attenuator, located at the high power coupler arm, may not be required if the coupling factor attenuates the signal adequately for the reference receiver channel. The same is also true for the measure receiver channels. The measure receiver attenuators for A IN, B IN, C IN and D IN may have sufficient range to compensate for the users desired power level. The isolators maybe eliminated if the amplifier reverse isolation is high. The DUT is not shown in the graphic. Refer to [Figure 14](#) and [Figure 15](#) on page 15.

Figure 14 4-Port Four Way High Power Configuration

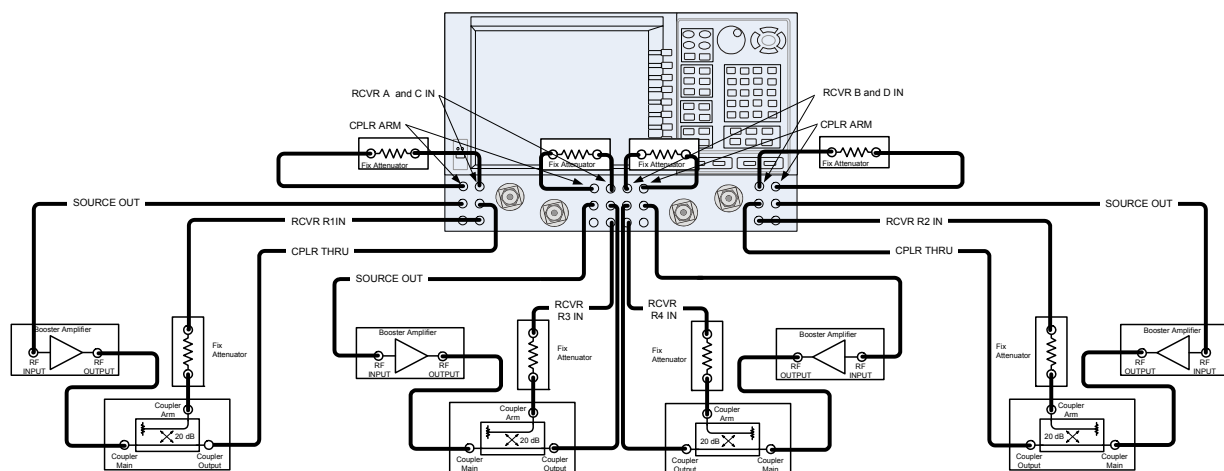
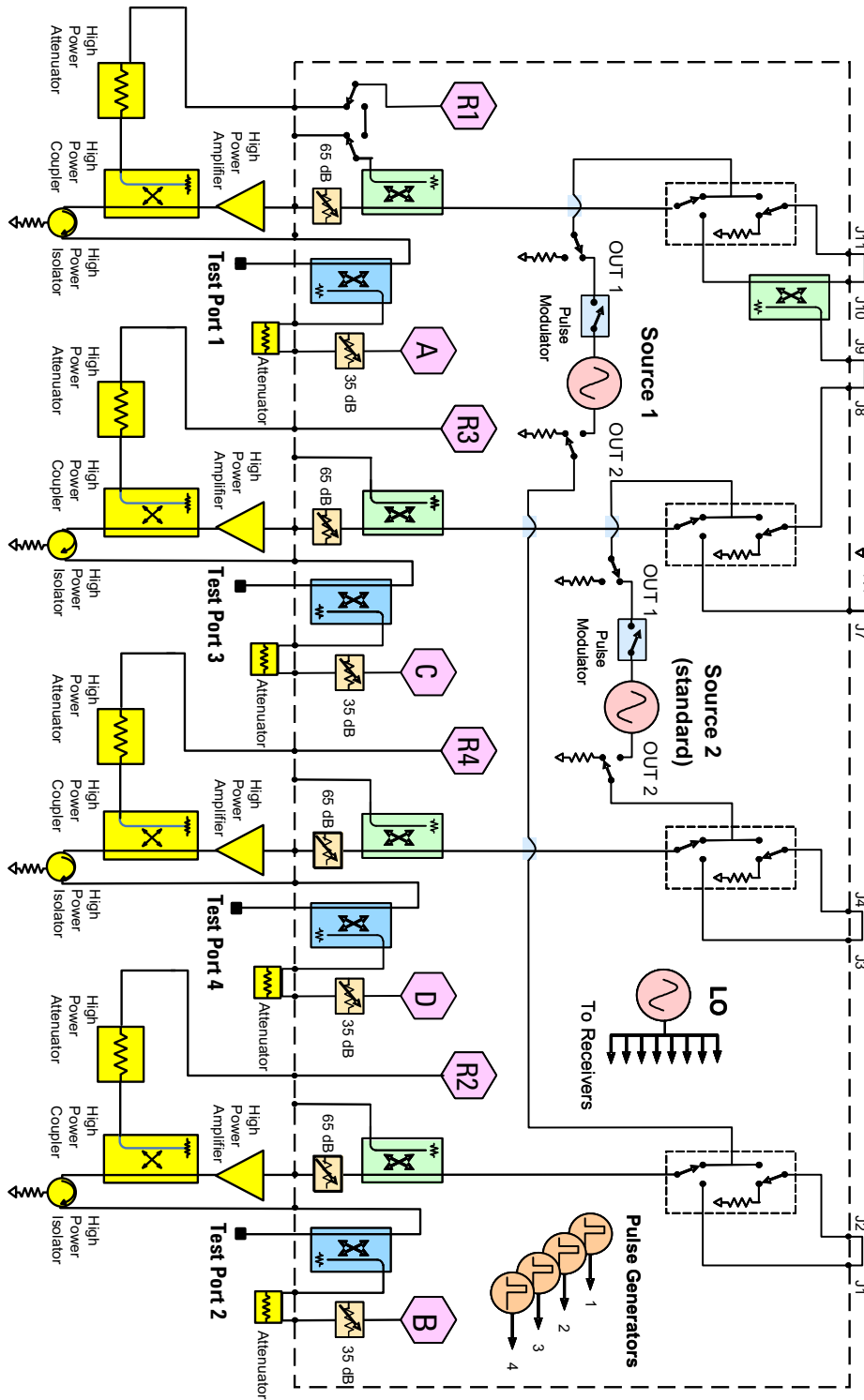


Figure 15 4-Port Four Way High Power Block Diagram



This configuration allows the user to stimulate Port 1 with high power. Port 1 must have a high power amplifier, high power coupler, isolator and attenuators. The isolator, reference and measured receiver attenuators are optional. They are dependent on the high power couplers coupling factor, amplifiers reverse isolation and power required to test the device. The attenuator, located at the high power coupler arm, may not be required if the coupling factor attenuates the signal adequately for the reference receiver channel. The same is true for the measure receiver channels. The measure receiver attenuators for A IN and B IN may have sufficient range to compensate for the users desired power level. Port 2 has a high power isolator located between the SOURCE OUT and CPLR THRU. This isolator is required to protect the components inside the PNA-X. The isolator can be replaced by a high power attenuator or circulator. Refer to [Figure 16](#) and [Figure 17](#) on page 17.

Figure 16 2-Port One Way High Power Configuration

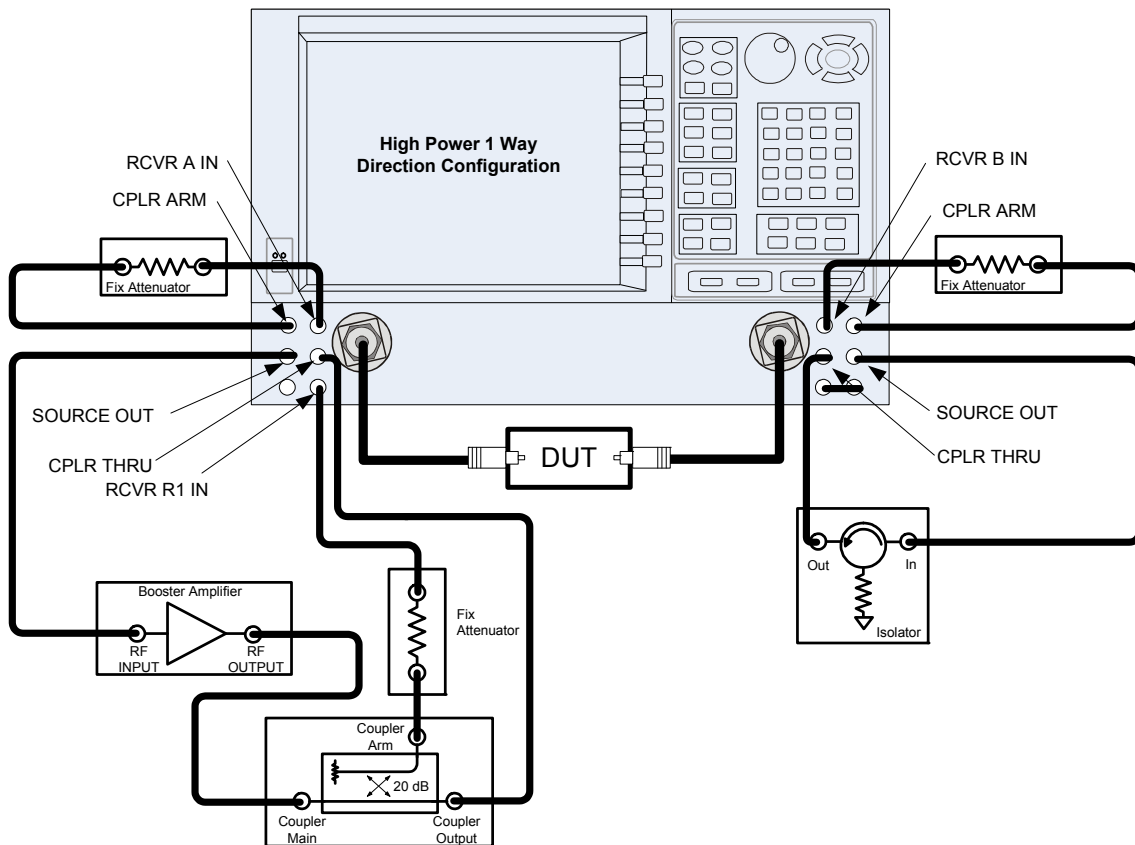


Figure 17 2-Port One Way High Power Block Diagram

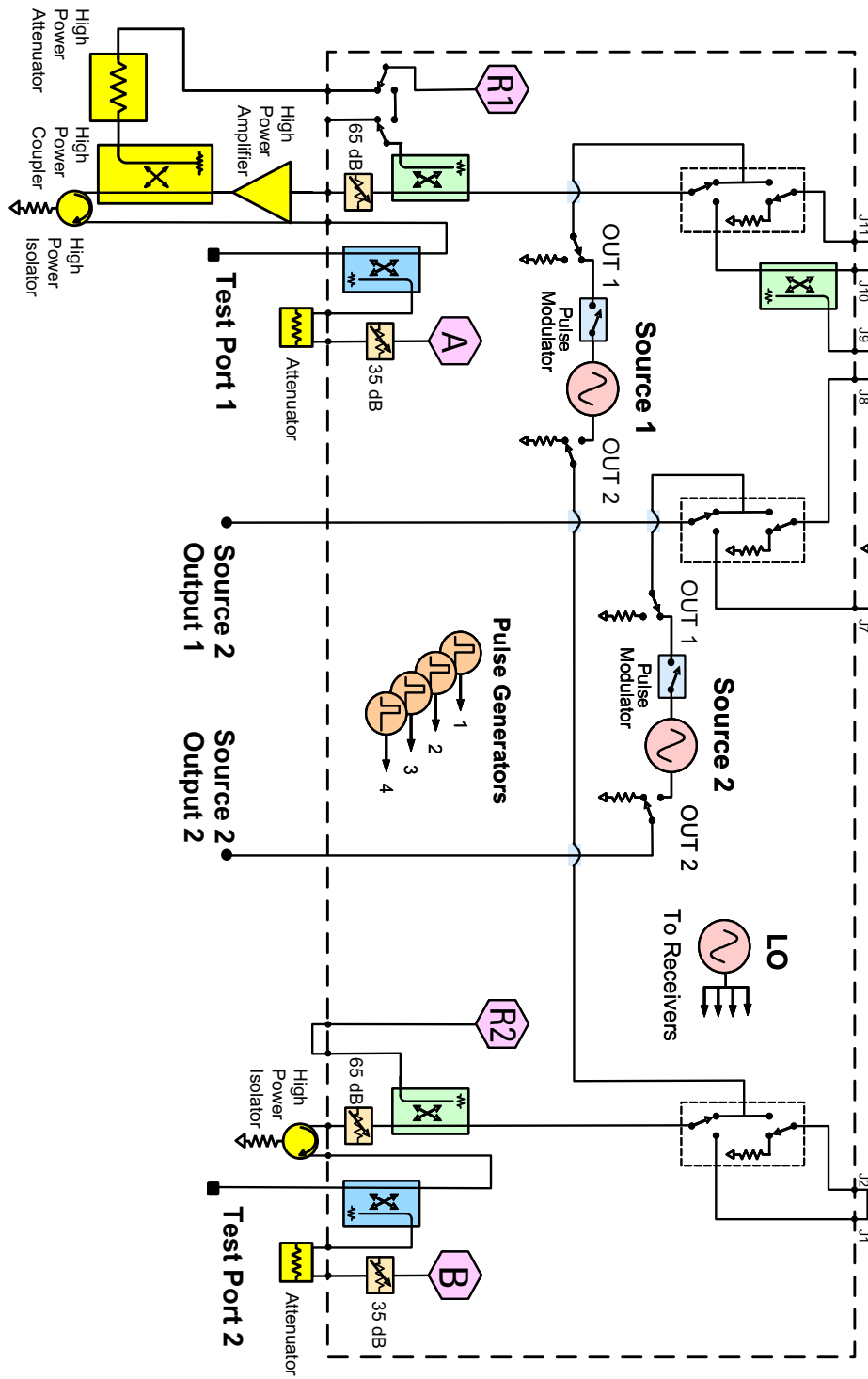
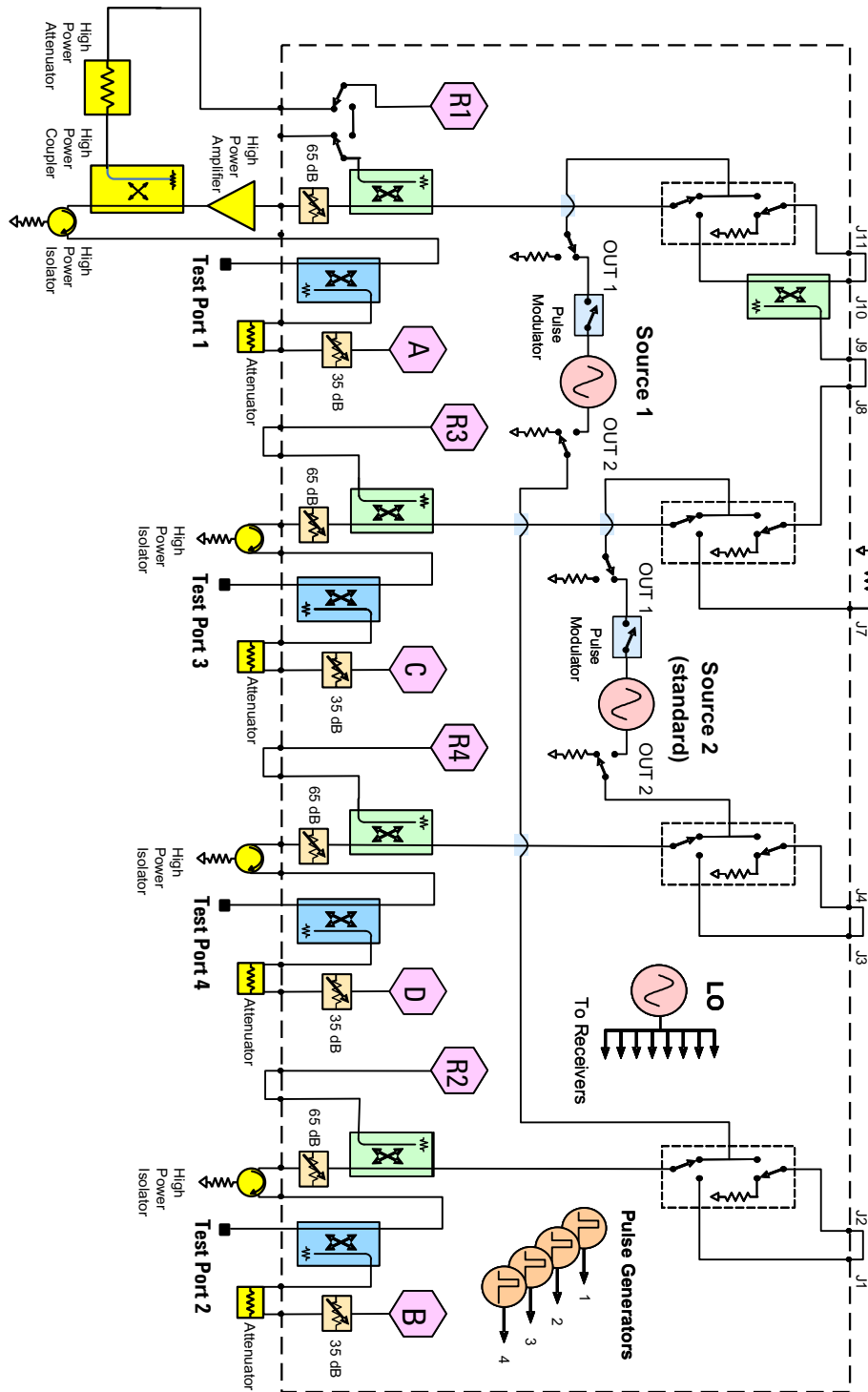


Figure 19 4-Port One Way High Power Block Diagram



In this configuration the DUT supplies the power. The measure receiver attenuator for B IN may have sufficient range to compensate for the users desired power level. Port 2 has a high power isolator located between the SOURCE OUT and CPLR THRU. This isolator is required to protect the components inside the PNA-X. The isolator can be replaced by a high power attenuator or circulator. Reference Channel R1 can be set to internal. Refer to [Figure 20](#) and [Figure 21 on page 21](#).

Figure 20 2-Port Forward DUT Configuration

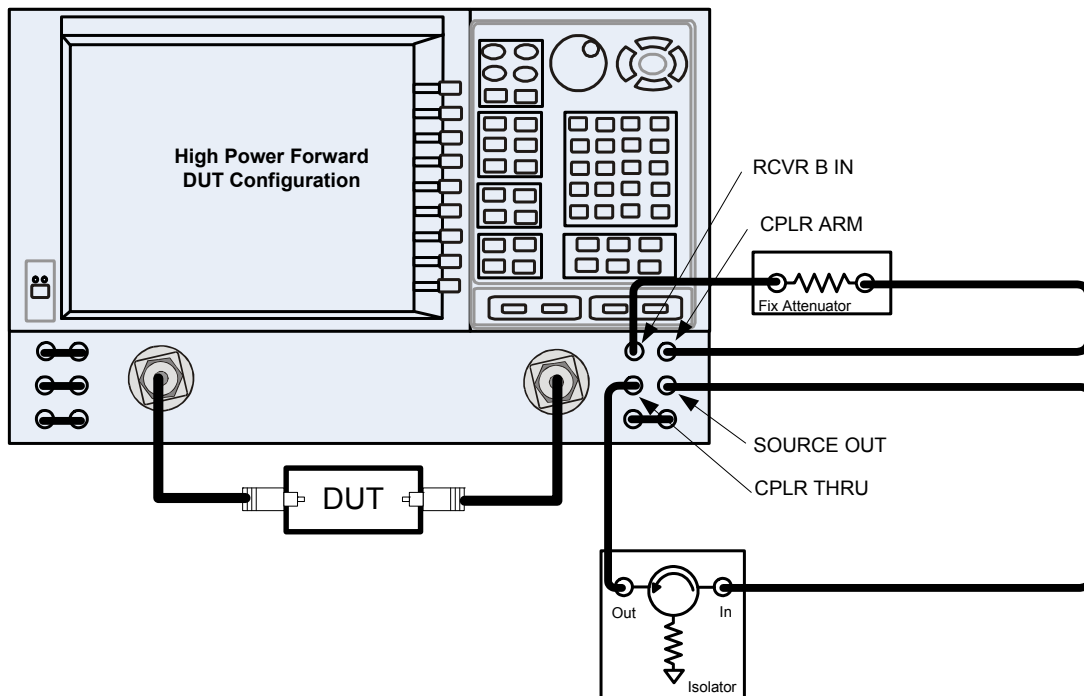
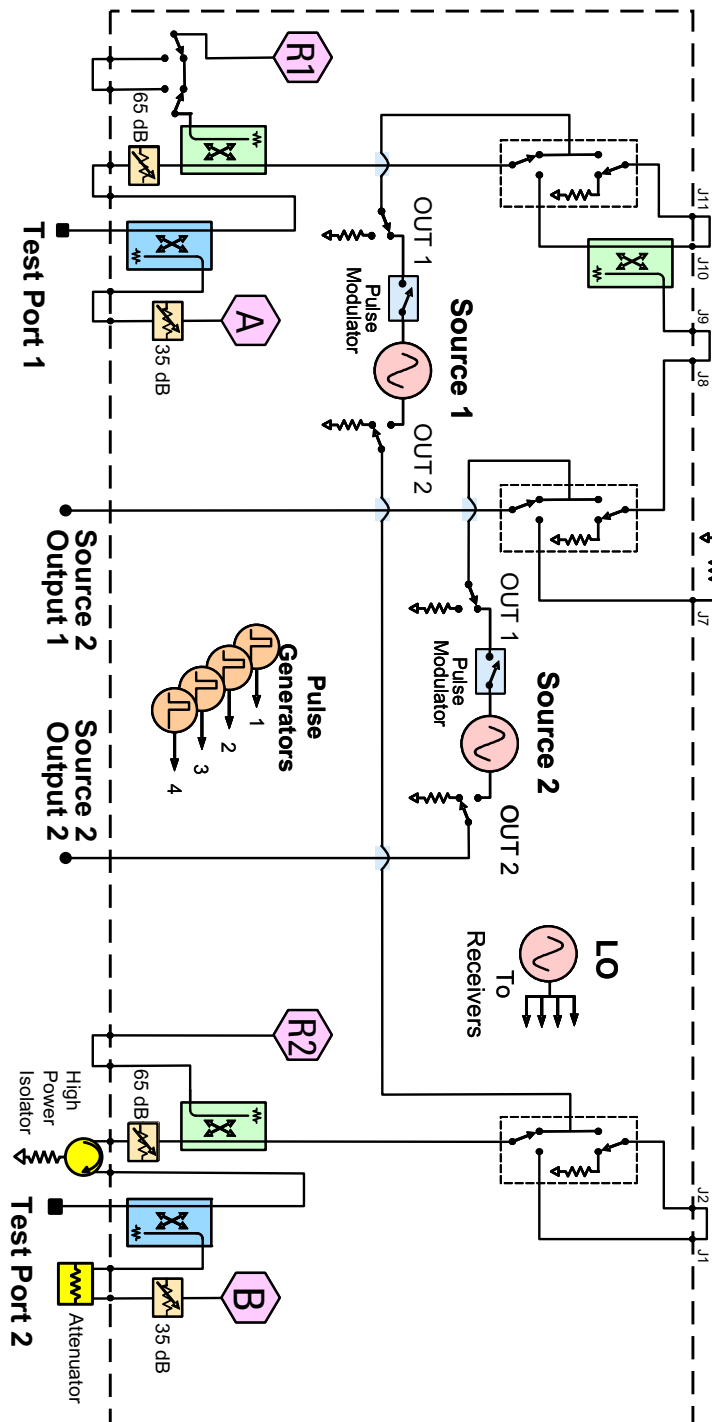


Figure 21 2-Port Forward DUT Block Diagram



Specifications: Front Panel Jumpers and Test Ports

Specifications for Option H85 are the same as the standard PNA-X with Option 219 or 419. The following specifications are available from the PNA-X Data Sheet on our web site at

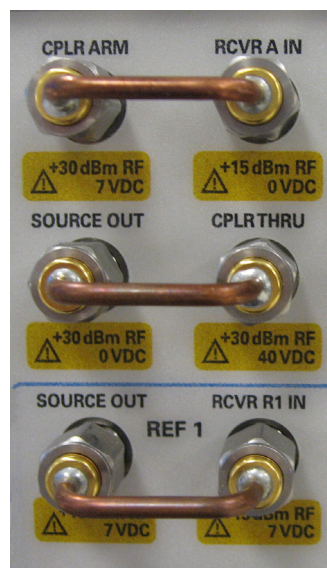
<http://www.keysight.com/find/pna>

- Measurement Receiver Inputs
- R1 Reference Receiver Inputs
- R2 - R4 Reference Receiver Inputs
- R1 Source Outputs
- R2 - R4 Source Outputs
- Source Outputs
- Coupler Inputs¹
- Coupler Outputs
- Test Port Inputs

CAUTION It is recommend that you do not operate components near damage or maximum levels. The power levels should be kept at less than 3 dB, preferably 6 dB, below damage and maximum levels.

All PNA-X options have the following front panel jumpers for each port.

Figure 22 Front Panel Jumpers



1. Port 1 through Port 4 Insertion Loss of Coupler Thru specifications are the same as the standard Option 200 or 400. Refer to the Keysight 2-Port and 4-Port PNA-X Network Analyzers Data Sheet and Technical Specifications (N5242-90007). The maximum DC Level is 0 VDC.

NOTE Refer to your PNA-X specifications to optimize the power levels in the receivers.

The following tables specify the receiver damage levels for the N5241/42AS Option H85.

Table 1 Damage Power Levels

Measurement Receiver Inputs:	
RCVR A IN through RCVR D IN @ 0.1 dB Typical Compression	
Damage Level	+15 dBm
Maximum DC Level	0 V
R1 Reference Receiver Inputs:	
RCVR R1 IN @ Max Specified Output Power	
Damage Level	+15 dBm
Maximum DC Level	± 7 V
R2 - R4 Reference Receiver Inputs:	
RCVR R2 IN through RCVR R4 IN @ Max Specified Output Power	
Damage Level	+15 dBm
Maximum DC Level	± 15 V
R1 Source Outputs:	
Ref 1 Source Out @ Max Specified Output Power	
Damage Level	+15 dBm
Maximum DC Level	± 7 V
R2 - R4 Source Outputs:	
Ref 2 Source Out through Ref 4 @ Max Specified Output Power	
Damage Level	+15 dBm
Maximum DC Level	0 V
Source Outputs:	
Port 1 Source Out through Port 4 @ Max Specified Output Power	
Damage Level	+30 dBm
Maximum DC Level	0 V
Coupler Inputs:	
Port 1 CPLR THRU through Port 4 @ Insertion Loss of Coupler Thru	
Damage Level	+43 dBm
Maximum DC Level	0 V

Table 1 Damage Power Levels

Coupler Outputs:	
Port 1 CPLR ARM through Port 4 @ Max Specified Output Power	
Damage Input Level	+30 dBm
Maximum DC Level	± 7 V
Test Port Inputs:	
Test Port 1 through Port 4 @ Max Specified Output Power	
Damage Level	+43 dBm (without jumpers) +30 dBm (with jumpers)
Maximum DC Level	0 V

Table 2 Watts to dBm Reference Table

Linear (watts)	Log (dBm)
0.001	+0
0.01	+10
0.1	+20
1	+30
2	+33
4	+36
10	+40
20	+43
40	+46
50	+47
100	+50
200	+53

Table 3 Frequency Band-Crossings

Band	Mixer Brick L.O. Harmonic Number (N)	①	②	③	④
		A11 Synthesizer Frequency (GHz)	A21 MA 26.5 Frequency (GHz)	A4/A7 Synthesizer Frequency (GHz)	A5/A8 Source Frequency (GHz)
0	-	-	-	-	-
1	-	-	-	-	-
2	1	0.012535 to 0.016535	0.012535 to 0.016535	0.010 to 0.014	0.010 to 0.014
3	1	0.016535 to 0.021535	0.016535 to 0.021535	0.014 to 0.019	0.014 to 0.019
4	1	0.021535 to 0.029535	0.021535 to 0.029535	0.019 to 0.027	0.019 to 0.027
5	1	0.029535 to 0.040535	0.029535 to 0.040535	0.027 to 0.038	0.027 to 0.038
6	1	0.040535 to 0.055535	0.040535 to 0.055535	0.038 to 0.053	0.038 to 0.053
7	1	0.060606 to 0.082606	0.060606 to 0.082606	0.053 to 0.075	0.053 to 0.075
8	1	0.082606 to 0.112606	0.082606 to 0.112606	0.075 to 0.105	0.075 to 0.105
9	1	0.112606 to 0.153606	0.112606 to 0.153606	0.105 to 0.146	0.105 to 0.146
10	1	0.153606 to 0.212606	0.153606 to 0.212606	0.146 to 0.205	0.146 to 0.205
11	1	0.212606 to 0.257606	0.212606 to 0.257606	0.205 to 0.250	0.205 to 0.250
12	1	0.257606 to 0.403606	0.257606 to 0.403606	0.250 to 0.396	0.250 to 0.396
13	1	0.403606 to 0.507606	0.403606 to 0.507606	0.396 to 0.500	0.396 to 0.500
14	1	0.507606 to 0.635606	0.507606 to 0.635606	0.500 to 0.628	0.500 to 0.628
15	1	0.635606 to 1.007606	0.635606 to 1.007606	0.628 to 1.000	0.628 to 1.000
16	1	1.007606 to 1.507606	1.007606 to 1.507606	1.000 to 1.500	1.000 to 1.500
17	1	1.507606 to 2.007606	1.507606 to 2.007606	1.500 to 2.000	1.500 to 2.000
18	1	2.007606 to 3.007606	2.007606 to 3.007606	2.000 to 3.000	2.000 to 3.000
19	1	3.007606 to 3.207606	3.007606 to 3.207606	3.000 to 3.200	3.000 to 3.200
20	1	3.207606 to 4.007606	3.207606 to 4.007606	3.200 to 4.000	3.200 to 4.000
21	1	4.007606 to 5.339606	4.007606 to 5.339606	4.000 to 5.332	4.000 to 5.332
22	1	5.339606 to 6.759606	5.339606 to 6.759606	5.332 to 6.752	5.332 to 6.752
23	1	6.759606 to 8.007606	6.759606 to 8.007606	6.752 to 8.000	6.752 to 8.000
24	1	8.007606 to 8.507606	8.007606 to 8.507606	8.000 to 8.500	8.000 to 8.500
25	1	8.507606 to 10.67161	8.507606 to 10.67161	8.500 to 10.664	8.500 to 10.664
26	1	10.67161 to 12.00761	10.67161 to 12.00761	10.664 to 12.000	10.664 to 12.000
27	1	12.00761 to 12.80761	12.00761 to 12.80761	12.000 to 12.800	12.000 to 12.800
28	1	12.80761 to 13.51761	12.80761 to 13.51761	12.800 to 13.510	12.800 to 13.510
29	1	6.758803 to 7.703803	13.51761 to 15.40761	6.755 to 7.700	13.510 to 15.400
30	1	7.703803 to 8.003803	15.40761 to 16.00761	7.700 to 8.000	15.400 to 16.000
31	1	8.003803 to 9.003803	16.00761 to 18.00761	8.000 to 9.000	16.000 to 18.000
32	1	9.003803 to 10.00381	18.00761 to 20.00761	9.000 to 10.000	18.000 to 20.000
33	1	10.00381 to 10.66781	20.00761 to 21.33561	10.000 to 10.664	20.000 to 21.328
34	1	10.66781 to 11.25381	21.33561 to 22.50761	10.664 to 11.250	21.328 to 22.500
35	1	11.25381 to 12.00381	22.50761 to 24.00761	11.250 to 12.000	22.500 to 24.000
36	1	12.00381 to 13.25381	24.00761 to 26.50761	12.000 to 13.250	24.000 to 26.500

Example: Making High Power Measurements with Option H85

This section describes how to set up the analyzer to perform high power measurements. Analyzers equipped with the Option H85 can be configured to measure high power devices. This ability is useful if the required power for the device under test is greater than the analyzer can provide, or if the maximum output power from an amplifier under test exceeds safe input limits for a standard analyzer.

This 2-Port example of the high power procedure chooses an optimal power level of -12 dBm for all receivers. You may choose to optimize your measurement performance by using [Table 1 on page 23](#).

Typeface Key Conventions

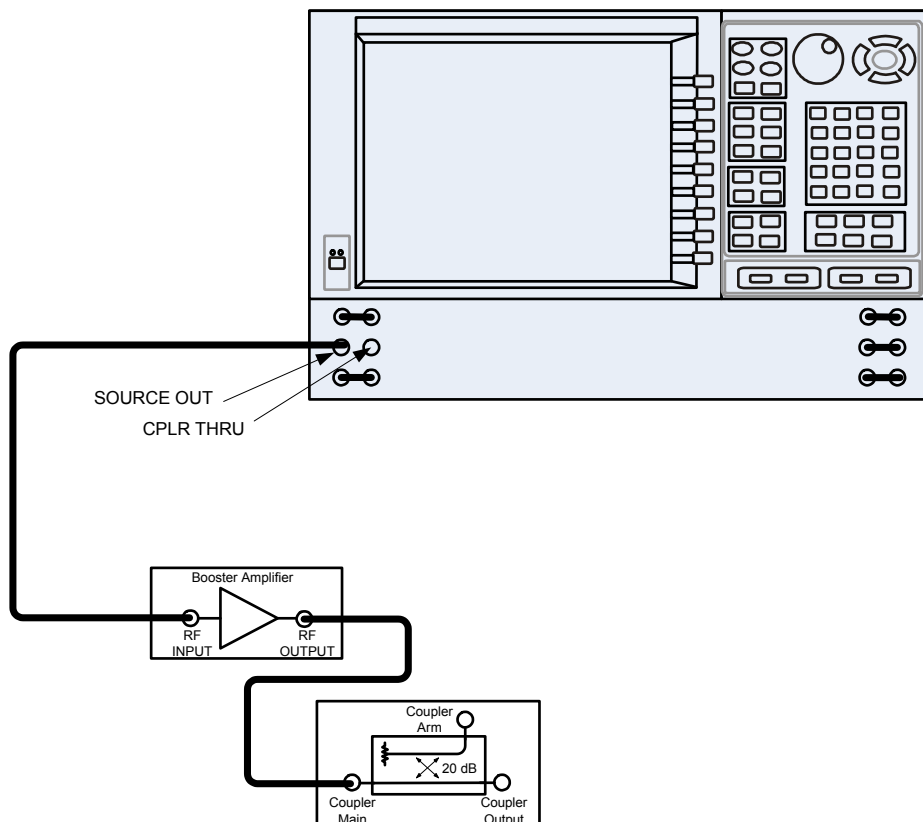
The following key conventions are used throughout this document.

- **[HARDKEYS]** are labeled front panel keys.
- **SOFTKEYS** are unlabeled key whose function is indicated on the instrument display.

Initial Setup

1. If the analyzer is in the standard mode configuration remove the jumper between Port 1 SOURCE OUT and CPLR THRU connector on the front panel. This can also be done for Port 2 if high power measurements are necessary for the reverse parameters of a device under test (DUT). Two booster amplifiers and two 20 dB couplers are required for both forward and reverse measurements. Refer to [Figure 23](#).
2. Connect the booster amplifier RF INPUT connector to the Port 1 SOURCE OUT connector on the front panel of the analyzer.
3. Connect a 20 dB coupler (that operates within the frequency range of interest) to the booster amplifier RF OUTPUT connector.

Figure 23 Booster Amplifier and 20 dB Coupler Connection Setup



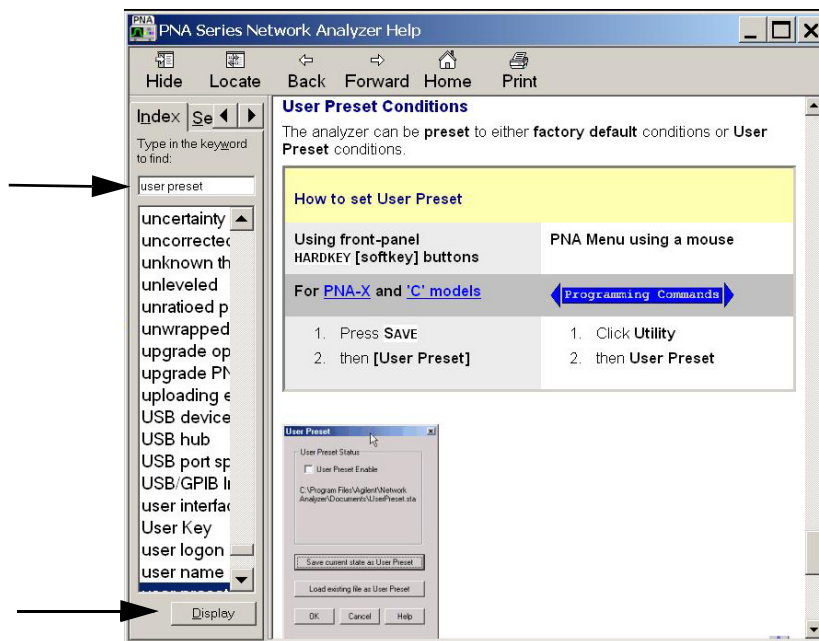
Determining Power Levels

NOTE For all high power configurations refer to [Table 1 on page 23](#) for maximum input damage levels, and PNA-X specifications to optimize the power levels on the receivers.

Before continuing, save this state and set it up as the **User Preset**. The User Preset Conditions can be found in the PNA-X Series Network Analyzer's help menu.

1. Press **[Help]** on the front panel, or in the **Help** drop-down menu select **Network Analyzer Help**. Type **User Preset** in the index or search field and select **Display**. This will describe how to setup a User Preset. The final state should be saved as the User Preset to avoid an over power condition from the factory preset.

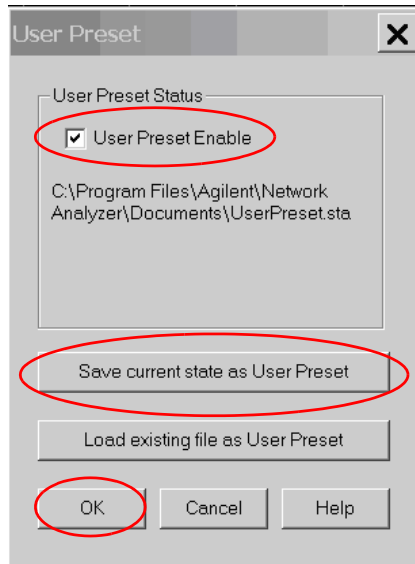
Figure 24 Help Menu



To find the User Preset:

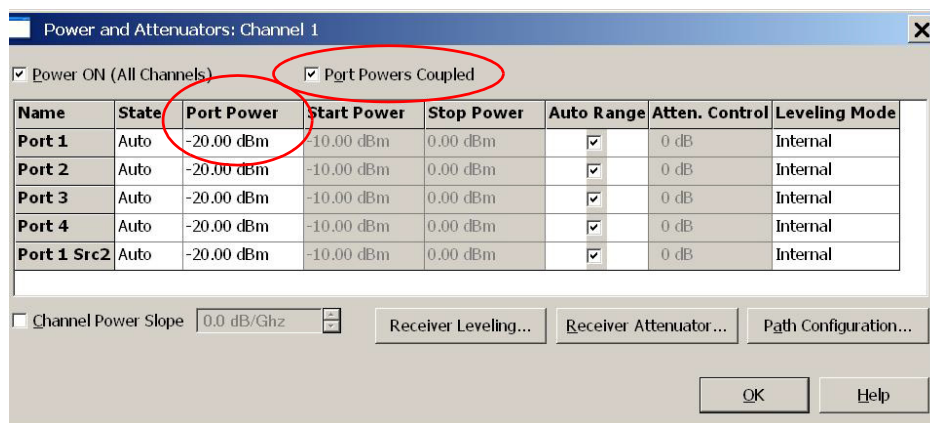
- In the **Utility** drop-down menu select **User Preset**. Select **User Preset Enable** > **Save current state as User Preset** and select **OK**. See [Figure 25](#).

Figure 25 User Preset



- In the **Stimulus** drop-down menu select **Power** > **Power and Attenuators**. In the dialog box type **[-20 dBm]** into **Port Power** for **Port 1**. Verify that **Port Powers Coupled** is checked to ensure that Ports 1 and Port 2 power levels are the same and select **OK**. Uncoupled ports should be used when adjusting the S12 power level. See [Figure 26](#).

Figure 26 Power and Attenuators



4. Turn On the booster amplifier.
5. Measure the output power from the coupled arm and the open port “Coupler Output” of the coupler, using a power meter and sensor.

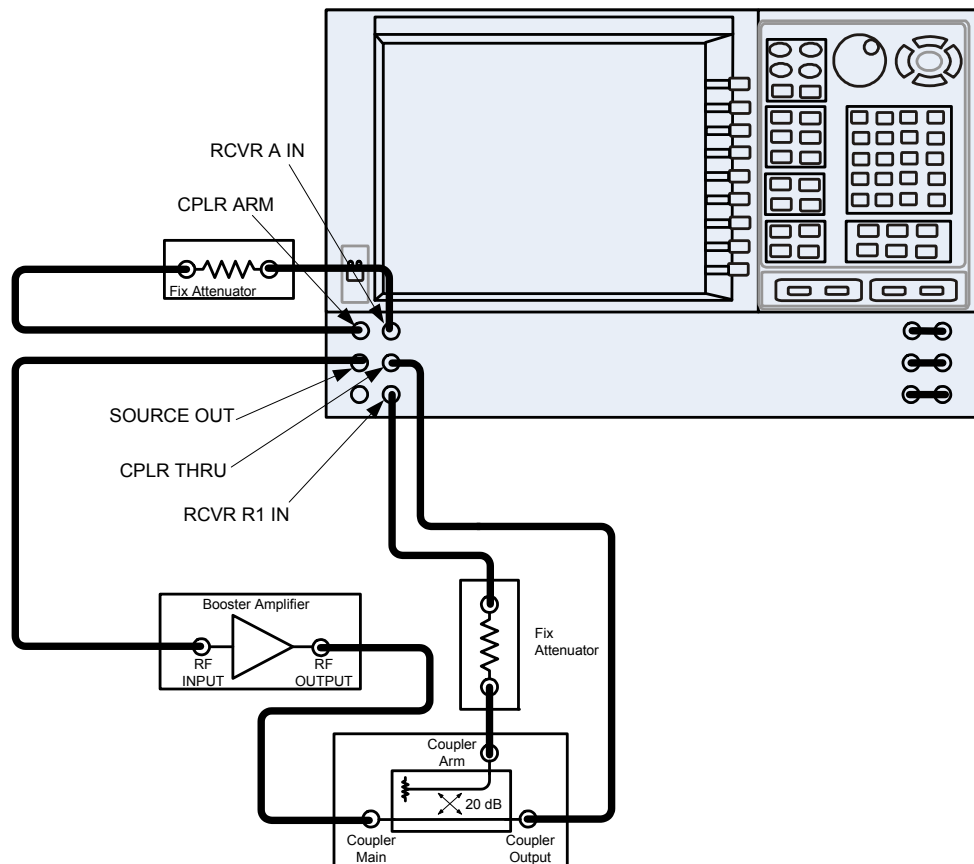
NOTE Depending on the power used, additional attenuation may have to be added between the coupler and the power meter.

6. Verify the gain of the booster amplifier(s). For example; if the analyzer output power level was set to -20 dBm and the output power measured from the open end of the coupler was -5 dBm, the gain of the booster amplifier would be $+15$ dB.
7. Verify that the power measured in the previous steps is within the acceptable limits (less than -12 dBm for the coupled arm, less than $+43$ dBm for the open port). Estimate the maximum power level needed to force the DUT into compression.
8. At the maximum estimated power level, determine if the maximum output power from the coupled arm of the coupler will be higher than the acceptable limit. If so, add the appropriate amount of attenuation that will keep the coupler arm output power below -12 dBm.

Additional Setup

9. Turn Off the booster amplifier.
10. Connect the open port of the 20 dB coupler to the Port 1 CPLR THRU connector on the front panel. This can also be done on Port 2 if reverse parameters high power measurements are required.
11. Disconnect the REFERENCE SOURCE OUT and RCVR R1 IN jumper on the front panel. Connect the coupled arm of the 20 dB coupler (along with any added attenuation) to the RCVR R1 IN. The same instructions apply to Port 2 with one exception; disconnect the jumper to RCVR R2 IN if high power measurements are required for the reverse parameters.

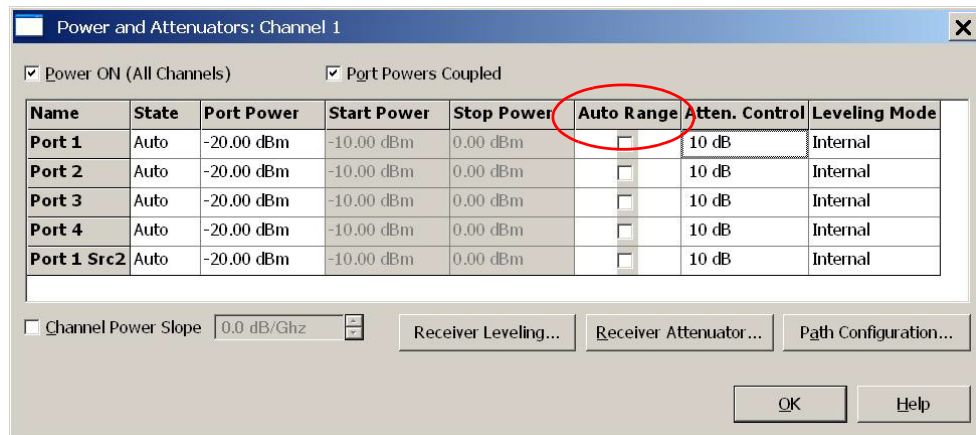
Figure 27 PNA-X Port 1 Amplifier, Coupler, Attenuator Connections



Selecting Power Ranges and Attenuator Settings

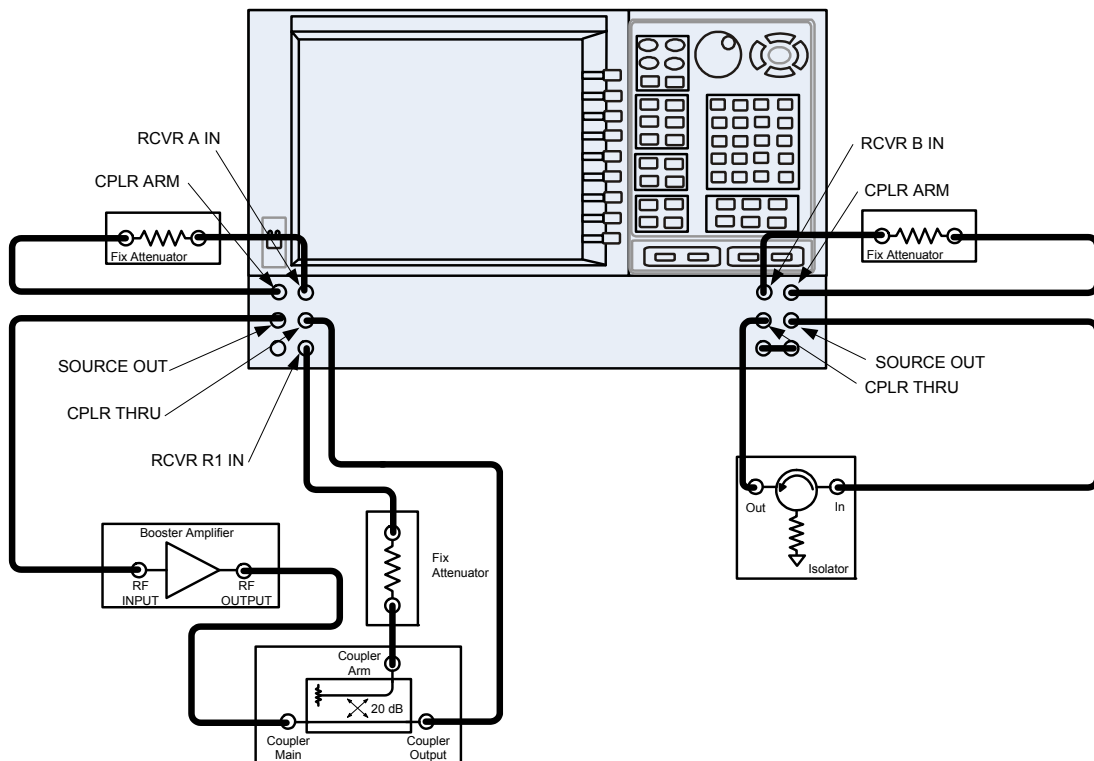
12. Select a power range that will not exceed the maximum estimated power level, but will force the DUT into compression. For example; if your booster amplifier has a gain of +15 dB, the DUT will compress if supplied with +15 dBm. You may need to adjust the analyzer output power to not exceed 0 dBm.
13. In the **Stimulus** drop-down menu select **Power > Power and Attenuators**. In the dialog box, clear the **Auto Range** boxes, and type [10 dB] into **Atten. Control** for **Port 1**. Verify that **Port Powers Coupled** is checked to ensure that Ports 1 and Port 2 power levels are the same and select **OK**.

Figure 28 Attenuator Control



14. Estimate the maximum amount of gain that could be provided by the DUT, and as a result, the maximum amount of power that could be received by Test Port 2 when the DUT is in compression. For example; if a DUT with a maximum gain of +10 dB receives an input of +10 dBm, the maximum amount of power that could be received by Test Port 2 is +20 dBm. An isolator or attenuator may be require depending on the amount of power at Test Port 2. For Port 2 isolators and attenuator connections, an isolator is place between the CPLR THRU and SOURCE OUT as shown in Figure 29.

Figure 29 Isolators and Attenuator Connections



15. Calculate the amount of attenuation needed between the analyzer's coupler and receivers, so that you do not exceed the optimum receiver power level of -12 dBm.

It will be necessary to take the following into consideration:

- Receiver A will be coupled to the analyzer RF path that could receive power reflections as high as $+10$ dBm.
- Receiver B will be coupled to the analyzer RF path that could receive a maximum of $+20$ dBm from the DUT.
- Analyzer coupler loss is -13 dB.
- The optimum receiver power level is -12 dBm.

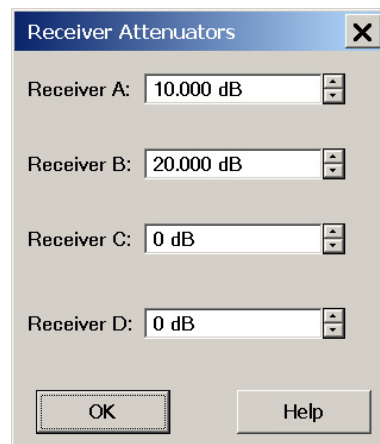
With the previous points in mind, the amount of attenuation can be calculated from the following equations:

$$\text{Receiver Attenuator A} = +10\text{dBm} - 13\text{dBm} - (-12\text{dBm}) \quad \text{Attenuator A} = +10\text{dBm}$$

$$\text{Receiver Attenuator B} = +20\text{dBm} - 13\text{dBm} - (-12\text{dBm}) \quad \text{Attenuator B} = +20\text{dBm}$$

16. Set the receiver attenuator to the value calculated in the previous step (rounding off to the highest 5 dB step). Setting the receiver attenuation will establish the internal attenuation. In the **Stimulus** drop-down menu select **Power > Power and Attenuators**. In the dialog box, select **Receiver Attenuators**. Set Receiver A to **[10 dB]** and Receiver B to **[20 dB]** and select **OK**, see [Figure 30](#). Power levels greater than $+35$ dBm will require additional attenuation between Port 2 access ports CPLR ARM and RCVR B IN, see [Figure 29 on page 33](#).

Figure 30 Receiver Attenuator

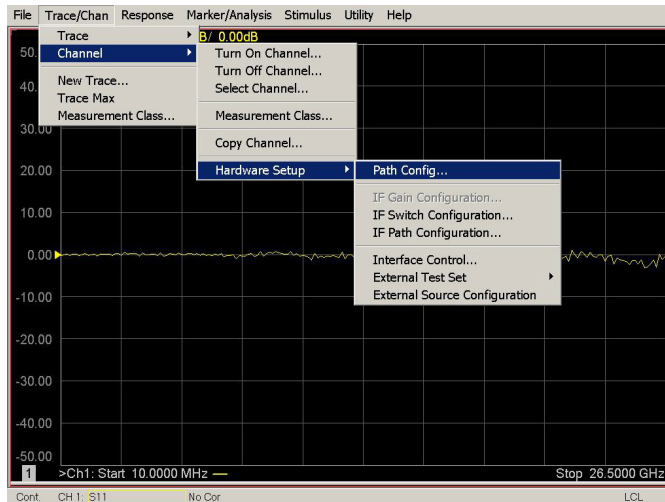


17. Turn On the booster amplifier.

CAUTION From this point forward, *do not* press Preset unless you have turned off the booster amplifier(s), or have renamed and saved this state as User Preset. Pressing Preset will return the analyzer to its default power level and default internal attenuator settings. This increase in power may result in damage to the DUT or analyzer.

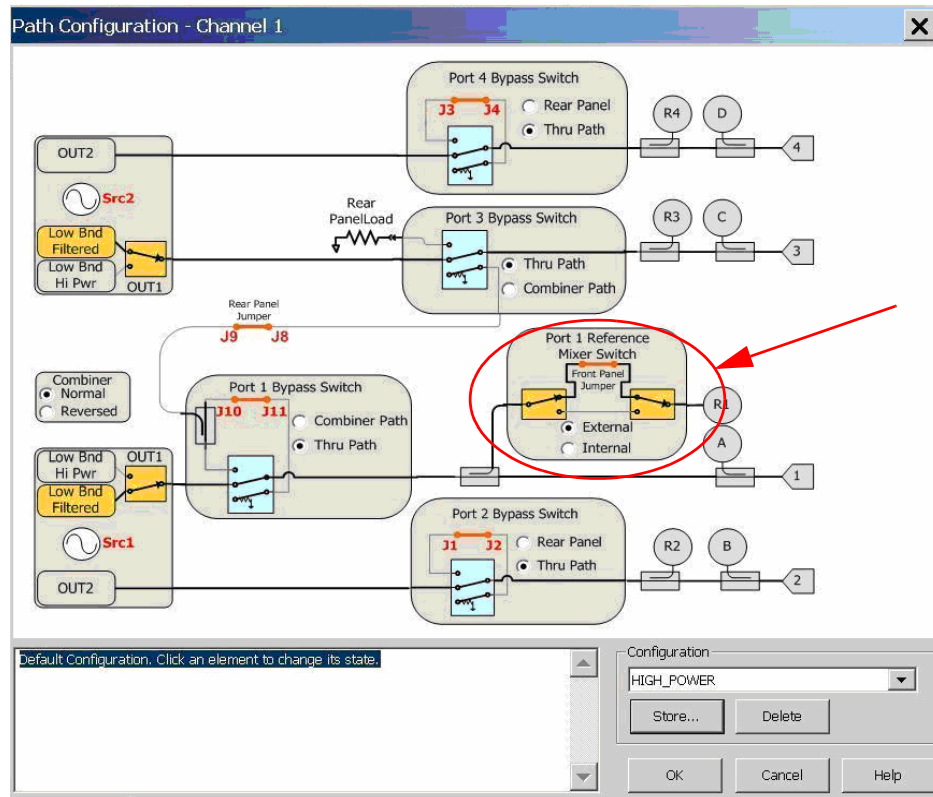
18. In the Trace/Chan drop-down menu select **Channel > Hardware Setup > Path Config.**

Figure 31 Trace/Chan



19. In the dialog box, select **Port 1 Reference Mixer Switch** > **External** and select **OK** to activate the R1 Input path.

Figure 32 Port 1 Mixer Switch



20. Measure the output power at Test Port 1, using a power meter. Verify the power measurement.

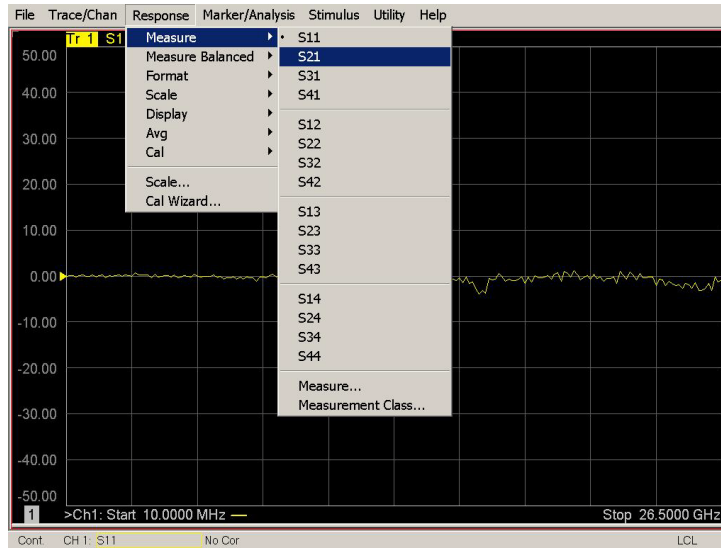
If you are measuring a highly reflective device, a high power isolators should be inserted between the 20 dB coupler and CPLR THRU front panel ports to protect Port 1 Source.

Final Setup

21. Verify that all of the power and attenuator settings are correct.

22. In the **Response** drop-down menu select **Measure > S21**.

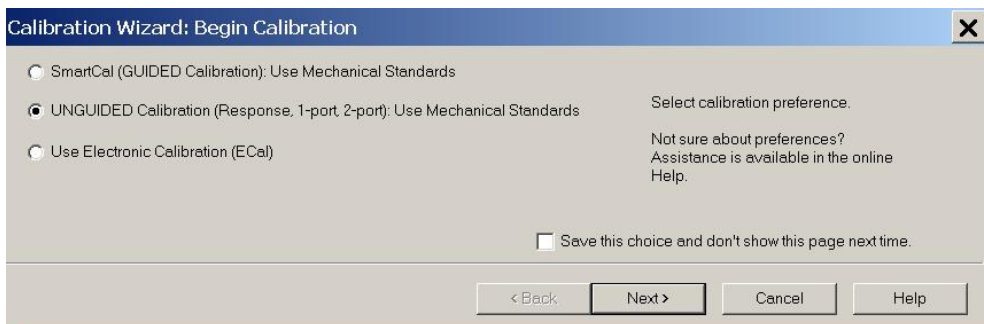
Figure 33 Response Menu



23. To Perform a response calibration following steps a, b, c and d:

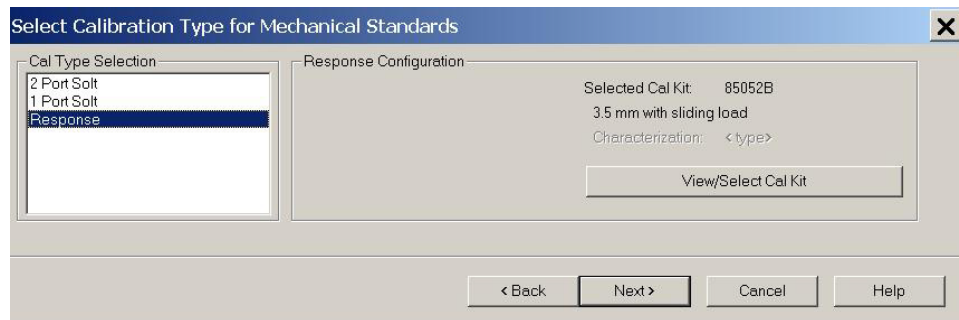
- a. Connect the test port cables of the analyzer to form a thru configuration.
- b. In the **Response** drop-down menu select **Cal Wizard** (see **Figure 33**). In the dialog box, select **UNGUIDED Calibration (Response, 1-port 2-port): Use Mechanical Standards > Next**.

Figure 34 Mechanical Standards



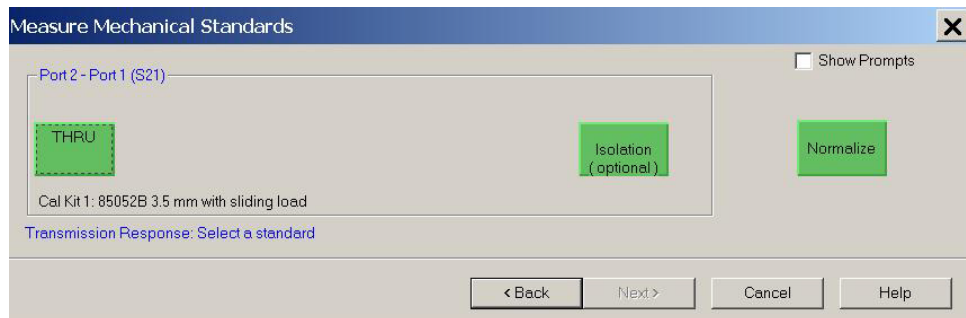
c. Select **Response** > **Next**.

Figure 35 Response



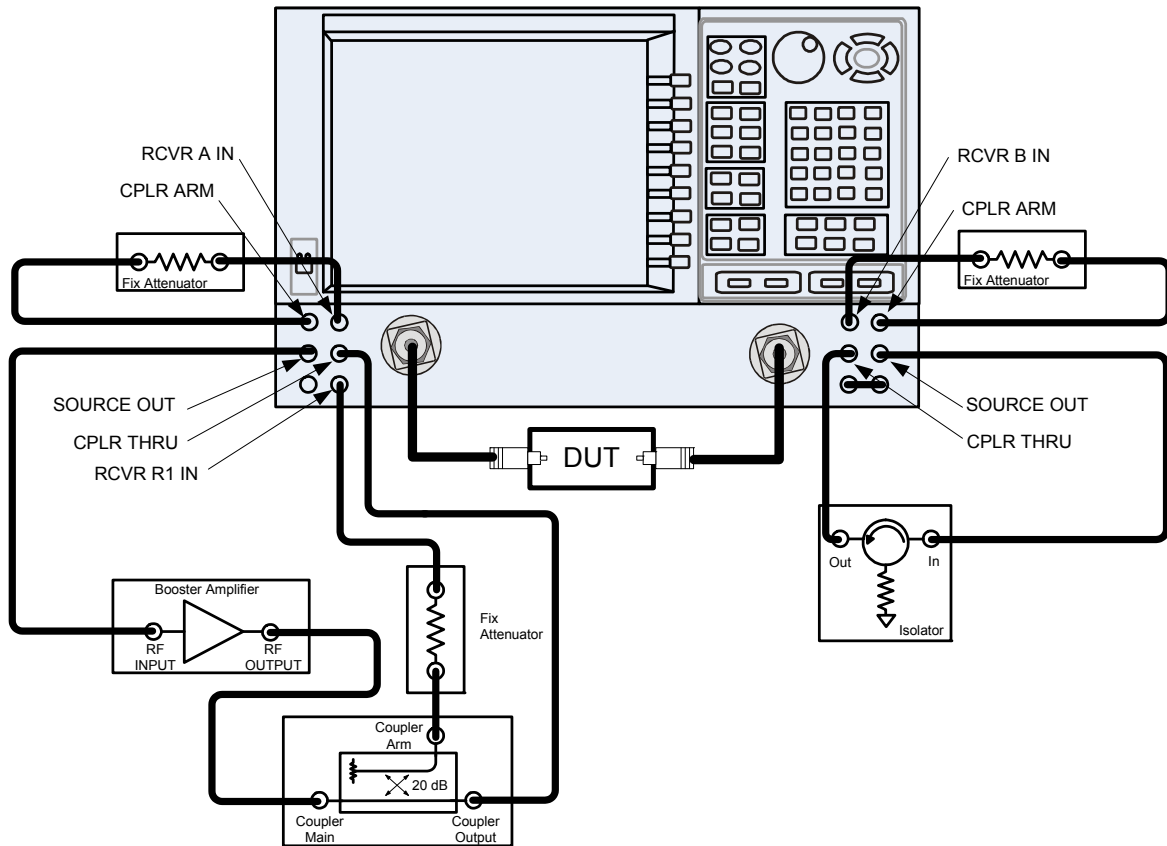
d. Select **THRU** > **Next**. Follow the analyzers window prompts to finish calibration.

Figure 36 Thru



24. Configure the test setup as shown in **Figure 37**. Turn On the DUT and measure the **S21** gain of the amplifier under test to confirm the proper operation of the measurement test setup.

Figure 37 Forward High Power Measurement Configuration



25. Continue with any other high power measurements.

NOTE Ratio measurements, such as gain, will be correctly displayed. However, the displayed absolute power levels on the analyzer will *not* be correct. To correctly interpret power levels and the gain of the booster amplifier, the attenuator setting must be taken into consideration.

If no calibration has been performed or if the instrument is in an un-calibrated state, the following must be taken into consideration when interpreting the measured data:

- The value of attenuation added to receiver A and B.
- The R channel reference level supplied from the coupler arm of the 20 dB coupler.

This procedure can be repeated to setup the reverse high power configuration.

Specifications

The N5241/42AS models are tested to the performance closest matching their configuration. Specifications for the N5241/42AS with Option H85 (Delete Bias Tees) are equivalent to the N5241/42A with Options 200/219 (2-Port PNA-X, Source/Receiver Attens + Bias Tees) or Options 400/419 (4-Port PNA-X, Source/Receiver Attens + Bias Tees). Deviations from these specifications are documented in this manual.

Specifications are both viewable and printable from the PNA-X Data Sheet. Visit our web site at <http://www.keysight.com/find/pna>, enter your analyzer model number (N5241A or N5242A) in the search field and select the data sheet or manual of your choice.

The specifications for Option H85, when configured in high power or large signal capability, are not tested nor guaranteed.

Definitions for Specifications

Specifications describe the warranted performance of calibrated instruments that have been stored for a minimum of 2 hours within the operating temperature range of 0 to 55°C, unless otherwise stated, and after a 45 minute warm-up period. Data represented in this document are specifications unless otherwise noted.

Characteristics describe product performance that is useful in the application of the product, but that is not covered by the product warranty. Characteristics are often referred to as *Typical* or *Nominal* values.

- **Nominal** describes representative performance that is useful in the application of the product when operated over a 20 to 30 °C temperature range. Nominal performance is not warranted.
- **Typical** describes characteristic performance, which 80% of instruments are expected to meet when operated over a 20 to 30 °C temperature range. Typical performance is not warranted.

Service Information

Information can be found in the Keysight 2-Port and 4-Port PNA-X Network Analyzers Data Sheet and Technical Specifications (N5242-90007). This document can be found using the our web site at <http://www.keysight.com/find/pna>, enter N5242-90007 in the search field.

Service information can be found in the Keysight N5241A or N5242A 2-Port and 4-Port PNA-X Microwave Network Analyzers Service Guide (N5242-90001). This document can be found using the our web site at <http://www.keysight.com/find/pna>, enter N5242-90001 in the search field. Replacement parts and procedures are listed “**Replaceable Parts**” on page 41.

The Keysight Technologies PNA-X Series Microwave Network Analyzers N5241/42A will display Options H85. Firmware Revision A.07.50.20 or higher must be used for this option. Service software is available for servicing the N5241/42A at local service centers.

Follow the N5241/42A Service Guide instructions for all repair, replacement procedures, tests and adjustments.

Replaceable Parts

NOTE Special options are built to order, so long lead times may be encountered when ordering replacement parts.

Reference Designator	PNA-X	Description	Keysight Part Number
Add:			
W11	N5241/42A-200	RF Cable: Port 1 CPLR THRU to A29 Test Port 1 Coupler	N5242-20111
W24	N5241/42A-200/029	RF Cable: Port 2 CPLR THRU to A32 Test Port 2 Coupler	N5242-20112
W12	N5241/42A-400	RF Cable: Port 1 CPLR THRU to A29 Test Port 1 Coupler	N5242-20055
W16	N5241/42A-400	RF Cable: Port 3 CPLR THRU to A30 Test Port 3 Coupler	N5242-20059
W24	N5241/42A-400/029	RF Cable: Port 2 CPLR THRU to A32 Test Port 2 Coupler	N5242-20063
W20	N5241/42A-400	RF Cable: Port 4 CPLR THRU to A31 Test Port 4 Coupler	N5242-20064
	N5241/42A-200/029	RF Cable: CPLR THRU to Switch, Port 1	N5242-20145
	N5241/42A-400/029	RF Cable: CPLR THRU to Switch, Port 1	N5242-20144
Delete:			
A38/A41	N5241/42A-219	Bias-tee with wire harness	5086-7239
A38/A39/A40/A41	N5241/42A-419	Bias-tee with wire harness	5086-7239
W73	All	RF Cable: Port 1 CPLR THRU to A38 Test Port 1 Bias-Tee	N5242-20039
W74	N5241/42A-219	RF Cable: A38 Test Port 1 Bias-Tee to A29 Test Port 1 Coupler	N5242-20115
W74	N5241/42AA-419	RF Cable: A38 Test Port 1 Bias-Tee to A29 Test Port 1 Coupler	N5242-20022
W85	All	RF Cable: Port 2 CPLR THRU to A41 Test Port 2 Bias-Tee	N5242-20045
W86	N5241/42A-219	RF Cable: A41 Test Port 2 Bias-Tee to A32 Test Port 2 Coupler	N5242-20108
W86	N5241/42A-419	RF Cable: A41 Test Port 2 Bias-Tee to A32 Test Port 2 Coupler	N5242-20023
W77	N5241/42A-419	RF Cable: Port 3 CPLR THRU to A39 Test Port 3 Bias-Tee	N5242-20026
W78	N5241/42A-419	RF Cable: A39 Test Port 3 Bias-Tee to A30 Test Port 3 Coupler	N5242-20021

Reference Designator	PNA-X	Description	Keysight Part Number
W81	N5241/42A-419	RF Cable: Port 4 CPLR THRU to A40 Test Port 4 Bias-Tee	N5242-20027
W82	N5241/42A-419	RF Cable: A40 Test Port 4 Bias-Tee to A31 Test Port 4 Coupler	N5242-20024
W11	N5241/42A-200/029	RF Cable: Port 1 CPLR THRU to A29 Test Port 1 Coupler	N5242-20111
W12	N5241/42A-400/029	RF Cable: Port 1 CPLR THRU to A29 Test Port 1 Coupler	N5242-20055

Safety and Information

Introduction

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument.

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Safety Earth Ground

WARNING This is a Safety Class I Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.

CAUTION Always use the three prong AC power cord supplied with this product. Failure to ensure adequate earth grounding by not using this cord may cause product damage and the risk of electrical shock.

Declaration of Conformity

A copy of the Declaration of Conformity is available upon request, or a copy is available on the Keysight Technologies web site at <http://regulations.corporate.keysight.com/DoC/search.htm>

Statement of Compliance

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Before Applying Power

Verify that the premises electrical supply is within the range of the instrument. The instrument has an autoranging power supply.

WARNING If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

CAUTION The Mains wiring and connectors shall be compatible with the connector used in the premise electrical system. Failure, to ensure adequate earth grounding by not using the correct components may cause product damage, and serious injury.

CAUTION Always use the three prong AC power cord supplied with this product. Failure to ensure adequate earth grounding by not using this cord may cause product damage and the risk of electrical shock.

CAUTION This product is designed for use in Installation Category II and Pollution Degree.

CAUTION Before switching on this instrument, make sure the supply voltage is in the specified range.

CAUTION Verify that the premise electrical voltage supply is within the range specified on the instrument.

CAUTION Ventilation Requirements: When installing the instrument in a cabinet, the convection into and out of the instrument must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the instrument by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, forced convection must be used.

-
- WARNING** Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended. Discard used batteries according to manufacturer's instructions.
-
- WARNING** For continued protection against fire hazard replace line fuse only with same type and rating. The use of other fuses or material is prohibited.
-
- WARNING** These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.
-
- WARNING** The opening of covers or removal of parts is likely to expose the user to dangerous voltages. Disconnect the instrument from all voltage sources before opening.
-
- WARNING** No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.
-
- WARNING** The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch (disconnecting device).
-

Connector Care and Cleaning Precautions

Remove the power cord to the instrument. To clean the connectors use alcohol in a well ventilated area. Allow all residual alcohol moisture to evaporate, and fumes to dissipate prior to energizing the instrument.

-
- WARNING** To prevent electrical shock, disconnect the Keysight N5241/42AS Option H85 from mains electrical supply before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.
-
- WARNING** If flammable cleaning materials are used, the material shall not be stored, or left open in the area of the equipment. Adequate ventilation shall be assured to prevent the combustion of fumes, or vapors.
-

Regulatory Information

This section contains information that is required by various government regulatory agencies.

Instrument Markings



The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.



The AC symbol indicates the required nature of the line module input power.



This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).



This symbol indicates that the power line switch is ON.



This symbol indicates that the power line switch is in the STANDBY position.



This symbol indicates that the power line switch is in the OFF position.



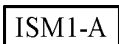
This symbol is used to identify a terminal which is internally connected to the product frame or chassis.



The CE mark is a registered trademark of the European Community. (If accompanied by a year, it is when the design was proven.)



The CSA mark is a registered trademark of the CSA International.



This mark designates the product is an Industrial Scientific and Medical Group 1 Class A product (reference CISPR 11, Clause 5)



This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001).



Direct Current.



The instrument has been designed to meet the requirements of IP 2 0 for ingress and operational environment.



The RCM mark is a registered trademark of the Australian Communications and Media Authority



Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.



This symbol on all primary and secondary packaging indicates compliance to China standard GB 18455-2001.



South Korean Certification (KC) mark; includes the marking's identifier code which follows the format: MSIP-REM-YYY-ZZZZZZZZZZZZZZ.

Battery Collection

Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Keysight Technologies for disposal. Refer to [“Contacting Keysight” on page 48](#) for assistance.

Electrical Safety Compliance

SAFETY

Complies with European Low Voltage Directive 2014/35/EU

- IEC/EN 61010-1:2010, 3rd Edition
- Canada: CSA C22.2 No. 61010-1-12
- USA: UL std no. 61010-1, 3rd Edition
- Acoustic statement (European Machinery Directive 2022/42/EC, 1.7.4.2U)
 Acoustical noise emission
 LpA < 70 dB
 Operator position
 Normal operation mode
 Per ISO 7779

EMI and EMC Compliance

EMC

Complies with European EMC Directive 2014/30/EU

- IIEC 61326-1:2012/EN 61326-1:2013
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11:2011
- ICES/NMB-001
 This ISM device complies with Canadian ICES-001.
 Cet appareil ISM est conforme a la norme NMB du Canada.
- South Korean Class A EMC declaration: This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

A 급 기기 (업무용 방송통신기자재) 이 기기는 업무용 (A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으로 합니다 .

Keysight Support, Services, and Assistance

Service and Support Options

There are many other repair and calibration options available from the Keysight Technologies support organization. These options cover a range of service agreements with varying response times. Contact Keysight for additional information on available service agreements for this product.

Contacting Keysight

Assistance with test and measurement needs, and information on finding a local Keysight office are available on the Internet at:

<http://www.keysight.com/find/assist>

You can also purchase accessories or documentation items on the Internet at:

<http://www.keysight.com/find>

If you do not have access to the Internet, contact your field engineer.

NOTE In any correspondence or telephone conversation, refer to the Keysight product by its model number and full serial number. With this information, the Keysight representative can determine the warranty status of your unit.

Shipping Your Product to Keysight for Service or Repair

IMPORTANT Keysight Technologies reserves the right to reformat or replace the internal hard disk drive in your analyzer as part of its repair. This will erase all user information stored on the hard disk. It is imperative, therefore, that you make a backup copy of your critical test data located on the analyzer's hard disk before shipping it to Keysight for repair.

If you wish to send your instrument to Keysight Technologies for service or repair:

- Include a complete description of the service requested or of the failure and a description of any failed test and any error message.
- Remove and retain the front handles and all rack mount hardware. The analyzer should be sent to Keysight in the same configuration as it was originally shipped.
- Remove and retain the front handles and all rack mount hardware. The analyzer should be sent to Keysight in the same configuration as it was originally shipped.
- Contact Keysight for instructions on where to ship your analyzer.