

# **Agilent Technologies N5244/45AS Option H86**

## **User's and Service Guide**

**Microwave PNA-X Series High Power Configurable Test Set**

PNA Series Network Analyzer On-line Help System

Application Note 1408-10



**Agilent Technologies**

**Manufacturing Part Number: N5245-90017**

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<b>CAUTION</b>	Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.
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- *Specifications* describe the performance of parameters covered by the product warranty (temperature –0 to 55 °C, unless otherwise noted.)
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# Contents

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# **N5244/45AS Option H86**

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## Introduction

This document describes the differences between the standard N5244/45A and the N5244/45AS Option H86 PNA-X Series Network Analyzer. For more technical information refer to Agilent PNA-X Network Analyzer Data Sheet and Technical Specifications (N5245-90008).

Information can be viewed or printed regarding the N5244/45A PNA-X Series Network Analyzer Data sheets, white papers, or manuals by visiting our web site at <http://www.agilent.com/find/pna>, or by typing N5244A or N5245A in the search field.

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## Description

The Agilent N5244/45AS Option H86 is a modified version of the standard N5244/45A PNA-X Series Network Analyzer. The Option H86 provides rear panel access to insert a device in the source path of the network analyzer, and to enable configurations for high power network measurements. This enables measurements with RF levels up to 20 watts (+43 dBm) from 10 MHz to 50 GHz. The Option H86 modification supplies extended power range attenuators *without* bias tees, source combiner and adds source path switches for Ports 1 and 2. The Option H86 is not available with Option 400 (4-Port configuration).

Option H86 includes Option 286 (adds extended power range (no bias tees) and Option 219 (Source/Receiver Attens + Bias Tees).

The Option H86 does not increase the output power of the PNA-X. This option only allows the PNA-X 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 H86. 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 guidelines in [Table 1 on page 5](#).

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**NOTE** The Bias Tee's are removed from the Option H86 to allow high power operation. Specifications for the Agilent N5244/45AS Option H86, when configured in Standard Configuration, are the same as those of an N5244/45A PNA-X Series Network Analyzer with Options N5244/45A-219.

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## Identifying the Options in Your N5244/45AS PNA-X

Your 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 PNA-X. Specifications, characteristics, or typical values, are based, leveraged or derived from the performance of the standard PNA-X network analyzers and their options.

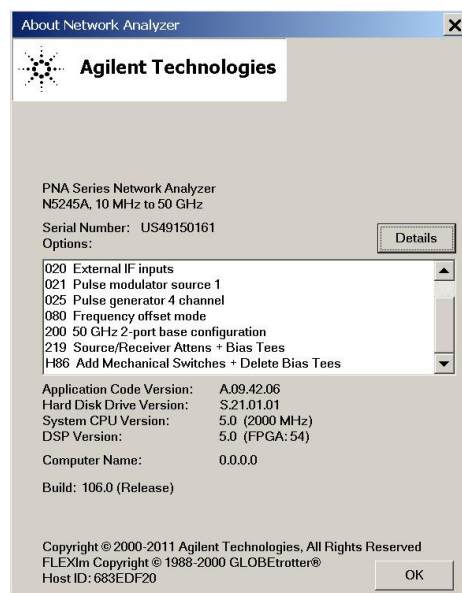
Ordering configurations and rear panel serial tags will differ from the standard model number and options indicated on the network analyzer front panel, and option field window of the instrument. When ordering and enabling Option H86, Option 219 is shown in the [Figure 2](#) in addition to the other options ordered.

- 200 50 GHz 2-Port base configuration<sup>1</sup>
- 219 Source/Receiver Attens + Bias Tees
- H86 Mechanical Switches - Delete Bias Tees
- 286 Extended power range for a 2-Port analyzer (no bias tees)

**Figure 1** Serial Tag



**Figure 2** About Network Analyzer



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

## Specifications

Specifications for Option H86 are the same as the standard PNA-X with Option 219. The following specifications are available from the PNA-X Data Sheet at our web site:

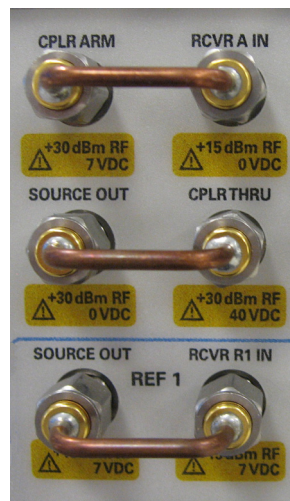
<http://www.agilent.com/find/pna>

- Measurement Receiver Inputs
- R1 Reference Receiver Inputs
- R2 Reference Receiver Inputs
- R1 Source Outputs
- R2 Source Outputs
- Source Outputs
- Coupler Inputs<sup>1</sup>
- Coupler Outputs
- Test Port Inputs
- Rear Panel Source Path Input/Output

**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 3 Front Panel Jumpers**



1. Port 1 through Port 4 Insertion Loss of Coupler Thru specifications are the same as the standard Option 200. Refer to the Agilent 2-Port PNA-X Network Analyzer Data Sheet and Technical Specifications (N5245-90008). The maximum DC Level is 0 VDC.

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

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The following tables specify the receiver damage levels for the N5244/45AS Option H86.

**Table 1 Damage Power Levels**

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

**Table 1      Damage Power Levels**

Maximum DC Level	0 V
<b>Coupler Output:</b>	
Port 1 CPLR ARM through Port 2 @ Max Specified Output Power	
Damage Input Level	+30 dBm
Maximum DC Level	± 7 V
<b>Test Port Input:</b>	
Test Port 1 through Port 2 @ Max Specified Output Power	
Damage Level	+43 dBm (without jumpers) +30 dBm (with jumpers)
Maximum DC Level	0 V
<b>Rear Panel:</b>	
SW TEST IN (J1)	+30 dBm, 0 V
SW SRC OUT (J2)	+30 dBm, 0 V
COMB IN (J10)	+30 dBm, 0 V
SW SRC OUT (J11)	+30 dBm, 0 V

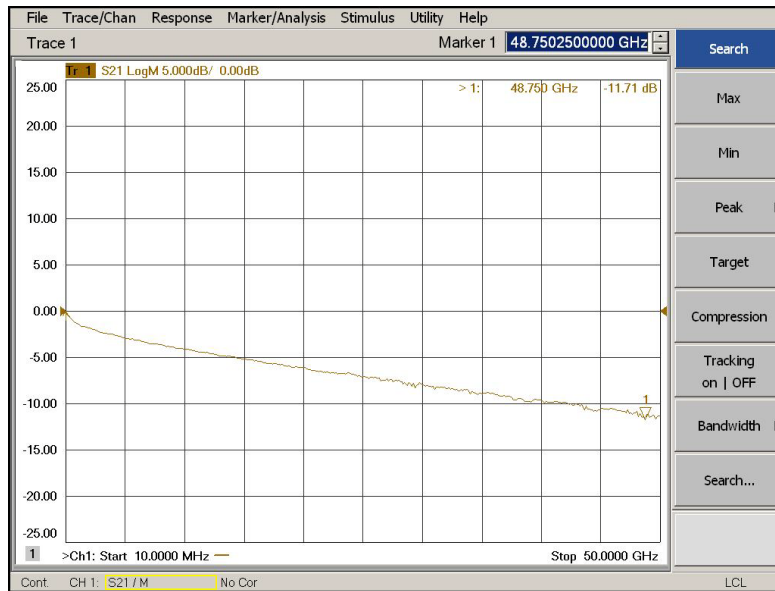
**Table 2      Watts to dBm Reference Table**

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

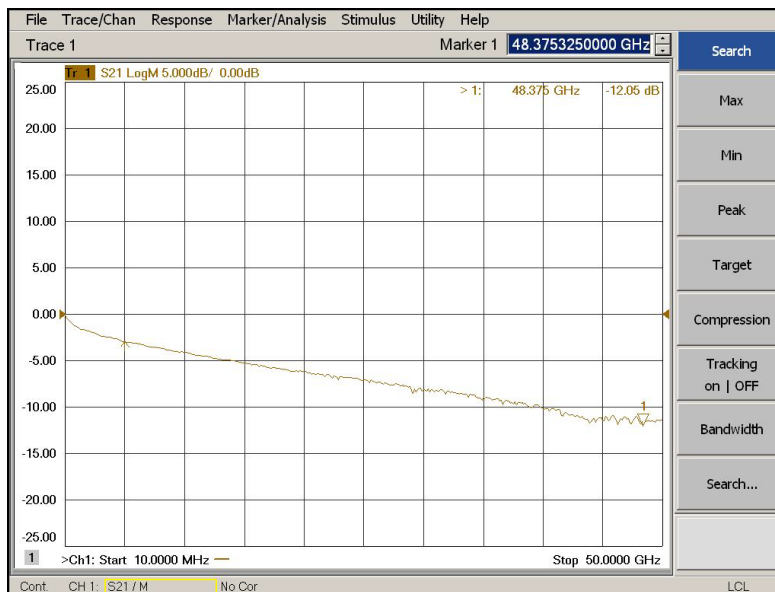
**Table 3 Frequency Band-Crossing**

Band	Mixer Brick L.O. Harmonic Number	(1)	(2)	(3)	(4)	(5)
		A15 Synthesizer Frequency (GHz)	A25 HMA26.5 Frequency (GHz)	A4/A17 Synthesizer Frequency (GHz)	A5/A10 Source Frequency (GHz)	A7/A8/A12/A13 50 GHz Doubler Frequency (GHz)
0	-	-	-	-	-	-
1	-	-	-	-	-	-
2	1	0.01254 to 0.01654	0.01254 to 0.01654	0.010 to 0.014	0.010 to 0.014	0.010 to 0.014
3	1	0.01654 to 0.02154	0.01654 to 0.02154	0.014 to 0.019	0.014 to 0.019	0.014 to 0.019
4	1	0.02154 to 0.02954	0.02154 to 0.02954	0.019 to 0.027	0.019 to 0.027	0.019 to 0.027
5	1	0.02954 to 0.04054	0.02954 to 0.04054	0.027 to 0.038	0.027 to 0.038	0.027 to 0.038
6	1	0.04054 to 0.05554	0.04054 to 0.05554	0.038 to 0.053	0.038 to 0.053	0.038 to 0.053
7	1	0.06061 to 0.08261	0.06061 to 0.08261	0.053 to 0.075	0.053 to 0.075	0.053 to 0.075
8	1	0.08261 to 0.11261	0.08261 to 0.11261	0.075 to 0.105	0.075 to 0.105	0.075 to 0.105
9	1	0.11261 to 0.15361	0.11261 to 0.15361	0.105 to 0.146	0.105 to 0.146	0.105 to 0.146
10	1	0.15361 to 0.21261	0.15361 to 0.21261	0.146 to 0.205	0.146 to 0.205	0.146 to 0.205
11	1	0.21261 to 0.25761	0.21261 to 0.25761	0.205 to 0.250	0.205 to 0.250	0.205 to 0.250
12	1	0.25761 to 0.40361	0.25761 to 0.40361	0.250 to 0.396	0.250 to 0.396	0.250 to 0.396
13	1	0.40361 to 0.50761	0.40361 to 0.50761	0.396 to 0.500	0.396 to 0.500	0.396 to 0.500
14	1	0.50761 to 0.63561	0.50761 to 0.63561	0.500 to 0.628	0.500 to 0.628	0.500 to 0.628
15	1	0.63561 to 1.00761	0.63561 to 1.00761	0.628 to 1.000	0.628 to 1.000	0.628 to 1.000
16	1	1.00761 to 1.50761	1.00761 to 1.50761	1.000 to 1.500	1.000 to 1.500	1.000 to 1.500
17	1	1.50761 to 2.00761	1.50761 to 2.00761	1.500 to 2.000	1.500 to 2.000	1.500 to 2.000
18	1	2.00761 to 3.00761	2.00761 to 3.00761	2.000 to 3.000	2.000 to 3.000	2.000 to 3.000
19	1	3.00761 to 3.20761	3.00761 to 3.20761	3.000 to 3.200	3.000 to 3.200	3.000 to 3.200
20	1	3.20761 to 4.00761	3.20761 to 4.00761	3.200 to 4.000	3.200 to 4.000	3.200 to 4.000
21	1	4.00761 to 5.33961	4.00761 to 5.33961	4.000 to 5.332	4.000 to 5.332	4.000 to 5.332
22	1	5.33961 to 6.75961	5.33961 to 6.75961	5.332 to 6.752	5.332 to 6.752	5.332 to 6.752
23	1	6.75961 to 8.00761	6.75961 to 8.00761	6.752 to 8.000	6.752 to 8.000	6.752 to 8.000
24	1	8.00761 to 8.50761	8.00761 to 8.50761	8.000 to 8.500	8.000 to 8.500	8.000 to 8.500
25	1	8.50761 to 10.67161	8.50761 to 10.67161	8.500 to 10.664	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	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	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	12.800 to 13.510
29	1	6.75880 to 7.70380	13.51761 to 15.40761	6.755 to 7.700	13.510 to 15.400	13.510 to 15.400
30	1	7.70380 to 8.00380	15.40761 to 16.00761	7.700 to 8.000	15.400 to 16.000	15.400 to 16.000
31	1	8.00380 to 9.50380	16.00761 to 19.00761	8.000 to 9.500	16.000 to 19.000	16.000 to 19.000
32	1	9.50380 to 10.00380	19.00761 to 20.00761	9.500 to 10.000	9.500 to 10.000	19.000 to 20.000
33	1	10.00380 to 10.66781	20.00761 to 21.33561	10.000 to 10.664	10.000 to 10.664	20.000 to 21.328
34	1	10.66781 to 12.00381	21.33561 to 24.00761	10.664 to 12.000	10.664 to 12.000	21.328 to 24.000
35	1	12.00381 to 13.25381	24.00761 to 26.50761	12.000 to 13.250	12.000 to 13.250	24.000 to 26.500
36	3	8.83587 to 9.00520	8.83587 to 9.00520	13.250 to 13.504	13.250 to 13.504	26.500 to 27.008
37	3	9.00520 to 10.66920	9.00520 to 10.66920	6.752 to 8.000	13.504 to 16.000	27.008 to 32.000
38	3	10.66920 to 12.16920	10.66920 to 12.16920	8.000 to 9.125	16.000 to 18.250	32.000 to 36.500
39	3	12.16920 to 13.50254	12.16920 to 13.50254	9.125 to 10.125	18.250 to 20.250	36.500 to 40.500
40	3	6.75127 to 7.11060	13.50254 to 14.22120	10.125 to 10.664	20.250 to 21.328	40.500 to 42.656
41	3	7.11060 to 7.25127	14.22120 to 14.50254	10.664 to 10.875	21.328 to 21.750	42.656 to 43.500
42	3	7.25127 to 7.70127	14.50254 to 15.40254	10.875 to 11.550	21.750 to 23.100	43.500 to 46.200
43	3	7.70127 to 8.00127	15.40254 to 16.00254	11.550 to 12.000	23.100 to 24.000	46.200 to 48.000
44	3	8.00127 to 8.33460	16.00254 to 16.66920	12.000 to 12.500	24.000 to 25.000	48.000 to 50.000

**Figure 4 Source Path Loss from J11 to Port 1 Test Port**



**Figure 5 Source Path Loss from J2 to Port 2 Test Port**



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## Using Rear Panel Source Paths

The Port 1 and Port 2 source paths can be configured to route the source signal through the rear panel access jumpers allowing you to insert a device, such as an amplifier into the path. You may send the following commands or use the path configuration window to select the source paths. Refer to the system Help menu for further information.

### Controlling with SCPI Commands

- To set Port 1 source path to the rear panel send command;  
SENSE:PATH:CONF:ELEMENT:STATE "Port1Bypass","Combiner".
- To set Port 1 source path to bypass the rear panel send command;  
SENSE:PATH:CONF:ELEMENT:STATE "Port1Bypass","Thru".
- To set Port 2 source path to the rear panel send command;  
SENSE:PATH:CONF:ELEMENT:STATE "Port2Bypass","RearPanel".
- To set Port 2 source path to bypass the rear panel send command;  
SENSE:PATH:CONF:ELEMENT:STATE "Port2Bypass","Thru".

### Controlling with Path Configuration Dialog Box

Select **Channel > Hardware Setup > Path Config**. Refer to [Figure 7 on page 10](#).

- To set Port 1 source path to the rear panel select **Combiner Path** in the Port 1 Bypass Switch dialog box.
- To set Port 1 source path to bypass the rear panel select **Thru Path** in the Port 1 Bypass Switch dialog box.
- To set Port 2 source path to the rear panel select **Rear Panel** in the Port 2 Bypass Switch dialog box.
- To set Port 2 source path to bypass the rear panel select **Thru Path** in the Port 2 Bypass Switch dialog box.

## Connecting the Device to Rear Panel Source Path

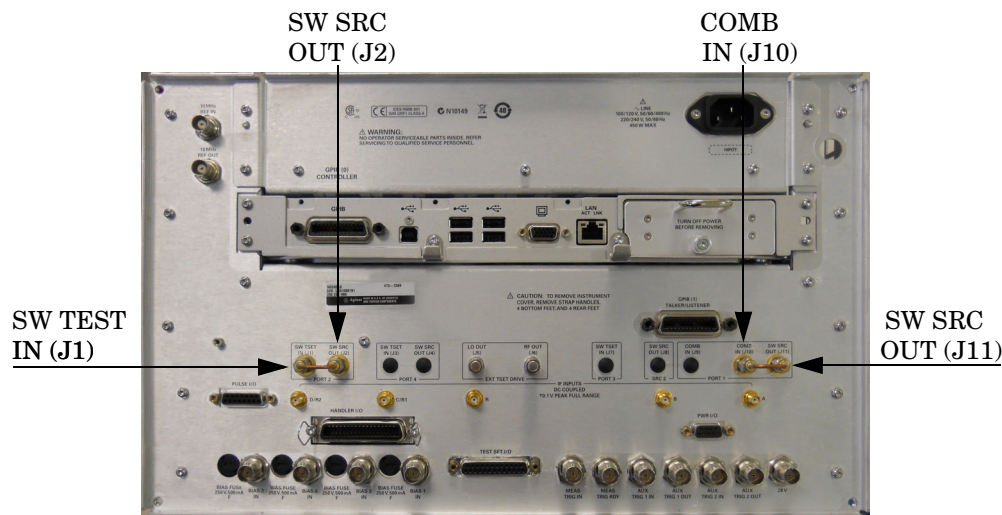
1. Connect the device input to SW SRC OUT J2 or J11.
2. Connect the device output to COMB IN (J10) or SW TSET IN (J11).

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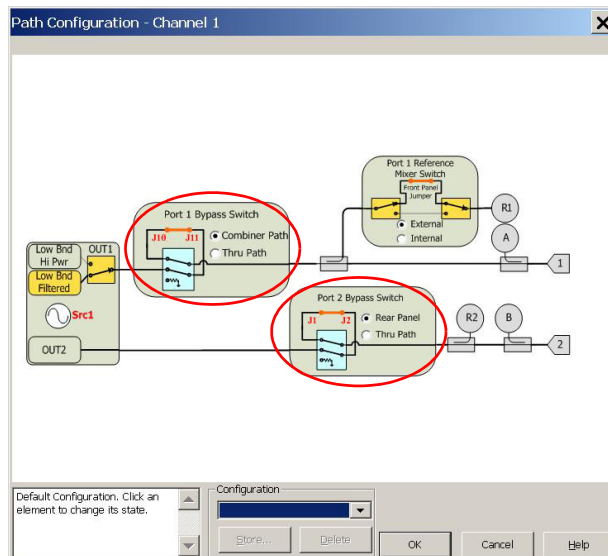
**CAUTION** Maximum RF power level is 30 dBm. Do not apply DC voltage on the source paths connectors when using the rear panel source paths (Port1, J10 & J11, Ports 2, J1 & J2) or damage to the source path attenuator can occur.

---

**Figure 6 N5244/45AS Option H86 Rear Panel**



**Figure 7 Port 1 and Port 2 Bypass Switch**



3. Perform a Source Cal to correct the power. Refer to [Figure 4](#) and [Figure 5](#) on page 8 to determine the power levels.



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## High Power Configuration

The Agilent Option H86 can be configured differently for many applications. Included in this manual are three typical high power configurations:

- [Figure 10, “2-Port, Two-Way High Power Configuration.”](#)
- [Figure 12, “2-Port, One-Way High Power Configuration.”](#)
- [Figure 14, “2-Port Forward DUT Configuration.”](#)

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**NOTE** The internal firmware of the PNA-X has not been modified for this option. The power levels indicated on the Agilent N5244/45AS Option H86 may differ depending on the user configuration that is chosen.

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Refer to the configuration diagrams for external component connections and/or operating constraints when utilizing the high power capability of the Agilent N5244/45AS Option H86. External components are not supplied with this option.

When using the Agilent N5244/45AS Option H86 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 24 on page 27](#). In the path configuration dialog box, select **Port 1 Reference Mixer Switch > External**, then click **OK** to activate the R1 Input path. See [Figure 25 on page 28](#).

---

**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 and 2 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 5](#).

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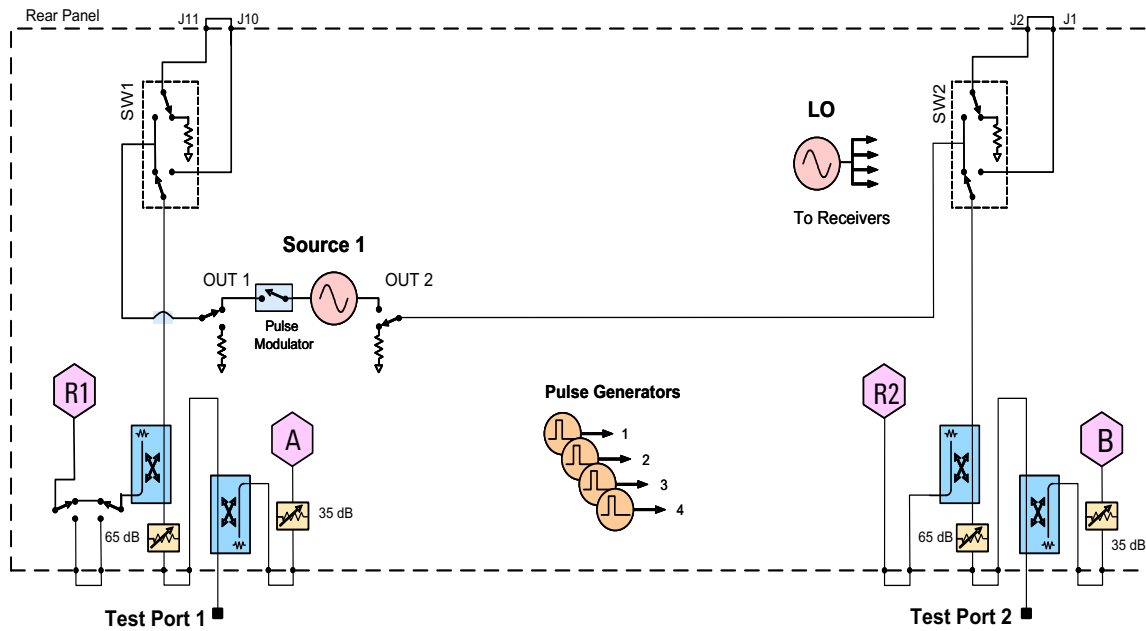
**CAUTION** Prior to powering-up the booster amplifier, it is highly recommended that the user verify the RF power levels seen by the various elements of the test setup. At high power levels an incorrect power level could permanently damage the instrument. Refer to [Table 1 on page 5](#).

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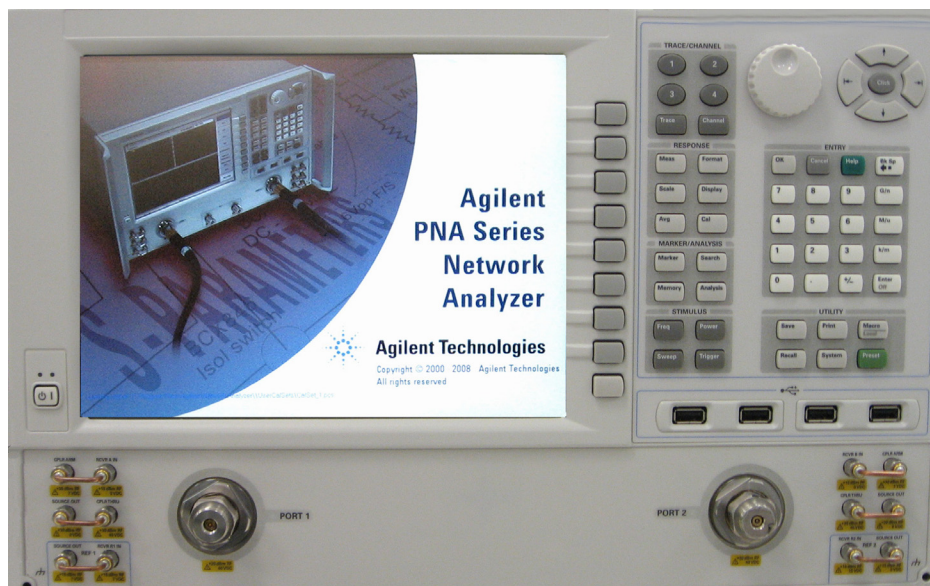
**CAUTION** To reduce risk of damaging the PNA-X or your device, reduce the initial power setting to -65 dBm at the test port. The microwave PNA-X has 44 frequency bands. The firmware turns off the RF power level during band-crossings. If you are testing a high-gain device with an ALC when the PNA-X 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 7](#).

---

**Figure 8 N5244/45AS Option 200 and H86 RF Block Diagram**



**Figure 9 2-Port Front Panel**



### 2-Port, Two-Way High Power Configuration

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 10](#) and [Figure 11](#) on page 14.

**Figure 10 2-Port, Two-Way High Power Configuration**

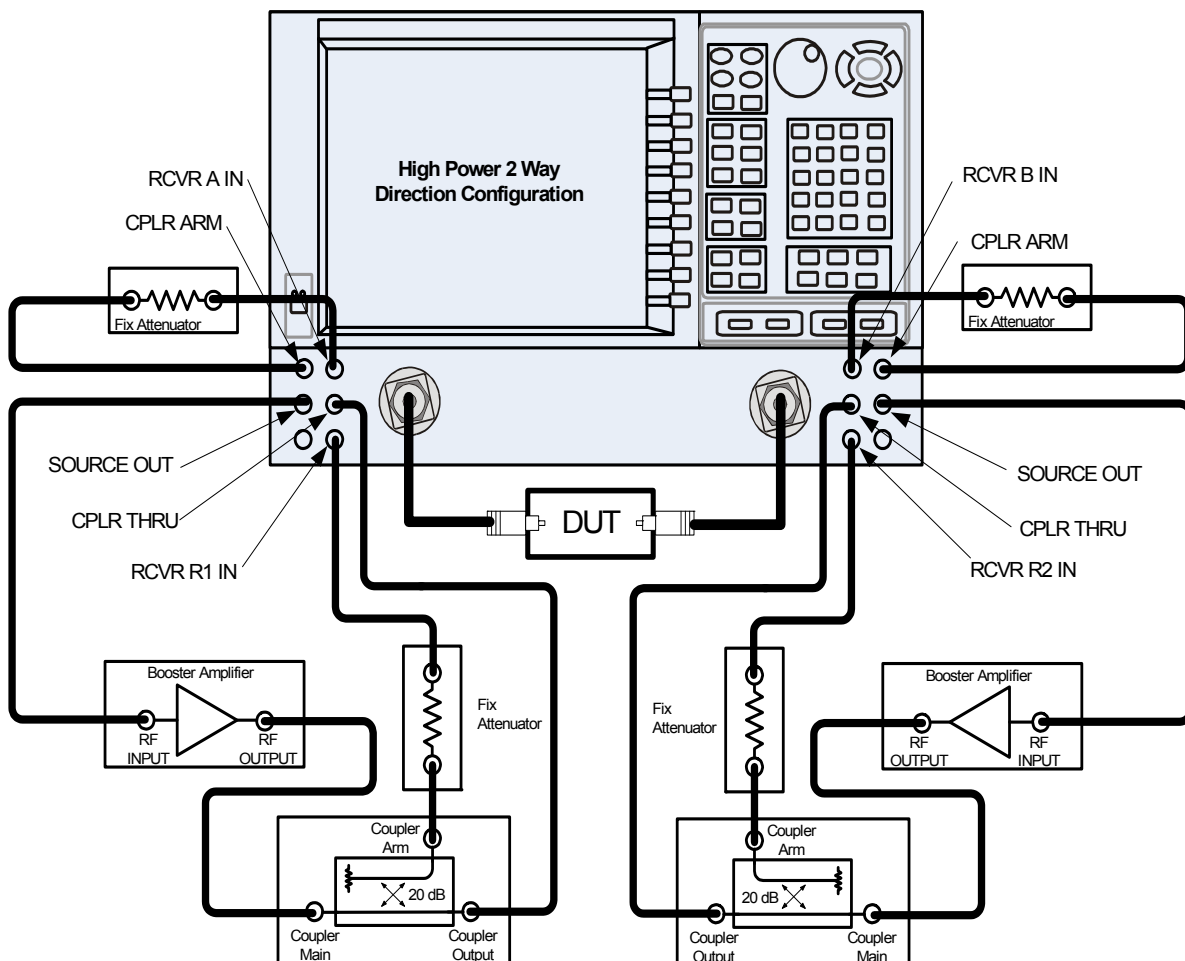
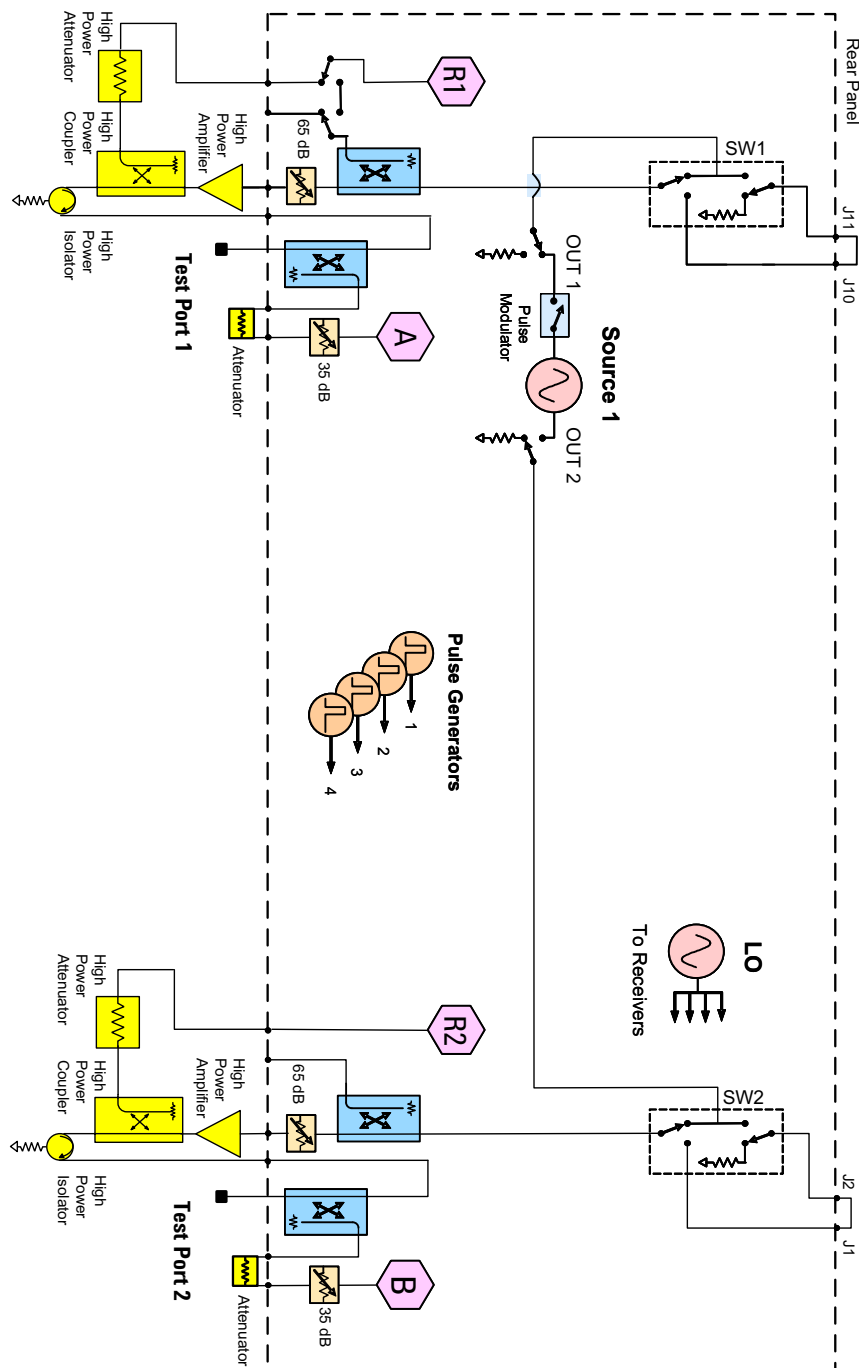


Figure 11 2-Port, Two-Way High Power Block Diagram



### 2-Port, One-Way High Power Configuration

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 12](#) and [Figure 13](#) on page 16.

**Figure 12 2-Port, One-Way High Power Configuration**

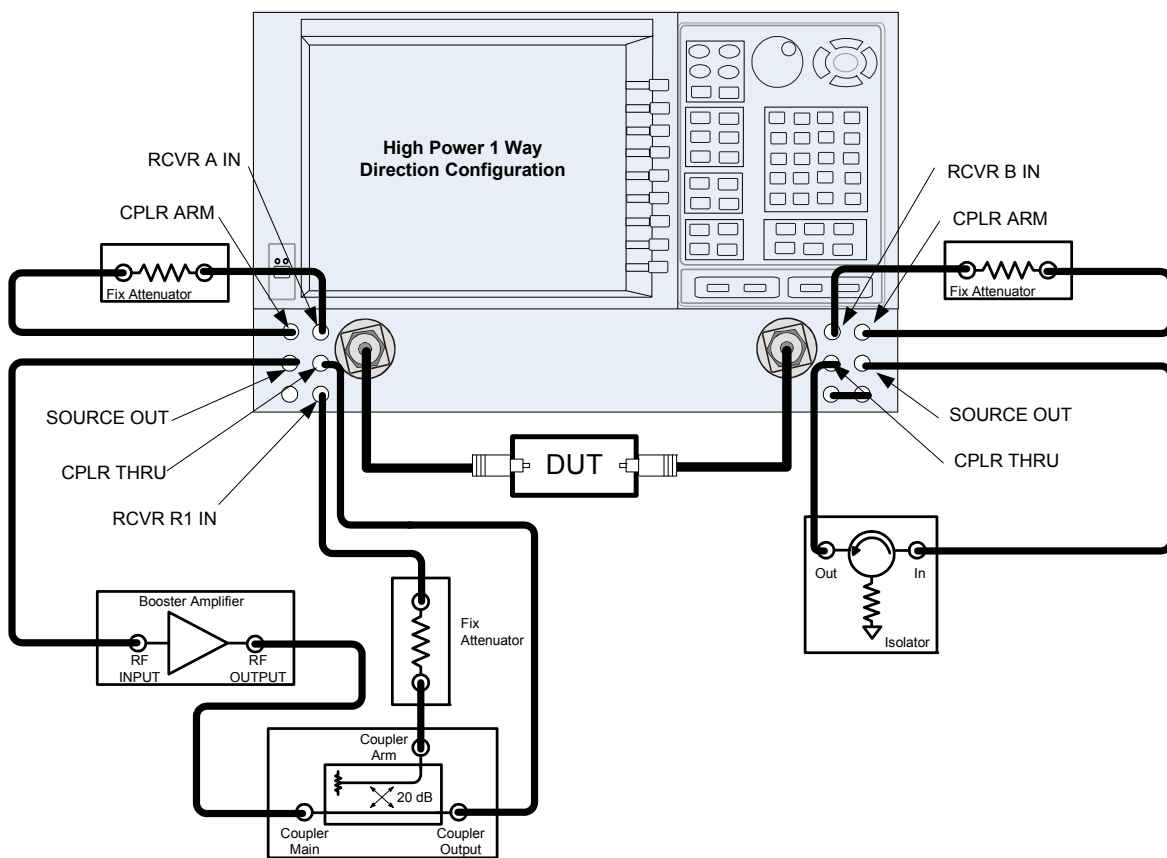
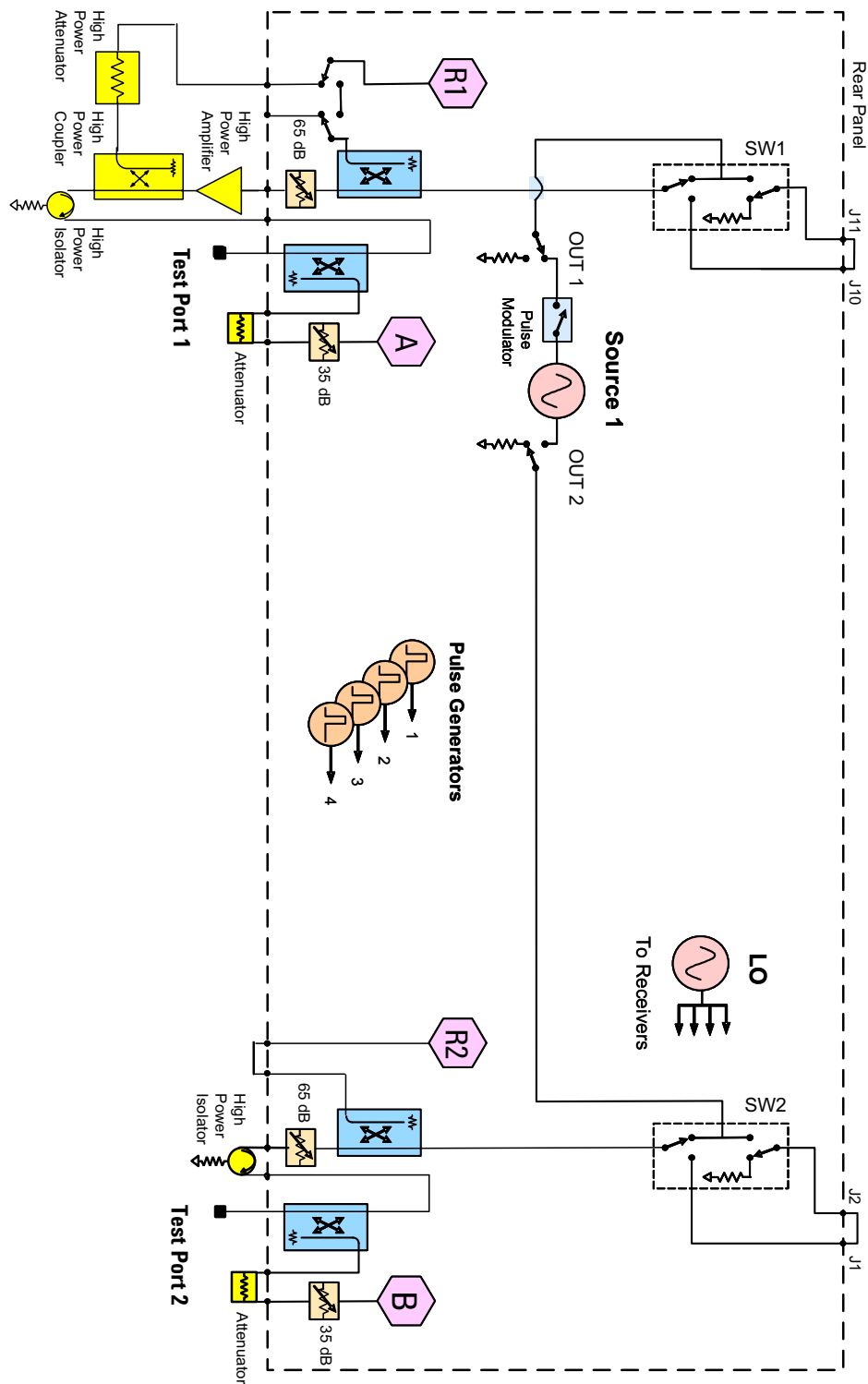


Figure 13 2-Port, One-Way High Power Block Diagram



### 2-Port Forward DUT Configuration

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 14](#) and [Figure 15 on page 18](#).

**Figure 14 2-Port Forward DUT Configuration**

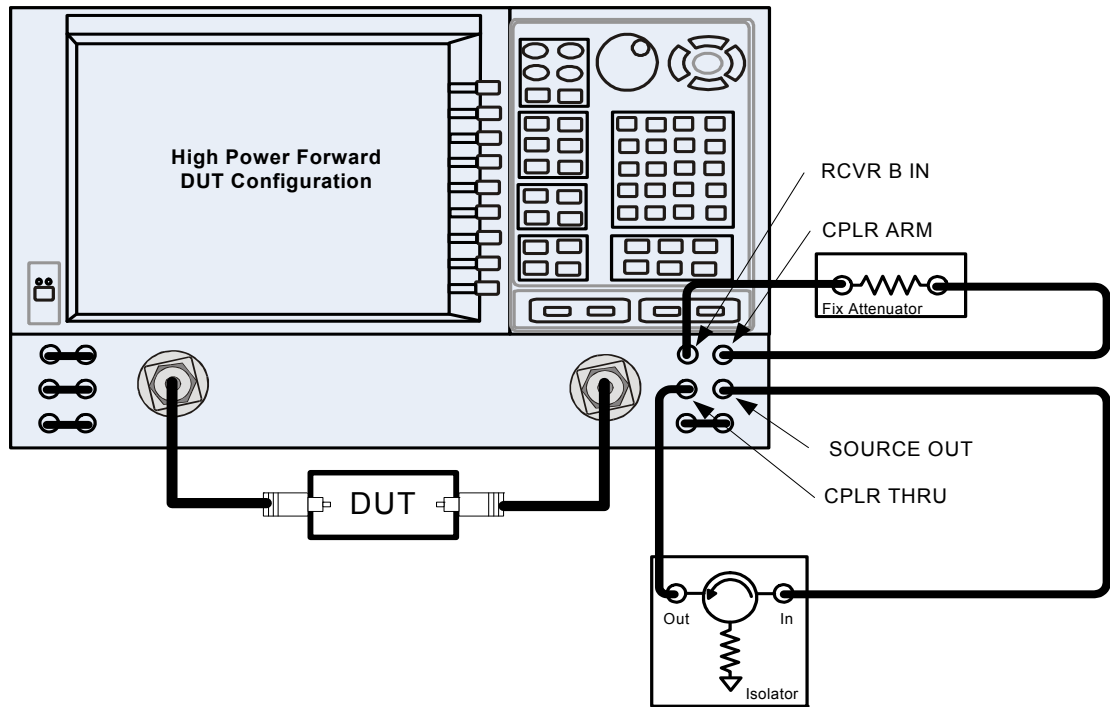
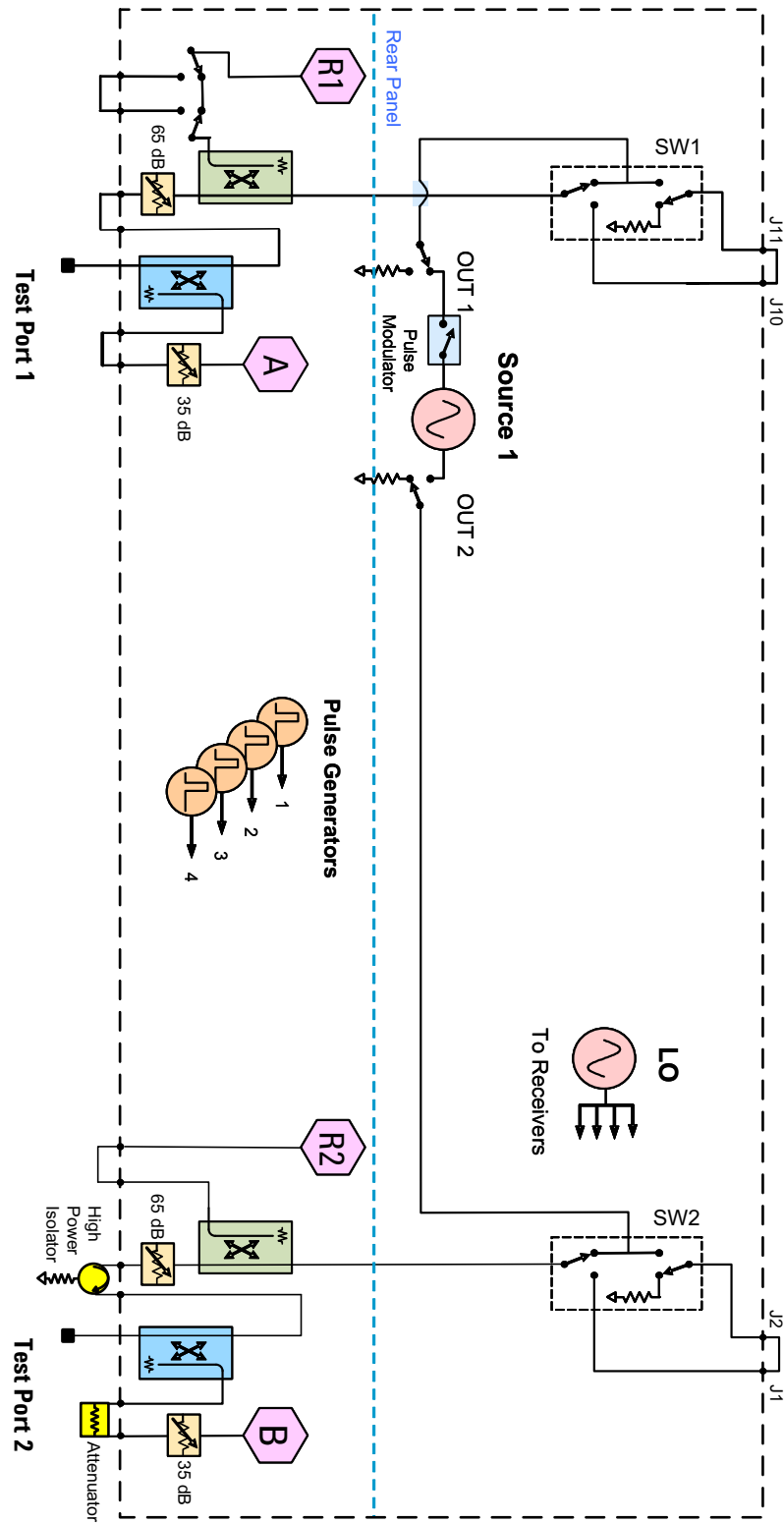


Figure 15 2-Port Forward DUT Block Diagram





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## Example: High Power Measurements With Option H86

This section describes how to set up the analyzer to perform high power measurements. Analyzers equipped with the Option H86 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 5](#).

### Typeface Key Conventions

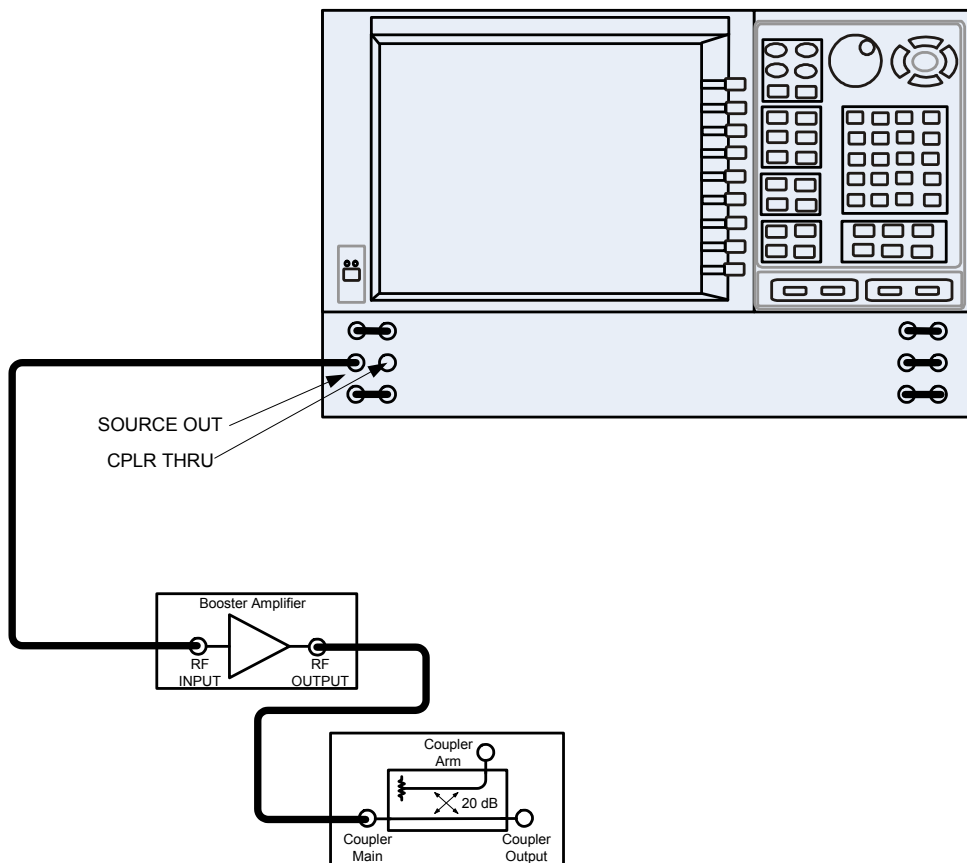
The following key conventions are used throughout this document.

- **[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 16](#).
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 16** Booster Amplifier and 20 dB Coupler Connection Setup



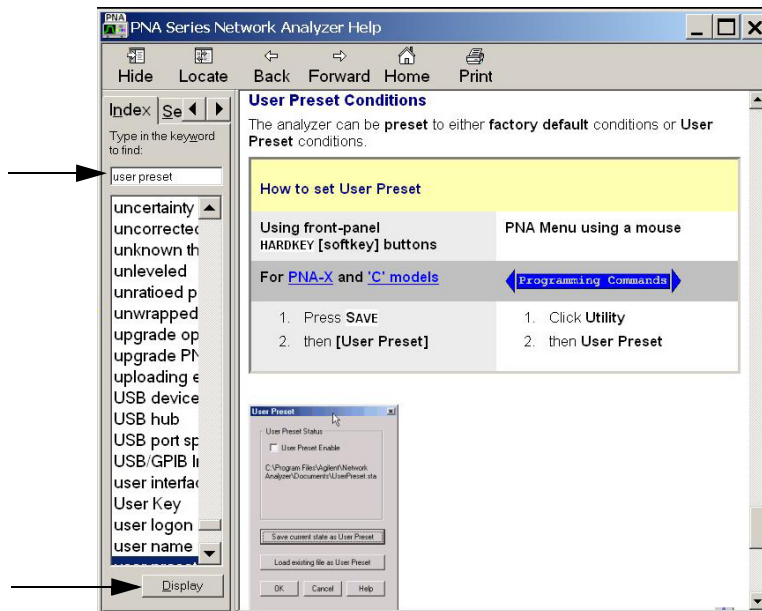
## Determining Power Levels

**NOTE** For all high power configurations refer to [Table 1 on page 5](#) 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.

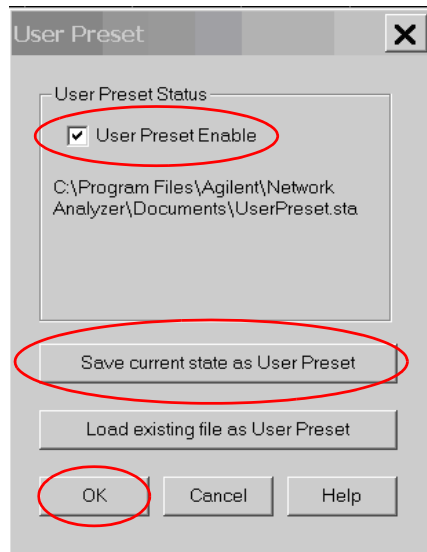
**Figure 17 Help Menu**



To find the User Preset:

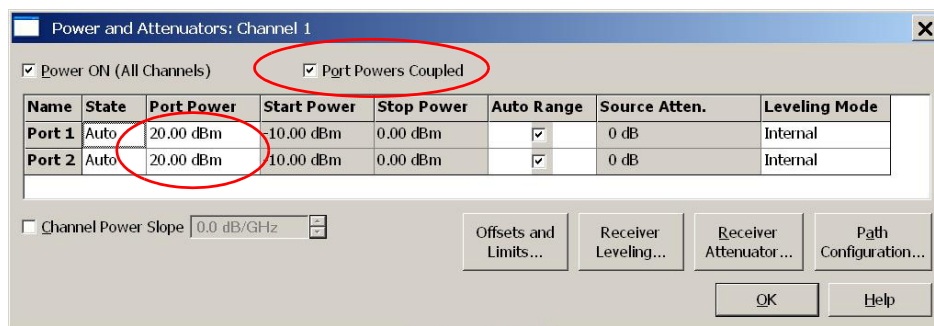
- In the **Utility** drop-down menu select **User Preset**. Select the **User Preset Enable** check box and **Save current state as User Preset** > **OK**.

**Figure 18** 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** check box is selected to ensure that Port 1 and Port 2 power levels are the same, then click **OK**. Uncoupled ports should be used when adjusting the S12 power level.

**Figure 19** 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.

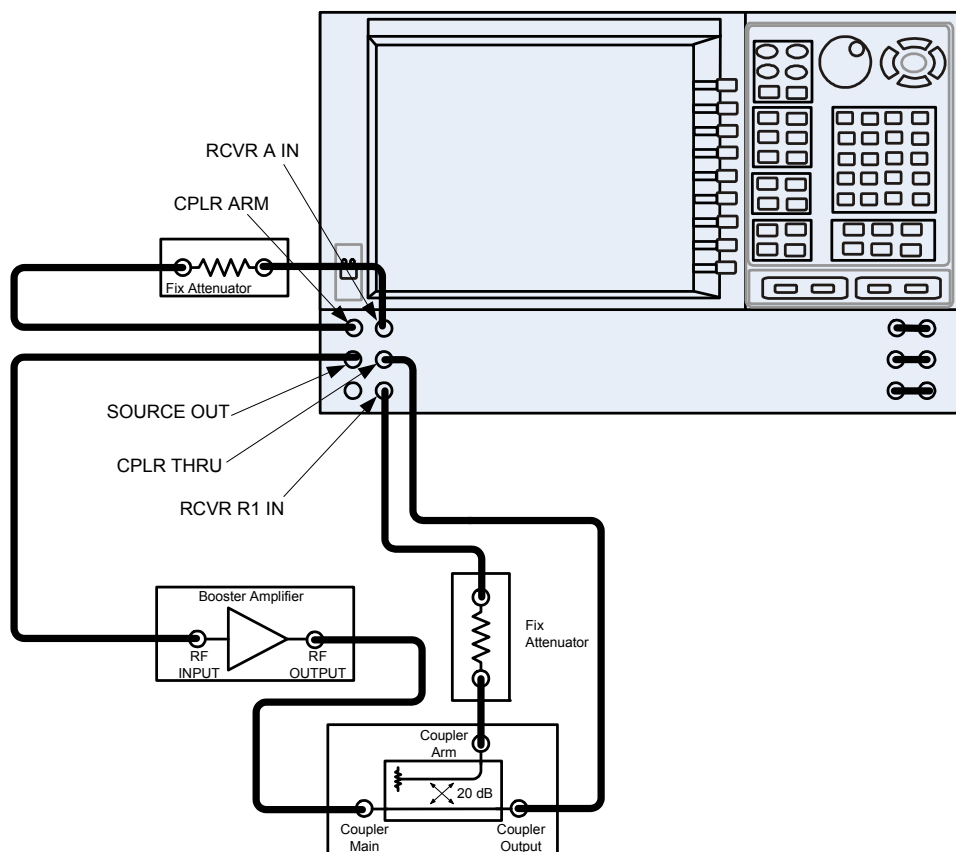
---

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.

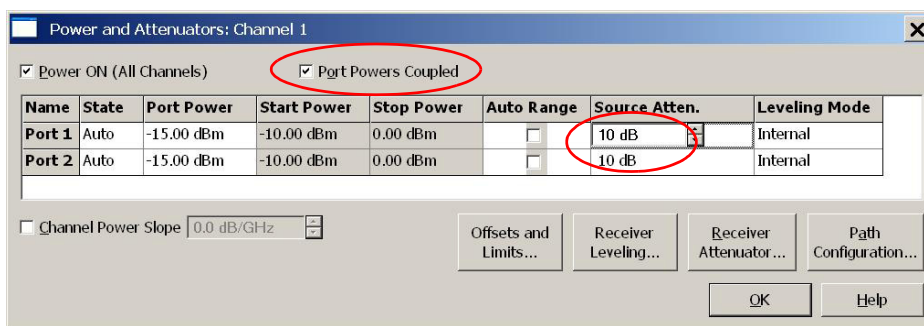
**Figure 20 PNA-X Port 1 Amplifier, Coupler, Attenuator Connections**



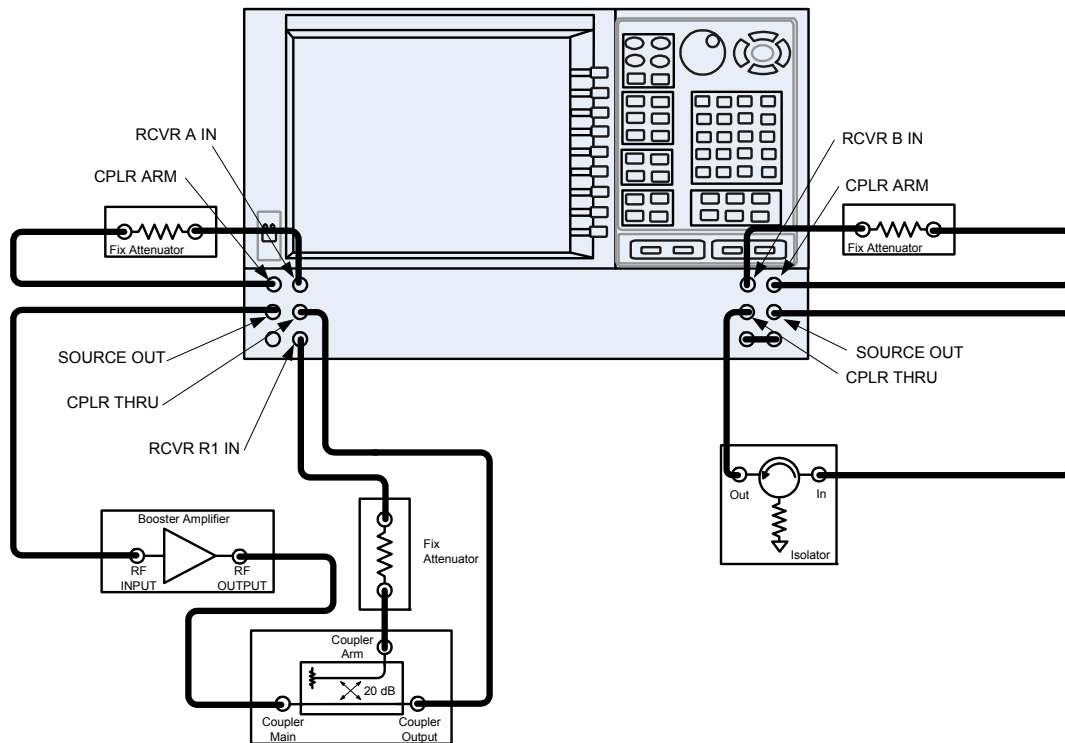
### Selecting Power Ranges and Attenuator Settings

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** check box and type **[10 dB]** into **Source Atten.** for **Port 1**. Verify that **Port Powers Coupled** is selected to ensure that Port 1 and Port 2 power levels are the same, then click **OK**.

**Figure 21 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.

**Figure 22 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:

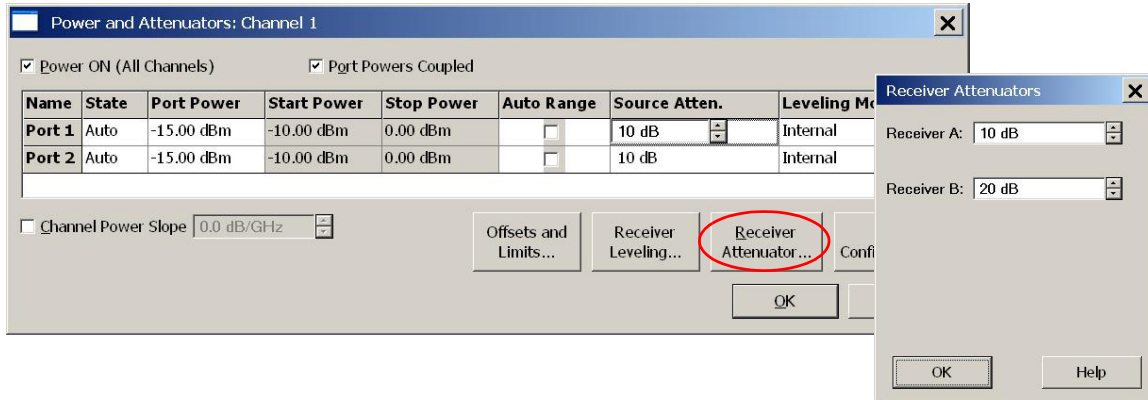
$$\text{Receiver Attenuator A} = +10\text{dBm} - 13\text{dBm} - (-12\text{dBm}) \quad \text{Attenuator A} = +10\text{dBm}$$

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



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]**, then click **OK**. Power levels greater than +35 dBm will require additional attenuation between Port 2 access ports CPLR ARM and RCVR B IN, see [Figure 22 on page 26](#).

**Figure 23 Receiver Attenuators**

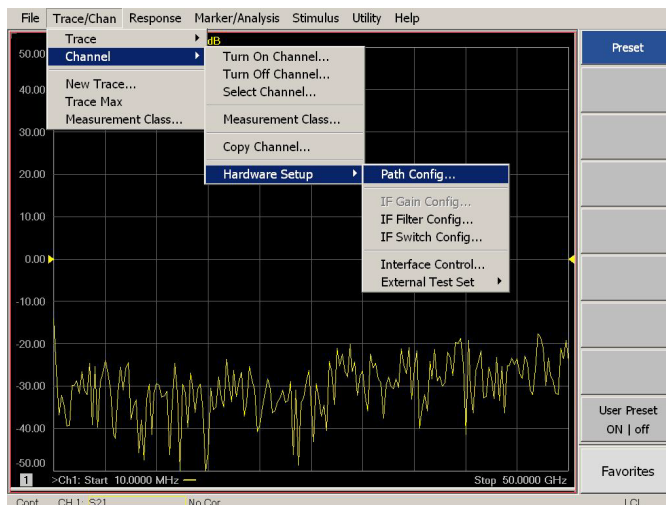


17. Turn On the booster amplifier.

**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.

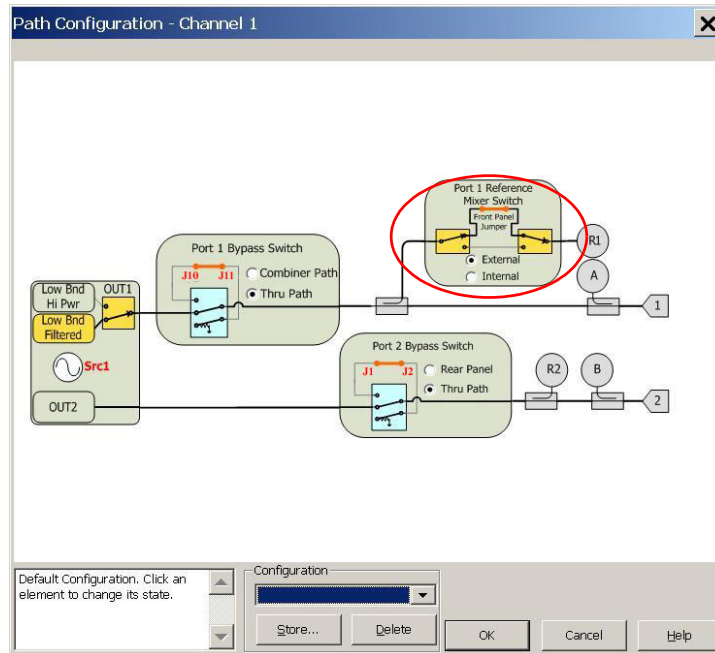
18. In the **Trace/Chan** drop-down menu select **Channel > Hardware Setup > Path Config**.

**Figure 24 Path Configuration**



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

**Figure 25** Port 1 Mixer Switch



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

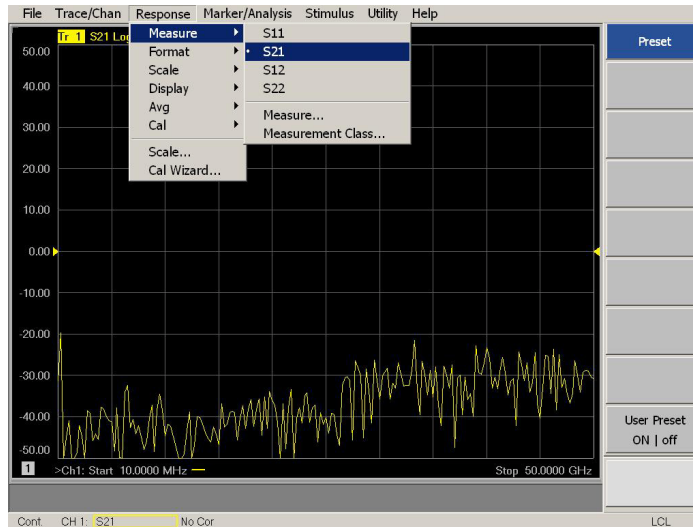
If you are measuring a highly reflective device, a high power isolators should be inserted between the 20 dB coupler and CPLR THRU front panel ports to protect Port 1 Source.

## Final Setup

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

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

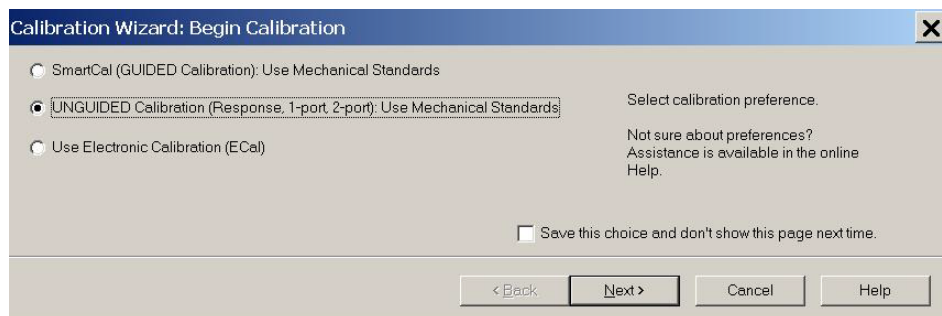
**Figure 26 Response Menu**



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

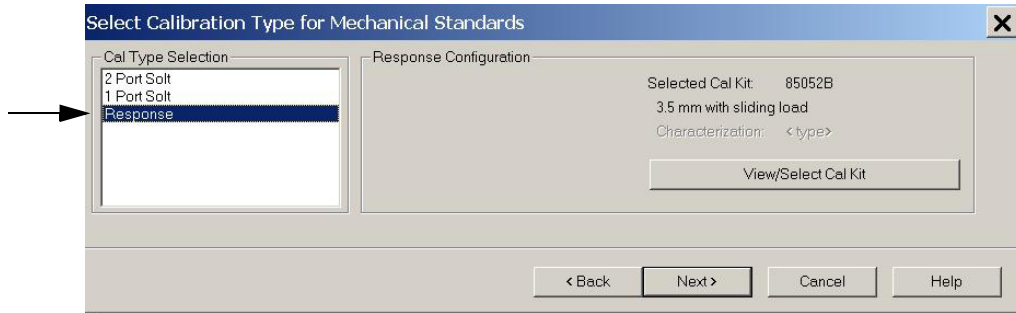
- a. Connect the test port cables of the analyzer to form a thru configuration.
- b. In the **Response** drop-down menu select **Cal Wizard** (see [Figure 26](#)). In the dialog box, select **UNGUIDED Calibration (Response, 1-port, 2-port): Use Mechanical Standards > Next**.

**Figure 27 Calibration Wizard**



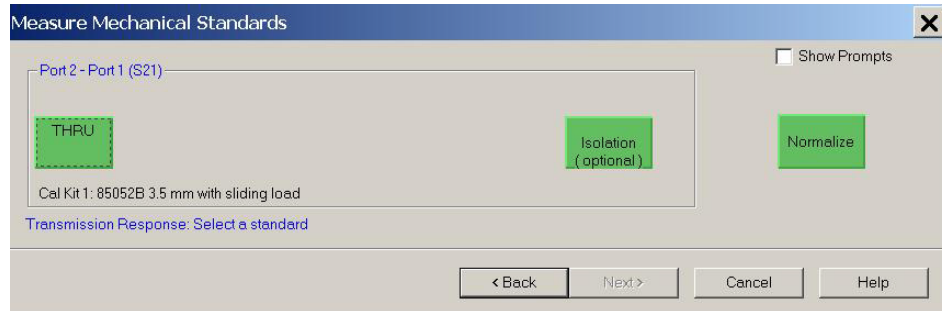
c. Select **Response** > **Next**.

**Figure 28**     **Response**



d. Select **THRU** > **Next**. Follow the analyzer's prompts to finish the calibration.

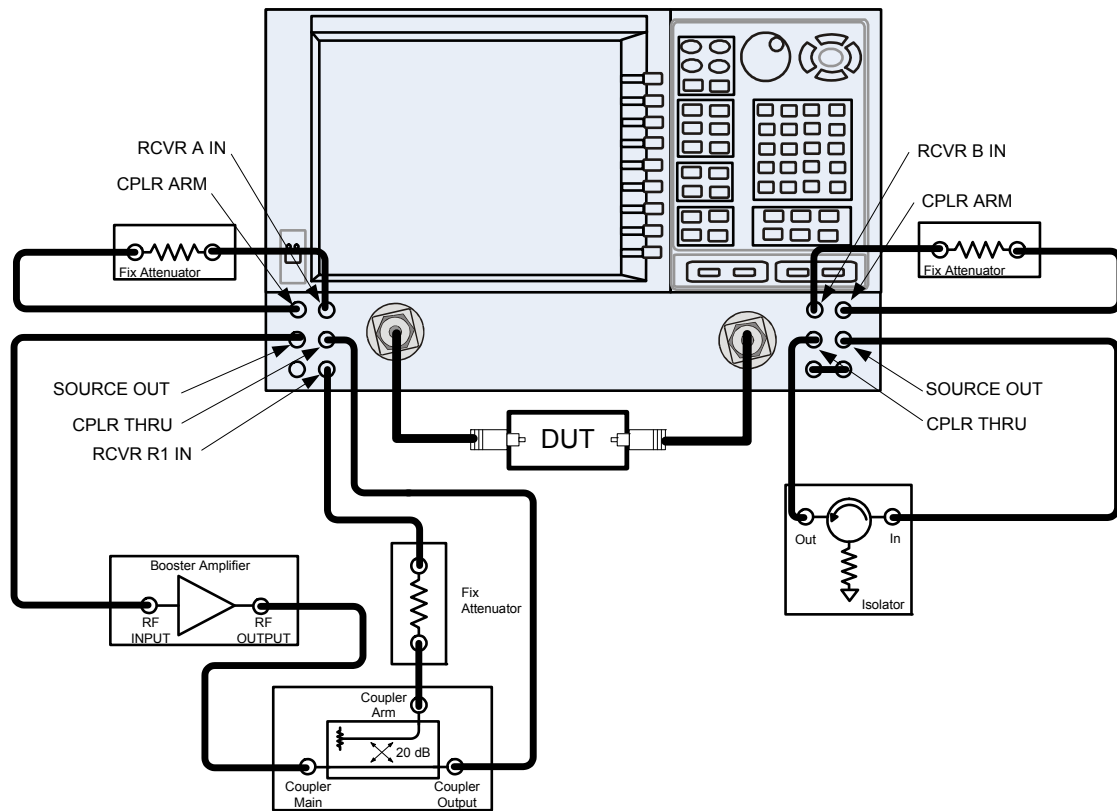
**Figure 29**     **THRU**



24. Configure the test setup as shown in [Figure 30](#).

25. 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 30 Forward High Power Measurement Configuration**



26. 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.

---

## Specification

The N5244/45AS models are tested to the performance closest matching their configuration. Specifications for the N5244/45AS with Option H86 (delete bias tees) are equivalent to the N5244/45A with Options 200/219 (2-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 Series Data Sheet. Visit our web site at <http://www.agilent.com/find/pna>, enter your analyzer model number (N5244/45A) in the search field and select the data sheet or manual of your choice.

The specifications for Option H86, when configured in high power or large signal capability, are not tested nor guaranteed.

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## Service Information

Information can be found in the Agilent PNA-X Network Analyzer Data Sheet and Technical Specifications (N5245-90008). This document can be found using the our web site at <http://www.agilent.com/find/pna>, enter N5245-90008 in the search field.

Service information can be found in the Agilent N5244A and N5245A PNA Microwave Network Analyzers Service Guide (N5245-90001). This document can be found using the our web site at <http://www.agilent.com/find/pna>, enter N5245-90001 in the search field. Replacement parts and procedures are listed in Chapters 6 & 7.

The Agilent Technologies PNA-X Series Microwave Network Analyzers N5244/45A will display Option H86. Firmware revision A.09.42.06 or higher must be used for this option. Service software is available for servicing the N5244/45A at local service centers.

Follow the N5244/45A 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	Agilent Part Number
<b>Add:</b>			
W20	N5244/45A-200	RF Cable: Port 1 CPLR THRU to A33 Port 1 Coupler	N5245-20045
W32	N5244/45A-200	RF Cable: Port 2 CPLR THRU to A36 Port 2 Coupler	N5245-20106
	N5244/45A-H86	RF Cable: SW2 - J1	N5245-20155
	N5244/45A-H86	RF Cable: SW1 - J10	N5245-20156
	N5244/45A-200/219/224	Front Panel Overlay, 2-Port (Option H86/224)	N5245-80013
	N5244/45A-200/219	Front Panel Overlay, 2-Port (Option H86)	N5242-80014
<b>Delete:</b>			
A42/A45	N5244/45A-219	Bias-tee with wire harness	5087-7331
W83	N5244/45A-219	RF Cable: Front Panel Port 1 CPLR THRU to A42 Port 1 Bias-Tee	N5245-20046
W84	All	RF Cable: A33 Port 1 Coupler to A42 Port 1 Bias-Tee	N5245-20076
W95	N5244/45A-219	RF Cable: Front Panel Port 2 CPLR THRU to A45 Port 2 Bias-Tee	N5245-20047
W96	All	RF Cable: A36 Port 2 Coupler to A45 Port 2 Bias-Tee	N5245-20030
	N5244/45A-200/219	Front Panel Overlay, 2-Port (Option 200/219)	N5242-80001
	N5244/45A-200/219/224	Front Panel Overlay, 2-Port (Option 224)	N5245-80005

---

## Safety and Regulatory 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 be 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 Agilent Technologies web site at  
*<http://regulations.corporate.agilent.com/DoC/search.htm>*

### Statement of Compliance

This instrument has been designed and tested in accordance with CAN/CSA 22.2 No. 61010-1-04, UL Std. 61010-1 (2nd Edition).



## Before Applying Power

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

### 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 instrument, will make the instrument dangerous. Intentional interruption is prohibited.

---

### Cautions applicable this instrument.

---

**CAUTION** Always use the three-prong ac power cord supplied with this instrument. Failure to ensure adequate earth grounding (by not using this cord) can cause instrument damage and the risk of electrical shock.

---

---

**CAUTION** This product is designed for use in Installation Category II and Pollution Degree 2.

---

---

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

---

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**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.

---

## Servicing

Warnings applicable to this instrument.

---

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

---

---

**WARNING** This product is designed for use in Installation Category II and Pollution Degree 2.

---

---

**WARNING** No operator serviceable parts inside. Refer servicing to qualified personnel.

---

---

**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.

---

---

**NOTE** There are no operator replaceable fuses in the mains input.

---

## 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 [Agilent Technologies N5244/45AS Option H86](#) 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.

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**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.

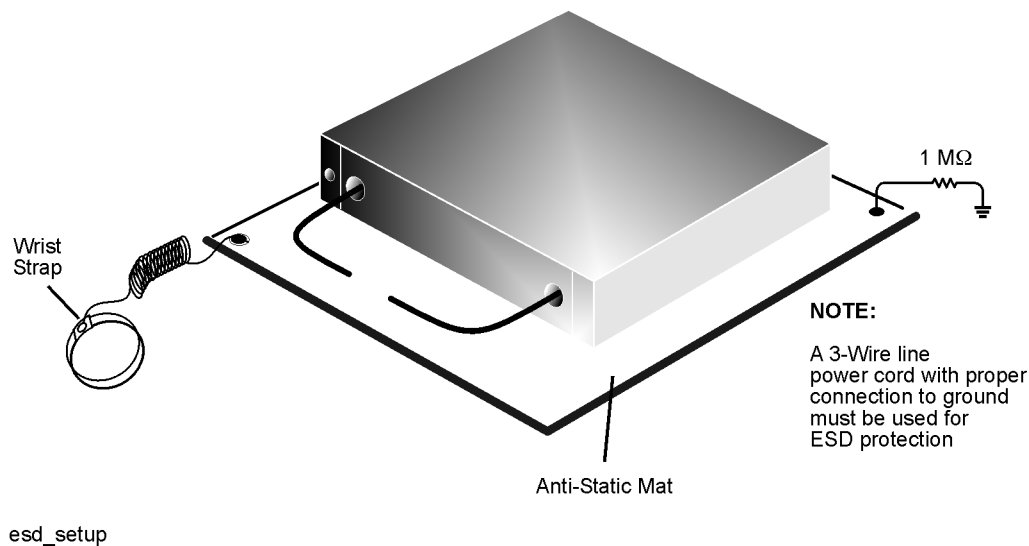
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## Electrostatic Discharge Protection

Protection against electrostatic discharge (ESD) is essential while removing assemblies from or connecting cables to the network analyzer. Static electricity can build up on your body and can easily damage sensitive internal circuit elements when discharged. Static discharges too small to be felt can cause permanent damage. To prevent damage to the instrument:

- *always* have a grounded, conductive table mat (9300-0797) in front of your test equipment.
- *always* wear a grounded wrist strap (9300-1367) with grounding cord (9300-0980), connected to a grounded conductive table mat, having a 1 M $\Omega$  resistor in series with it, when handling components and assemblies or when making connections.
- *always* wear a heel strap (9300-1126) when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.
- *always* ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port or cable connector briefly.
- *always* ground the center conductor of a test cable before making a connection to the analyzer test port or other static-sensitive device. This can be done as follows:
  1. Connect a short (from your calibration kit) to one end of the cable to short the center conductor to the outer conductor.
  2. While wearing a grounded wrist strap, grasp the outer shell of the cable connector.
  3. Connect the other end of the cable to the test port and remove the short from the cable.

**Figure 31 ESD Protection Setup**



## Regulatory Information

### Instrument Markings

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



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.



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 instrument complies with Canada: CSA 22.2 No. 61010-1-04.



This is a symbol of an Industrial Scientific and Medical Group 1 Class A product.



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



Direct Current.

**IP 2 0**

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



This is a required mark signifying compliance with an EMC requirement. The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.



China RoHS regulations include requirements related to packaging, and require compliance to China standard GB18455-2001.



This symbol indicates compliance with the China RoHS regulations for paper/fiberboard packaging.

### 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 Agilent Technologies for disposal. Refer to [“Contacting Agilent” on page 40](#) for assistance.

### Compliance with German Noise Requirements

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrrerordnung-3. GSGV Deutschland).

Acoustic Noise Emission/Geraeuschemission	
LpA<70 dB	Lpa<70 dB
Operator Position	am Arbeitsplatz
Normal Operation	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

### EMC Information

Complies with European EMC Directive 2004/108/EC

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11
- This ISM device complies with Canadian ICES-001.  
Cet appareil ISM est conforme a la norme NMB du Canada.

---

## Agilent Support and Assistance

### Service and Support Options

The analyzer's standard warranty is a one-year return to Agilent Technologies service warranty.

See “[Service Information](#)” on page 32 for PNA-X information.

---

**NOTE** There are many other repair and calibration options available from the Agilent Technologies support organization. These options cover a range of service agreements with varying response times. Contact Agilent for additional information on available service agreements for this product. Refer to “[Contacting Agilent](#)” on page 40.

---

### Contacting Agilent

Assistance with test and measurements needs and information or finding a local Agilent office are available on the Web at:

*<http://www.agilent.com/find/assist>*

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

---

**NOTE** In any correspondence or telephone conversation, refer to the Agilent product by its model number and full serial number. With this information, the Agilent representative can determine whether your product is still within its warranty period.

---

### Shipping Your Analyzer to Agilent for Service or Repair

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**IMPORTANT** Agilent 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 Agilent for repair.

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If you wish to send your network analyzer to Agilent 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.
- Ship the analyzer using the original or comparable antistatic packaging materials.
- Contact Agilent for instructions on where to ship your analyzer.