

Agilent Technologies U3022AH10

User's Guide

**Use this manual with the following document:
PNA Series Network Analyzer On-line Help System and
Application Note 1408-12**



Agilent Technologies

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WARNING	Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.
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CAUTION	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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Statement of Compliance

This product has been designed and tested in accordance with the standards listed on the Manufacturer's Declaration of Conformity, 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.

Definitions

- *Specifications* describe the performance of parameters covered by the product warranty (temperature -0 to 55 °C, unless otherwise noted.)
- *Typical* describes additional product performance information that is not covered by the product warranty. It is performance beyond specification that 80% of the units exhibit with a 95% confidence level over the temperature range 20 to 30 °C. Typical performance does not include measurement uncertainty.
- *Nominal* values indicate expected performance or describe product performance that is useful in the application of the product, but is not covered by the product warranty.
- *Characteristic Performance* describes performance parameter that the product is expected to meet before it leaves the factory, but is not verified in the field and is not covered by the product warranty. A characteristic includes the same guard bands as a specification.

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U3022AH10

Introduction

This document describes how to use the U3022AH10 Multiport Test Set with the Agilent N5242A 2-Port or 4-Port PNA-X Network Analyzer.

Figure 1 N5242A 2-Port PNA-X with Test Set



Figure 2 N5242A 4-Port PNA-X with Test Set



Description

The Agilent U3022AH10 is a 10-Port mechanical high power switching extension test set capable of handling 20 watts of power. The 10-Port extension test set can be connected to a 12-Port device when configured with the N5242A Option 200 PNA-X 2-Port Network Analyzer and can be connected to a 14-Port device when configured with the N5242A 4-Port Network Analyzer. The Test Set ports are 3.5 mm male connectors. The test set is controlled by the test set I/O connector located on the rear panel of the network analyzers. Front panel connections allow external attenuators, isolators, couplers, and booster amplifiers to be installed for high power use.

For more U3022AH10 information, visit <http://www.agilent.com/find/multiport>.

Network Analyzer Requirement

- All PNA-L and PNA-X Network Analyzers require Option 551, which adds N-Port error correction and full cross-bar measurement capability. Firmware revision A.07.50.13 or greater is required.
- The N5242A PNA-X requires Option 200 or 400 to provide the test set interface connections and requires test set file `u3022ae10_pnax_p2.tsx` or `u3022ae10_pnax_p4.tsx`.

More PNA information is available on the following websites:

- Documentation - <http://www.agilent.com/find/pna>
- Network Analyzer Firmware - <http://na.tm.agilent.com/pna/firmware/firmware.htm>
- U3022AH10 Test Set Files - <http://na.tm.agilent.com/multiport>. (see test set files link)

Available Options

The U3022AH10 has one available option:

- Option 042 provides a cable set to connect the N5242A Option 200 or 400 (12 or 14 Port configuration).

Verifying 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 Agilent” on page 73](#). Keep the damaged shipping materials (if any) for inspection by the carrier and an Agilent representative.

Table 1 Content List

Agilent PN	Description	Qty
Common to the following Options		
9320-0333	Envelope-Cal Certificate	1
9320-6636	Functional Test Certificate	1
U3022-90002	U3022AH10 User's Guide	1
8120-6818	Test Set I/O Cable	1
5023-0132	Locking Feet	1
Option 042 Cables (12 or 14-Port)		
N5242-20138	Rear Locking Link (right)	1
N5242-20139	Rear Locking Link (left)	1
U3022-80002	Label (Port 13)	1
U3022-80003	Label (Port 14)	1
U3022-20091	Semi-rigid RF Cable	2
U3022-20092	Semi-rigid RF Cable	2
U3022-20093	Semi-rigid RF Cable	2
U3022-20094	Semi-rigid RF Cable	2
E8356-20072	RF CA Front Panel Jumper	16
0515-2317	Screw (T-15 M3.5 12 mm)	2

General Specifications

Specifications for the U3022AH10 Multiport Test Set are characteristic for the System performance of the PNA and Test Set. Actual performance of the system is based on the customers PNA that is used with the test set and components used for high power configurations.

A functional certificate is supplied for the U3022AH10. The U3022AH10 performance is based on external components such as the calibration kit and network analyzer. There are no internal adjustment in the U3022AH10, therefore an annual calibration is not required.

NOTE When connected to a PNA, without external power components, this test set will degrade the performance at the test ports. The internal mechanical switch paths reduce test port power and power to the receivers. This affects the test port power of the PNA and reduces dynamic range. The test port power, indicated by the PNA, and power to the receivers can be reduced as much as 3 dB. This will decrease the dynamic range (depending on the frequency) by as much as 6 dB.

Power Requirements

Verify that the required ac power is available at all necessary locations before installing the Test Set to the PNA.

- Air conditioning equipment (or other motor-operated equipment) should not be placed on the same ac line that powers the Test Set and PNA.
- [Table 2](#) contains the maximum wattage for all instruments. This table can be use to determine the electrical and cooling requirements.

NOTE Values are based on 120 Vac supplied to each instrument at 60 Hz.

Table 2 Power Requirements

Standard Equipment	
Instrument	Maximum Wattage
N5242A	450
U3022AH10	350

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 instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.**

Environmental Requirements

The environmental requirements of the PNA are listed in [Table 3](#). Note that these requirements are the same as those of the N5242A PNA-X.

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.

Table 3 PNA Operating Environment

Operating Environmental Requirements:	
Operation	0 °C to 40 °C (32 °F to 104 °F)
Storage	–40 °C to +70 °C (–40 °F to +158 °F)
Measurement Calibration	20 °C to 26 °C (68 °F to 79 °F)
Performance Verification	Temperature must be within 1 °C (1.8 °F) of the temperature at which the measurement calibration was performed.
Pressure Altitude (Operation or Storage)	0 to 4600 meters (~ 15,000 feet)
Enclosure Protection	IP 2 0

Environmental Tests

The U3022AH10 complies with all applicable safety and regulatory requirements for the intended location of use and have been evaluated to assure that they are consistent with Agilent quality and reliability goals. On the basis of that evaluation, the following environmental tests have been deemed unnecessary and have not been performed: temperature, humidity, shock, vibration, altitude and power line conditions.

Equipment Heating and Cooling

If necessary, install air conditioning and heating to maintain the ambient temperature within the appropriate range. Air conditioning capacity must be consistent with the BTU ratings given in [Table 2](#).

Required Conditions for Accuracy Enhanced Measurement

Accuracy-enhanced (error-corrected) measurements require the ambient temperature of the PNA and Test Set to be maintained within ± 1 °C of the ambient temperature at calibration.

Dimensions and Space Requirements

Standard installation of the U3022AH10 and PNA includes configuration and installation on a customer provided lab bench or table top of adequate size and strength.

Table 4 System Dimensions

Item	Weight
Required Bench Top Dimension:	
Clearance above the bench	43 cm (17 in)
Width	127 cm (50 in)
Depth	102 cm (40 in)
Weight	55 kg (110 lb)

Table 5 Instrument Dimensions

Model	Weight	Height	Width	Depth
N5242A	35.4 kg (78 lb, ±0.5 lb)	26.7 cm (10.5 in)	42.5 cm (16.7 in)	50.8 cm (19.7 in)
U3022AH10	11.4 kg (25 lb)	19.1 cm (7.5 in)	42.5 cm (16.7 in)	42.6 cm (16.8 in)

Frequency Range and Maximum Power Levels

The U3022AH10 frequency range is 10 MHz to 26.5 GHz.

CAUTION It is recommend that you do not operate near damage levels. The power levels must be 3 dB below maximum level to ensure no damage. See [Table 6](#).

Table 6 Maximum Power Level Inputs

Test Set or PNA-X Front Panel Connections	Power Level 1 Watt Standard Configuration ¹	Power Level 20 Watt Configuration ²
Maximum U3022AH10 Multiport Test Set RF Power Levels:		
PORT 3-12	+30 dBm 40 Vdc	+43 dBm 40 Vdc
SOURCE OUT	+30 dBm 0 Vdc	+30 dBm 0 Vdc
CPLR ARM	+30 dbm 7 Vdc	+30 dbm 7 Vdc
CPLR THRU	+30 dBm 40 Vdc	+43 dBm 40 Vdc
RVCR A IN and B IN ³	+15 dBm 0 Vdc	+15 dBm 0 Vdc
RVCR R1 or R2 IN ³	+15 dBm 7 Vdc	+15 dBm 7 Vdc
Damage Power Levels to U3022AH10 Access and Test Ports:⁴		
Max Level to Port 1 & 2 Test Ports	+30 dBm 40 Vdc	+43 dBm 40 Vdc

1. All jumpers installed are considered standard configuration.
2. Isolators and attenuators installed. Refer to [Page 34](#).
3. Refer to your PNA-X specifications to determine the maximum input power levels for the access and test ports.
4. Add the RF signal to the DC component to determine the maximum wattage.

The examples shown assumes a 10 dBm (0.01w) RF signal and 7 volt DC.

Equation 1 DC Wattage ($E^2/R = DC$ Wattage)

$$7v^2/50\Omega = 0.98w$$

Equation 2 Maximum Wattage (RF + DC = Maximum Wattage)

$$0.01w + 0.98w = 0.99w$$

Front and Rear Panel Features

Figure 3 Front Panel (Multiport Test Set)



Active LED

- When the test set power switch is On and is connected and addressed by a PNA, the LED is On (illuminated).
- The LED is Off (not illuminated) when the test set power switch is in Standby, or not addressed by a PNA.

Test Port LEDs

- An illuminated LED indicates an active port and if it is in Source or Receiver mode.
- If all of the Source (amber) or Receiver LEDs (green) are illuminated, all of the ports are terminated.
- If all of the odd numbered ports are Off, Port 1 of the PNA is active.
- If all of the even numbered ports are Off, Port 2 of the PNA is active.

Test Ports – 3.5 mm Bulkhead (male)

- Port 3–12


Access Ports for External High Power Devices

- Odd/Even Ports
 - RCVR IN RCVR OUT, Jumper can be removed to install the attenuator.
 - SRC IN SRC OUT, Jumper can be removed to install the amplifier and coupler.
- Port 1 Port 2
 - CPLR THRU SRC OUT, Jumper can be removed to install the amplifiers and isolators.
- Port 3 – 12
 - SRC OUT CPLR THRU, Jumper can be removed to install the amplifiers and isolators.

PNA-X Interconnect Ports – 3.5 mm (female)

- SOURCE OUT Source from PNA-X
- CPLR THRU PNA-X coupler connection to test set
- CPLR ARM PNA-X coupler ARM connection to test set
- A IN – B IN PNA-X RCVR A or B connection to test set

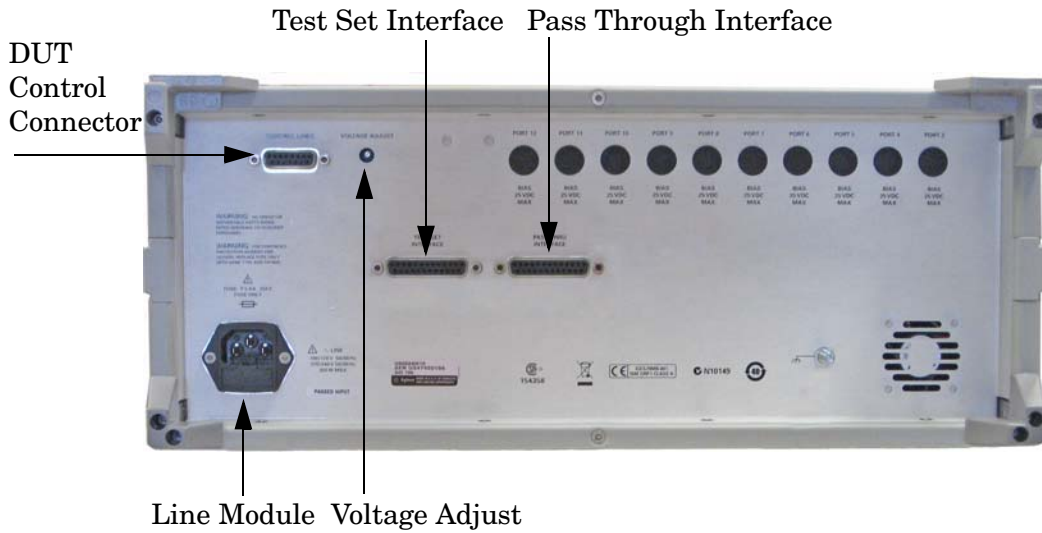
Line Switch

-  – Standby
- | – ON

Control Lines and Voltage Adjust

For further information pertaining to control lines and voltage adjustments see [“DUT Control Lines” on page 46](#).

Figure 4 Rear Panel (Multiport Test Set)



Test Set Interface

The Test Set Interface connector is used to send address and data to the test set from the PNA.

Pass Through Interface

Connection to another test set.

Line Module

The line fuse, as well as a spare, reside within the line module. [Figure 5 on page 12](#) illustrates where the fuses are located and how to access them.

Available Fuses

- **United States (115 V orientation)**
Fuse (F 5 A/250V, 2110-0709) UL listed and CSA certified

WARNING For continued protection against fire hazard replace line fuse only with same type and rating: Fuse 5A/250V, Part Number 2110-0709
The use of other fuses or material is prohibited.

Figure 5 Line Fuse



CAUTION This instrument has autoranging line voltage input; be sure the supply voltage is within the specified range.

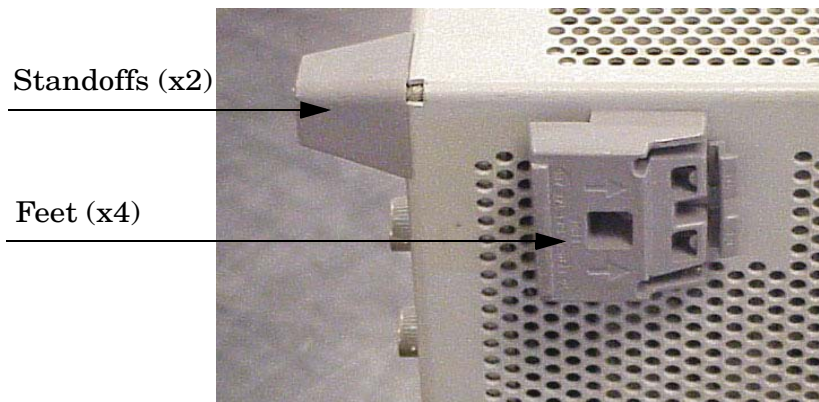
System Setup N5242A PNA-X

WARNING The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

Preparing the PNA Network Analyzer

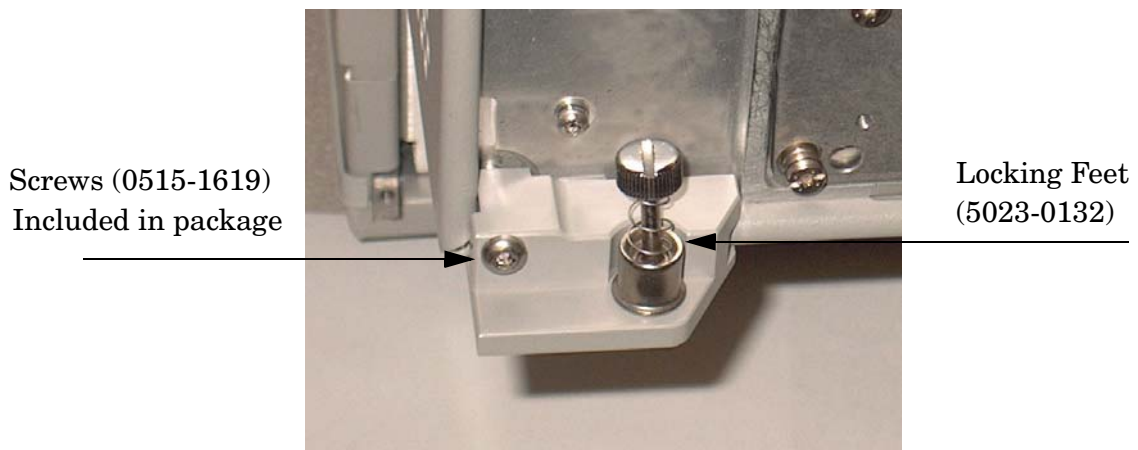
1. Remove the feet from the bottom of the network analyzer. Refer to [Figure 6](#).
2. Remove the 2 lower standoffs and screws (0515-1619) from the rear panel on the network analyzer.

Figure 6 Rear Bottom Feet



3. Install the two rear locking feet (5023-0132) using the included screws (0515-1619), where the standoffs were removed. Refer to [Figure 7](#).

Figure 7 Install Locking Feet



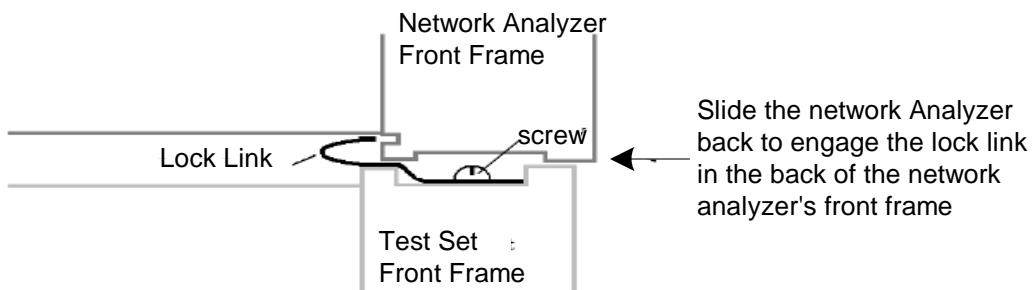
4. Install the two rear locking feet onto the U3022AH10. Looking at the front panel, the N5242-20138 is the right foot and the N5242-20139 is the left foot. Two screws (0515-2317) are included with this option.

Figure 8 Install Locking Feet on U3022AH10



5. Place the network analyzer on top of the Test Set and ensure that the front frame of the network analyzer is positioned slightly forward of the locks that are attached to the Test Set. Slide the network analyzer back so the locks engage the front frame of the analyzer.

Figure 9 Locking the Analyzer's



- Secure the network analyzer's lower locking feet to the Test Set upper locking feet, using the spring-loaded screws on the locking feet, as shown in [Figure 10](#). If the network analyzer's lower locking feet are not aligned with the screw holes in the Test Set's upper locking feet, loosen the screws securing the feet to the instrument slightly to align.

Figure 10 Locking Feet Screws



-
- NOTE** There are two Lock-Feet kits available. Refer to [“Contacting Agilent” on page 73](#) for ordering information.
- PNA – 5023-0132 (Kit includes locking feet and screws)
 - Test Set – N5242-20138 is the right foot and the N5242-20139 is the left foot.
 - Screw – 0515-2317
-

RF Cable Connections for the PNA-X Standard Power Configuration (12-Port or 14-Port)

The Agilent U3022AH10 High Power Test Set can be configured for many applications. Included in this document are four typical configurations:

- [Figure 11, “Standard Power Configuration.”](#)
- [Figure 41, “1 Watt High Power Configuration.”](#)
- [Figure 42, “20 Watt High Power Configuration.”](#)

Refer to section, [“High Power Measurements with U3022AH10” on page 34.](#)

NOTE The internal firmware of the Agilent N5242A PNA-X Series Network Analyzer has not been modified for this test set option. Power levels may differ from those indicated on the PNA-X when the Test Set is connected.

NOTE Refer to the configuration diagrams for external component connections and/or operating constraints when utilizing the high power capability. External components are not supplied with the high power test set. See [Figure 41](#) and [Figure 42 on page 43](#), [Figure 55](#) through [Figure 57](#) beginning on [Page 63](#).

CAUTION The high power test set is equipped with receiver access ports. The jumpers can be removed to insert attenuators that will reduce the RF power to the PNA-X A,B and R channel receivers. Recommended power levels to the PNA-X receiver ports is -15 dBm. Refer to your PNA-X specifications to optimize power levels to the receiver ports.

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. Both the PNA and Test Set power levels must be taken into consideration. At high power levels, a mistake could damage the instruments. Accordingly, the following key values are given in [Table 6 on page 8](#).

[Figure 11](#) and [Figure 12 on page 19](#) illustrates the standard power configuration of the U3022AH10 Multiport Test Set and how it should be configured to the N5242A Option 200 (2-Port) or 400 (4-Port) PNA-X Network Analyzer.

1. Remove the four front panel jumpers on the PNA-X (Ports 1 & 2) from the SOURCE and RCVR ports. The Reference jumpers must remain installed.
2. Connect the RF cables from the N5242A Network Analyzer to the test set. Torque each cable to 8 in-lb. Refer to [Table 7](#), [Figure 11](#) and [Figure 12 on page 19](#).
3. Connect the 16 front panel jumpers (E8356-20072), as shown in [Figure 3 on page 9](#).

CAUTION Each end of the interconnect RF cables have a different length from the bend. When connecting the RF Interconnect cables be sure that the longer end from the bend is connected to the PNA.

CAUTION Over torque will cause damage to the test set and may cause connectors to spin or become loose.

4. Add the front panel port labels to the N5242A Option 400 (4-Port). Refer to [Figure 11 on page 18](#).
 - Port 13 over Port 3 (U3022-80002)
 - Port 14 over Port 4 (U3022-80003)
5. Connect the cable (8120-6818) from the PNA Test Set I/O to the U3022AH10 Test Set I/O on the rear panel. See [Figure 12 on page 19](#).

Table 7 PNA-X to Test Set Cable Connections

Numeric Order	RF Cables	From (PNA)	To (Test Set)
1	U3022-20092	N5242A Port 1, CPLR ARM	CPLR ARM
2	U3022-20094	N5242A Port 1, SOURCE OUT	SOURCE OUT
3	U3022-20091	N5242A Port 1, RCVR A IN	A IN
4	U3022-20093	N5242A Port 1, CPLR THRU	CPLR THRU
5	U3022-20093	N5242A Port 2 CPLR THRU	CPLR THRU
6	U3022-20091	N5242A Port 2, RCVR B IN	B IN
7	U3022-20094	N5242A Port 2, SOURCE OUT	SOURCE OUT
8	U3022-20092	N5242A Port 2, CPLR ARM	CPLR ARM

- Connect the front panel jumpers. The numbers in [Figure 11](#) refer to the corresponding cable number listed in [Table 7](#).

Figure 11 Standard Power Configuration



Figure 12 Rear Panel



Controlling the System with N5242A

This section will describe how to setup and operate the U3022AH10 Multiport Test Set with the N5242A 2-Port or 4-Port PNA Network Analyzer.

The U3022AH10 Multiport Test Set is considered a “slave” instrument. The N5242A must be used to control the Test Set. There are three methods to control the Test Set. Multiport mode is recommended due to calibration and ease of use.

- PNA Multiport Mode Option 551 requires firmware revision \geq A.07.50.13. From the PNA drop-down menu select **Help > About Network Analyzer** to see the options installed and the installed firmware revision.

The following test set file must be installed into network analyzer file directory:
c:/program files/agilent/networkanalyzer. (see test set files link)

2-Port PNA-X requires test set: u3022ae10_pnax_p2.tsx

4-Port PNA-X requires test set: u3022ae10_pnax_p4.tsx

- PNA Interface Control
- PNA GPIB Command Processor

Visit our website for firmware revision and downloads.

<http://na.tm.agilent.com/pna/firmware/firmware.htm>

<http://na.tm.agilent.com/multiport> (see test set files link)

NOTE The internal firmware of the Agilent N5242A has not been modified for this test set option. Power levels may differ from those indicated on the PNA when the Test Set is connected.

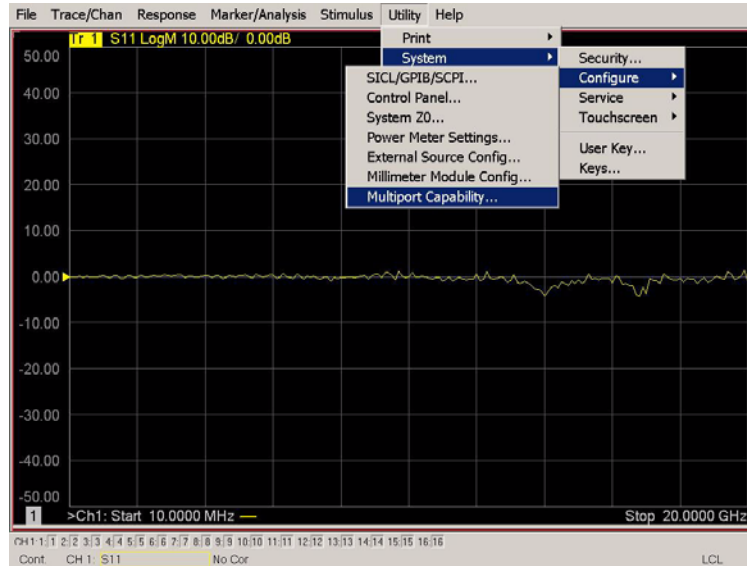
PNA Multiport Mode with Option 551

The PNA Multiport Mode selects the test set file that will enable the PNA to control the test set. The PNA Multiport Mode allows you to complete a N-Port calibration using the Cal Wizard application in the PNA. Refer to the PNA Help system for more information.

12-Port System with N5242A

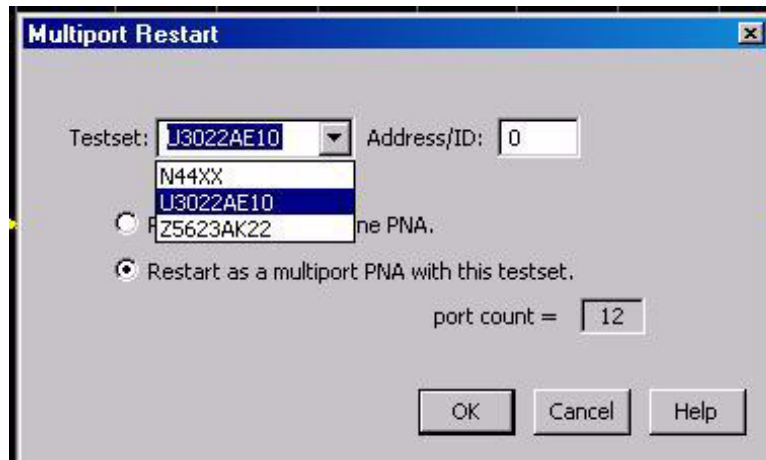
The N5242A Option 551 must be installed for Multiport capability. To access the multiport application select **Utility > System > Configure > Multiport Capability**.

Figure 13 System Configuration



Select **U3022AH10** from the test set drop-down menu and select **Restart as a Multiport PNA with this test set**. Press **OK**. The PNA will restart the network application with the U3022AH10 Multiport Test Set interface features.

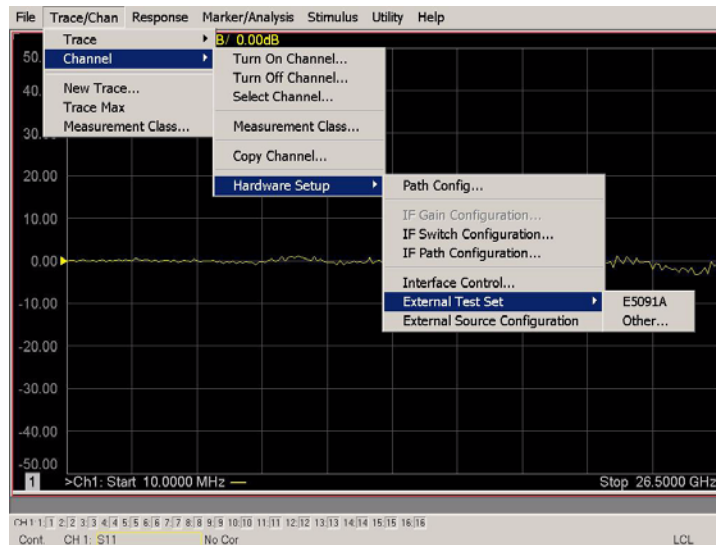
Figure 14 U3022AH10 Selection



External Test Set Control Feature

To verify that the network application has the U3022AH10 interface features, select **Channel > External Test Set > Other**. The U3022AH10 will be displayed as **External Test Set Control-U3022AH10**.

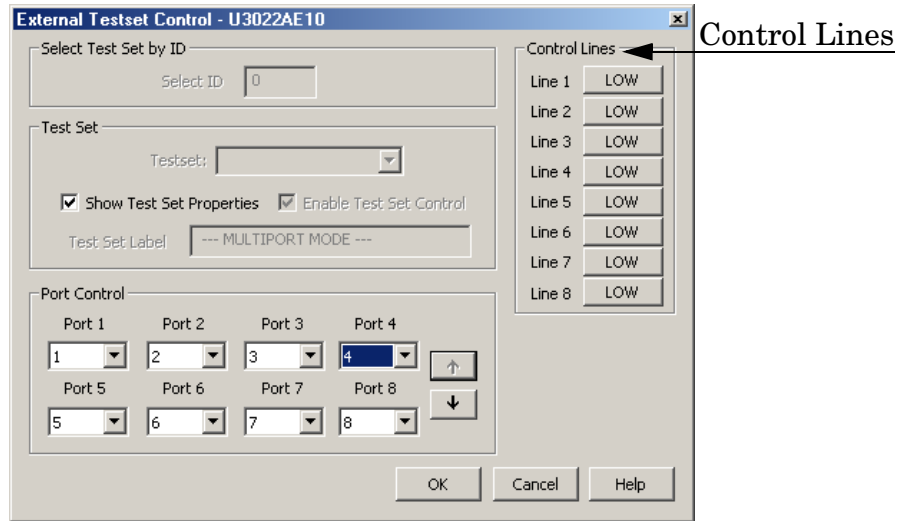
Figure 15 External Test Set Control



This menu will allow the physical Ports 1 through 12 to be identified as any port for your convenience. For example; Port 5 can be named Port 2.

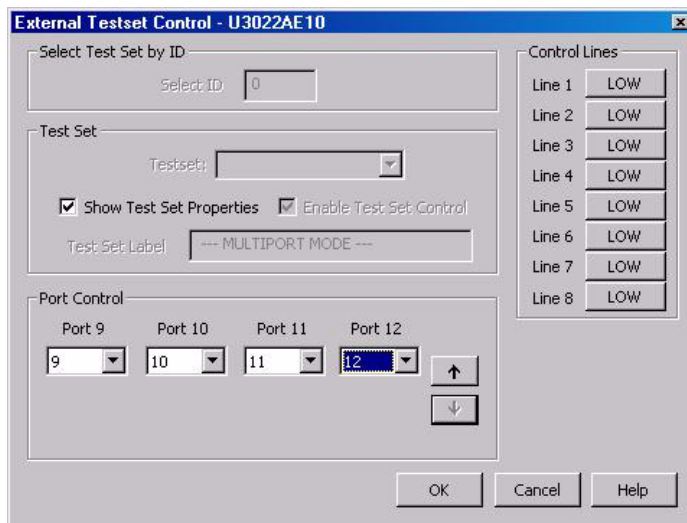
The **External Test Set Control-U3022AH10** also allows control of the DUT control lines, refer to “[DUT Control Lines](#)” on page 46. To change the state from LOW to HIGH, select the graphical user interface (GUI) for the specific control (LINE 1 through 8) and then press **OK**. Each line can be controlled separately, as shown in [Figure 16](#).

Figure 16 External Test Set U3022AH10 (Port 1 - 8)



Select the **Port Control** down arrow for Ports 9 through 12.

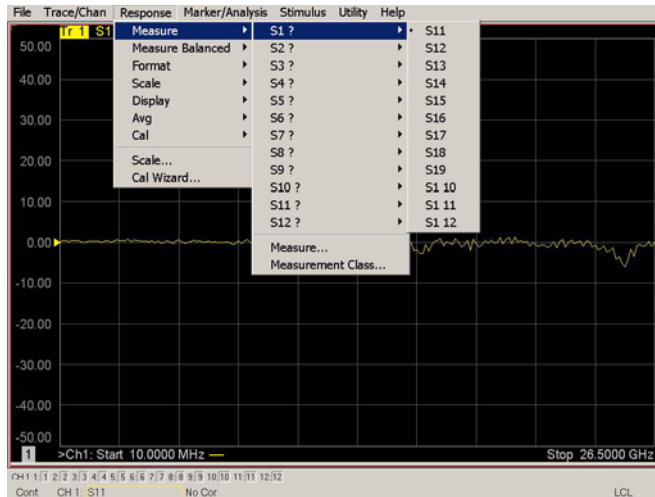
Figure 17 External Test Set U3022AH10 (Port 9 - 12)



Trace Measure S-Parameter

S-Parameter selection can be accomplished using **Response Measure** menu. Select **TRACE > Measure**. Use the drop-down menus to select 1 of 144 S-Parameters for the 12-Port system, as shown in [Figure 18](#). The first number in the Sxx selection is the Receiver Port and the second number will be the Source Port. Any port can be selected to be the Receiver, Source or both, as in S11. The front panel R LED indicates the port is the Receiver and the S LED indicates the port is the Source.

Figure 18 12-Port Trace Measure



New Trace Measure S-Parameter

S-Parameter Tab:

Multiple S-Parameters can be made from the **New Measurement** menu. In the drop-down menu select **Trace > New Trace**. The **New Measurement** window allows the selection of any of the 144 S-Parameter's.

Figure 19 Selecting PNA-X New Trace Measure

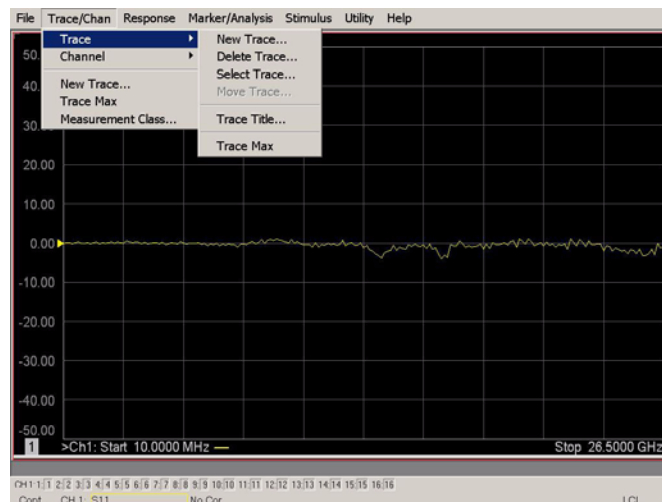
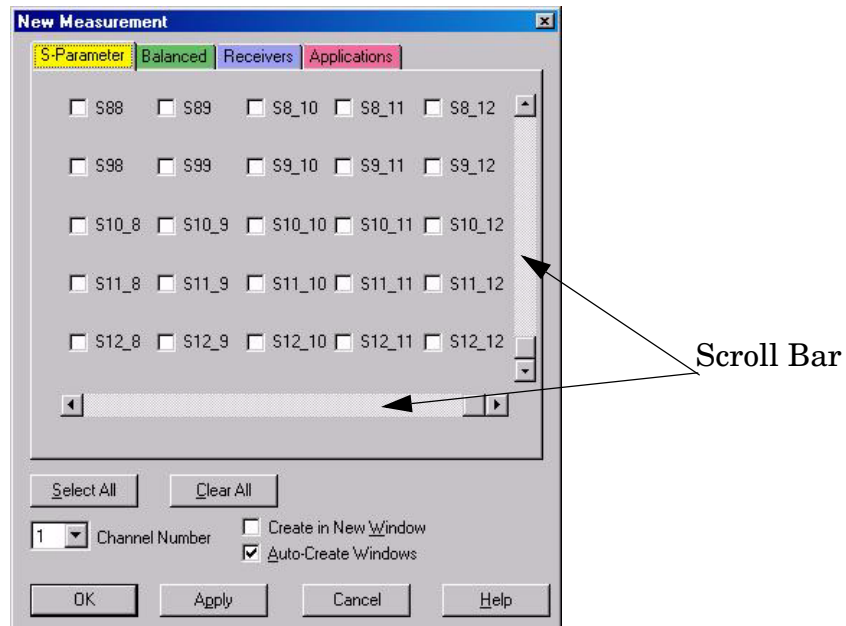


Figure 20 12-Port New Trace Measure (S11 - S88)



Figure 21 12-Port New Trace Measure (S88 - S12_12)

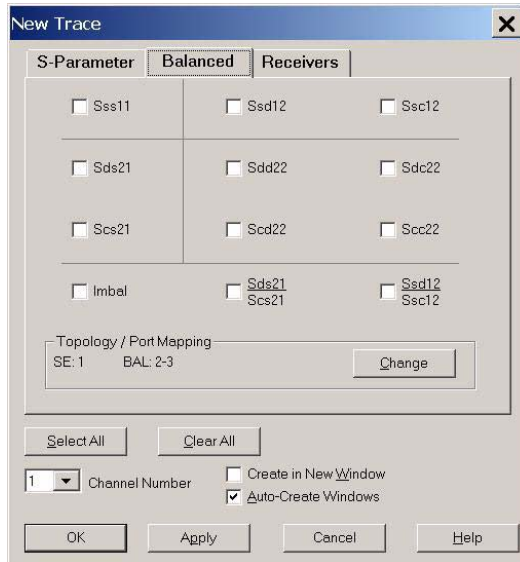


Balanced Tab:

Balanced Measurements can be configured by selecting the Balance tab in the **New Measurement** menu.

For more information on balanced (differential) component measurement, refer to the Application Note 1373-1 and 1373-2 (5988-5634EN and 5988-5635EN) at <http://www.home.agilent.com>. In the search menu type in “Multiport and Balanced.”

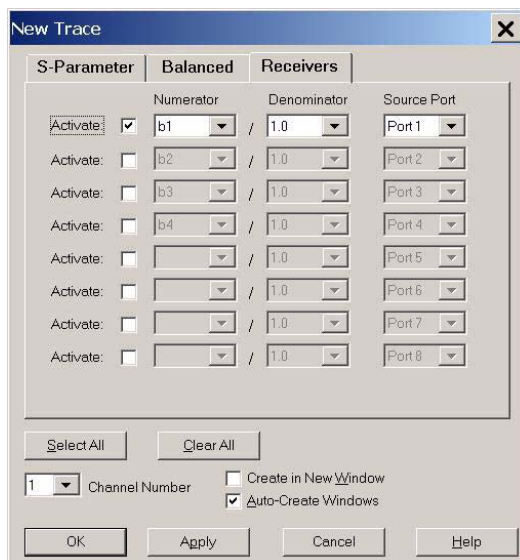
Figure 22 Balance



Receiver Tab:

The S-Parameter measurements can be ratioed with selectable Denominators for each port and receiver. Refer to the standard PNA-X documentation for more information.

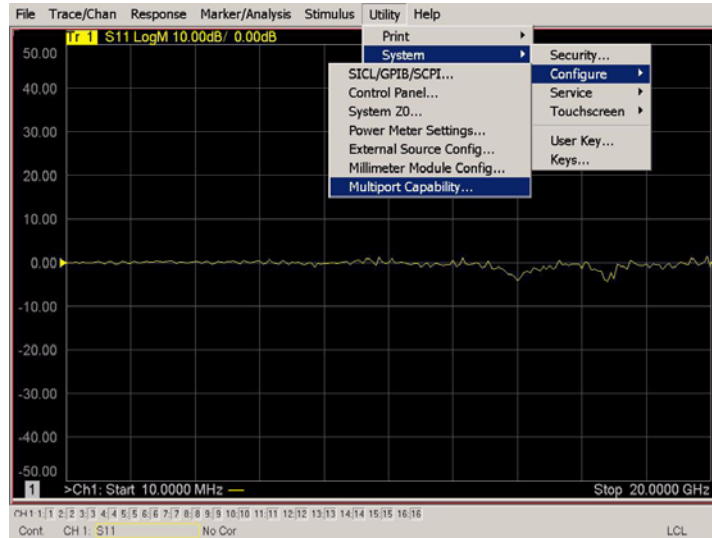
Figure 23 Receiver Ports



14-Port System Mode with N5242A

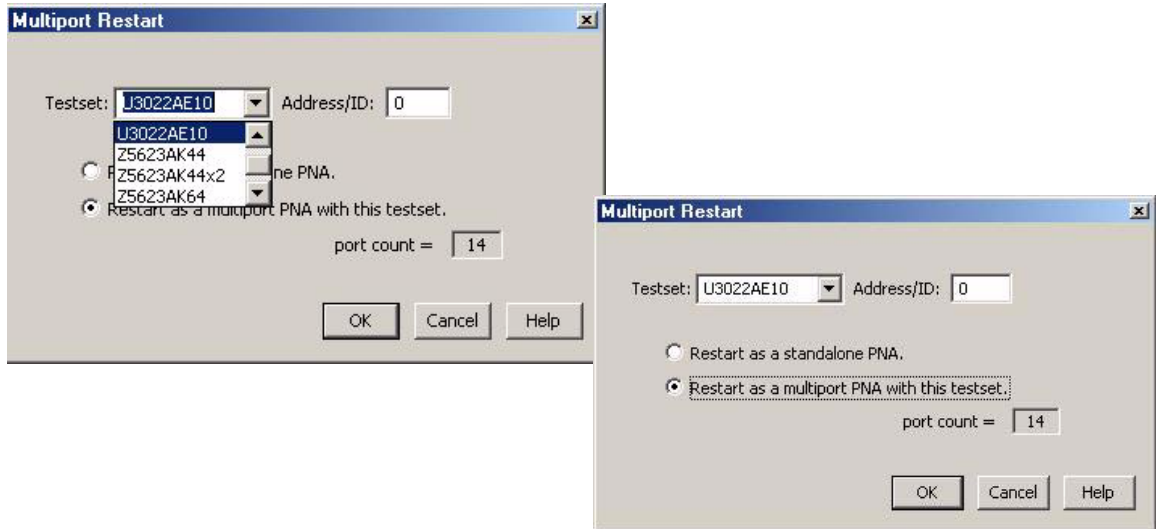
The N5242A Option 400 must have Option 551 installed for Multiport capability. To access the multiport application select **Utility > System > Configure > Multiport Capability**.

Figure 24 System Configuration



Select **U3022AH10** (14-Port System) from the test set drop-down menu and select **Restart as a Multiport PNA with this test set**. Press **OK**. The PNA will restart the network application with the U3022AH10 Multiport Test Set interface features.

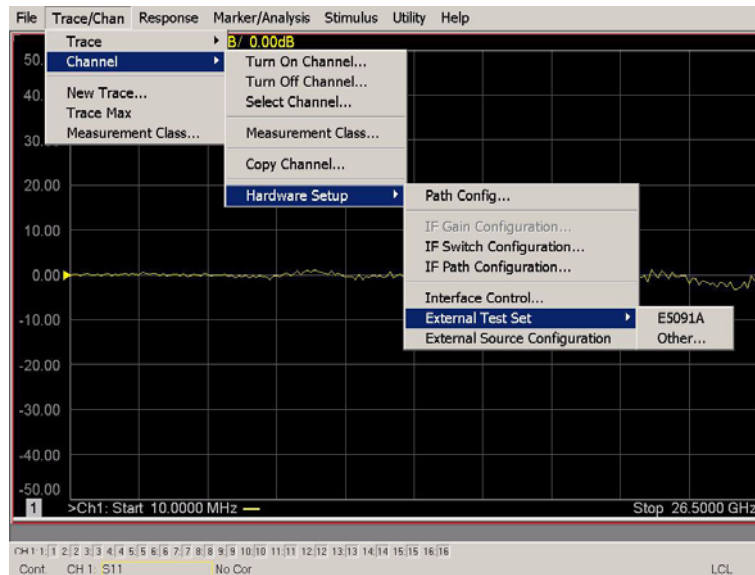
Figure 25 U3022AH10 Selection



External Test Set Control Feature

To verify that the network application has the U3022AH10 interface features, select **Channel > External Test Set > Other**. The U3022AH10 will be displayed as **External Test Set Control-U3022AH10**.

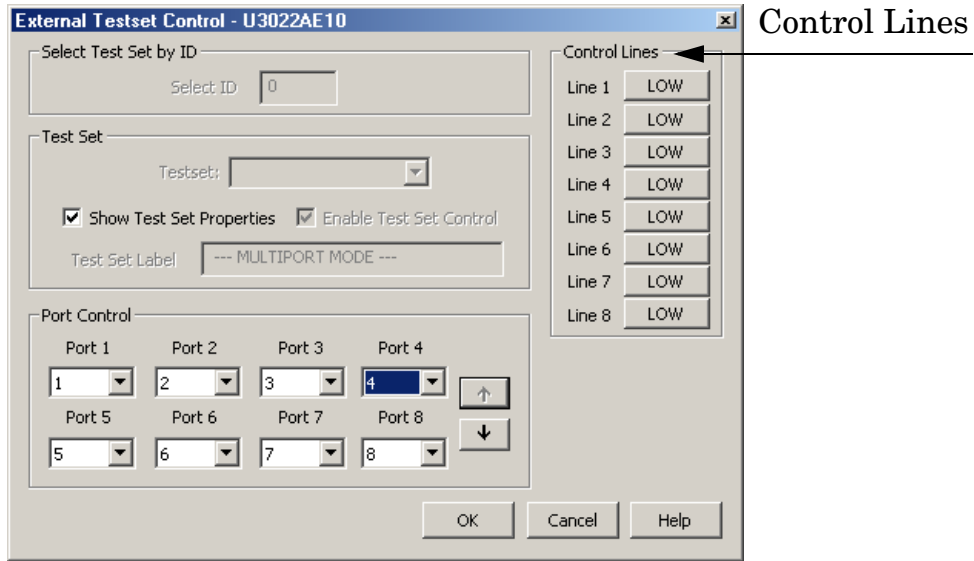
Figure 26 External Test Set Control Feature



This menu will allow the physical Ports 1 through 14 to be identified as any port for your convenience. For example; Port 5 can be named Port 2.

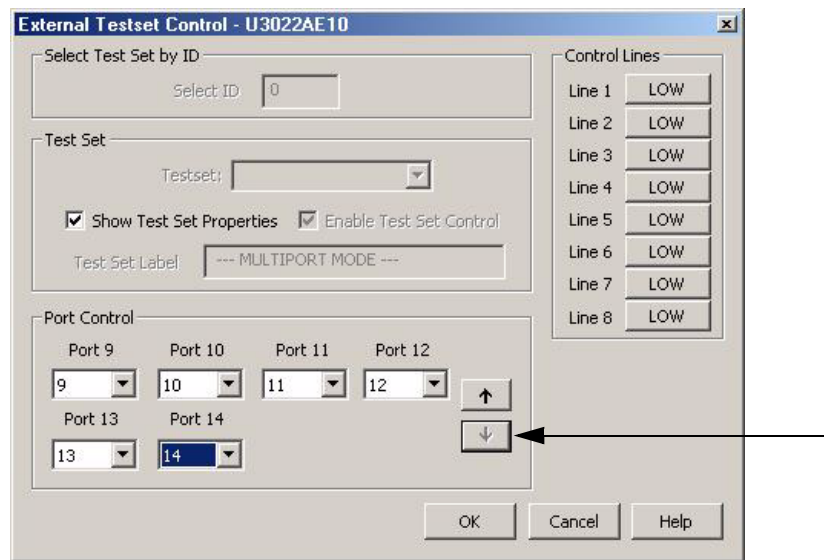
The **External Test Set Control-U3022AH10** menu also allows control of the DUT control lines, refer to [“DUT Control Lines” on page 46](#). To change the state from LOW to HIGH, select the graphical user interface (GUI) for the specific control (LINE 1 through 8) and then press OK. Each line can be controlled separately.

Figure 27 External Test Set U3022AH10 (Port 1 - 8)



Select the **Port Control** down arrow for Ports 9 through 14, see [Figure 28](#).

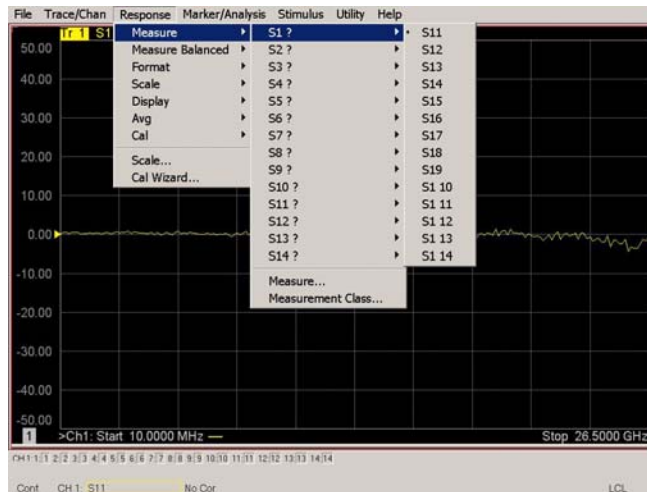
Figure 28 External Test Set U3022A H10 (Port 9 - 14)



Trace Measure S-Parameter

S-Parameter selection can be accomplished using the Response > Measure menu. Use the drop-down menus to select 1 of 196 S-Parameters for the 14-Port system, as shown in [Figure 29](#). The first number in the Sxx selection is the Receiver Port and the second number will be the Source Port. Any port can be selected to be the Receiver, Source or both, as in S11. The front panel R LED indicates the port is the Receiver and the S LED indicates the Port is the Source.

Figure 29 14-Port Trace Measure



New Trace Measure S-Parameter

S-Parameter Tab:

Multiple S-Parameters can be made from the **New Measurement** menu. In the drop-down menu select **Trace > New Trace**. The **New Measurement** window allows the selection of any of the 196 S-Parameter's. See [Figure 28](#) and [Figure 31](#).

Figure 30 New Trace Measurement

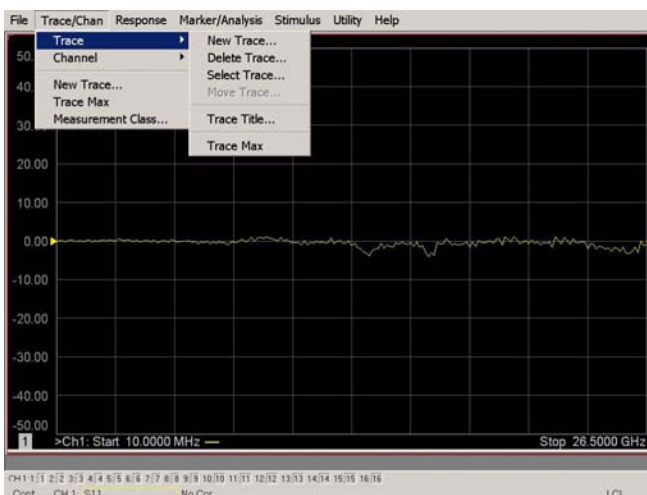


Figure 31 14-Port New Trace Measure (S11 - S55)

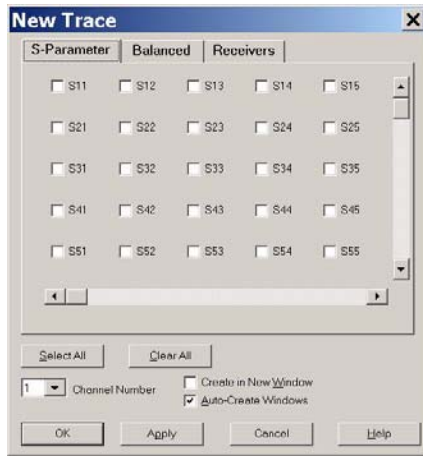
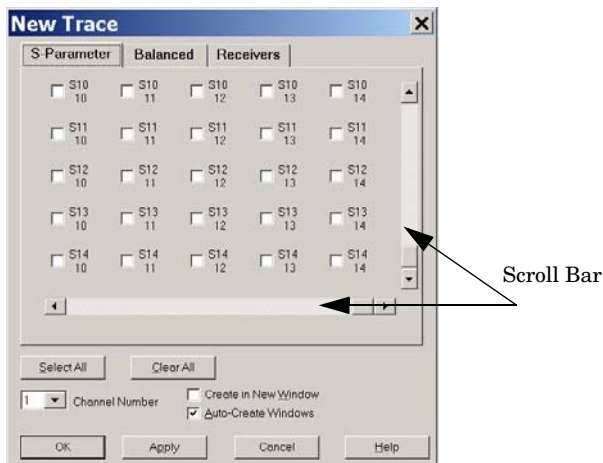


Figure 32 14-Port New Trace Measure (S55 - S99)



Figure 33 14-Port New Trace Measure (scroll down to S14_14)

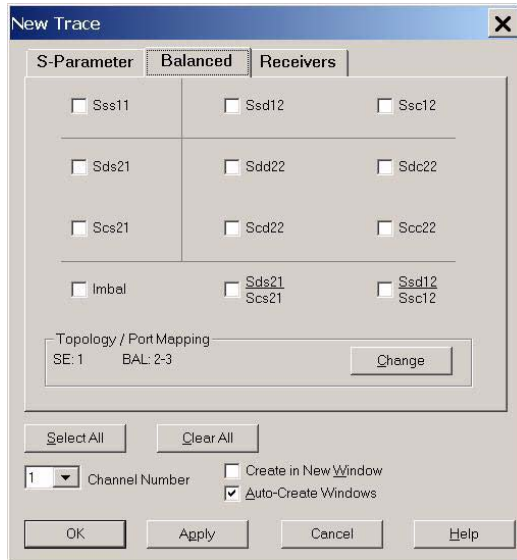


Balanced Tab:

Balanced Measurements can be configured by selecting the Balance tab in the **New Measurement** menu.

For more information on balanced (differential) component measurement, refer to the Application Note 1373-1 and 1373-2 (5988-5634EN and 5988-5635EN) at <http://www.home.agilent.com>. In the search menu type in “Multiport and Balanced.”

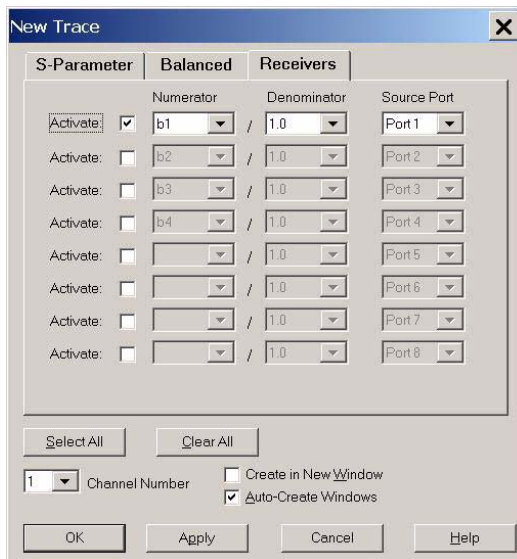
Figure 34 Balance



Receiver Tab:

The S-Parameter measurements can be ratioed with selectable Denominators for each port and receiver. Refer to the standard PNA-X documentation for more information.

Figure 35 Receiver Ports

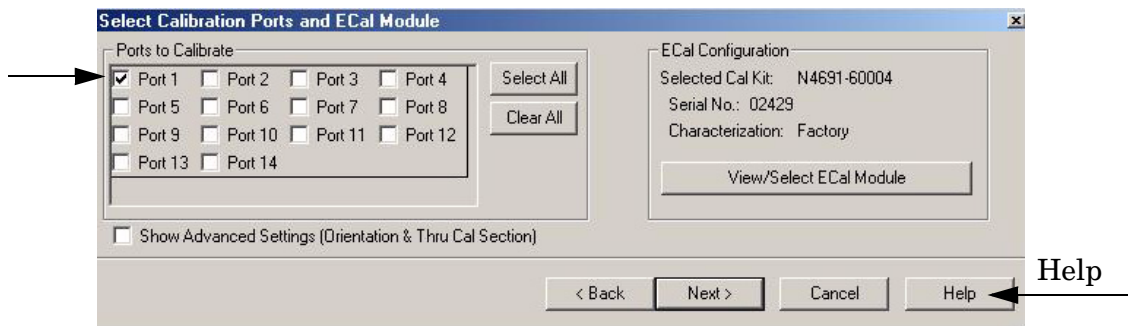


N-Port Calibration with N5242A

It is recommended that you perform an ECal characterization to minimize the connections required for multiple port calibration. Agilent Cable (85131F) is recommended.

1. On the network analyzer select **Response > Calibration Wizard**.
 - a. If using a mechanical cal kit, select **SmartCal**.
 - b. If using an ECal module, select **ECal**.
2. Continue following the Cal Wizard prompts. On the “Select Calibration Ports and ECal Module” window, press **Select All** or select the ports you are calibrating and press **Next**.

Figure 36 1-Port Calibration



3. Connect the ECal or the mechanical cal kit to the ports you are calibrating following the Cal Wizard prompts and press **Measure** after each connection.
4. At the Calibration Completed prompt, select **Save As User Calset** and type the name desired. Press **Save**.

High Power Measurements with U3022AH10

The U3022AH10 and the N5242A PNA-X can be configured to measure high power devices. This ability is useful if the required power for the device under test is greater than what the analyzer can provide, or if the maximum output power from the amplifier under test exceeds the safe input limits for the analyzer. This section describes how to set up the analyzer and test set with external couplers, attenuators, isolators and booster amplifiers to perform high power measurements.

- The external couplers are used to provide reference power to the PNA-X (REF 1 and REF 2) for accurate measurements.
- The attenuators are used to protect the PNA-X receivers.
- The isolators are used to protect the internal U3022AH10 switches and the PNA-X source.
- The booster amplifiers are used to provide added gain.

CAUTION When using high power configurations an attenuator must be placed in the receiver path, and the couplers and isolators must be installed in the source path or damage to the PNA-X, or the U3022AH10 test set will occur. Refer to [“Frequency Range and Maximum Power Levels” on page 8.](#)

Getting Started

NOTE A power meter is required for the following procedure.

1. Estimate the gain and power level needed to measure or force the DUT into compression. This will determine the amount of power required from the source.
2. Determine the type of high power system to be configured. Refer to the following examples.
 - [Figure 11, “Standard Power Configuration,” on Page 18](#). Used for the “Operational Check” on page 51.
 - [Figure 37, “Odd Ports \(1 Watt\),” on Page 37](#).
 - [Figure 38, “Port 1 \(20 Watt\),” on Page 37](#).
 - [Figure 55, “2-Way Power Configuration \(1 Watt\),” on Page 63](#).
3. Determine the ports that will be configured for high power source and receivers.
4. Measure the booster amplifiers gain. Refer to [“Measuring Booster Amplifier Gain” on page 36](#).
5. Set the power level out of the DUT. Refer to [“Setting the Power Level at the Output of the DUT” on page 40](#).
6. Select the attenuator values for optimum PNA receiver and REF Inputs.
7. Configure the system for DUT measurement. Refer to [“Calibrating the System and Measuring the DUT” on page 44](#).

Measuring Booster Amplifier Gain

1. Connect the Test Set to the PNA-X. See “[System Setup N5242A PNA-X](#)” on page 13.
2. Determine the test set and PNA-X ports that will be configured for high power measurements. Each port can be configured separately. Refer to [Figure 36](#), [Figure 37](#), and [Figure 38](#) on page 37. As well as the block diagrams [Figure 54](#) and [Figure 55](#) on page 63.
3. Remove the Test Set front panel jumpers for the selected high power configuration.
4. Connect the Coupler Main to the Amplifier Output.
5. Connect the Amplifier Input to the Odd Port SRC OUT or the port desired to be the source. The RF source power comes from the PNA-X SRC OUT connector. Do not connect the external Coupler Output or Coupler ARM at this time. Refer to [Table 8](#), [Figure 38](#), and [Figure 39](#) on page 38.
6. Turn On the PNA-X and U3022AH10 Test Set.
7. Select multipoint mode. Refer to “[Controlling the System with N5242A](#)” on page 20.
8. Select trace S11 if you are using Port 1 or Odd Ports SRC Out. If you are using another port as the source port, set Sxx to the port desired. Example; S33 would be Port 3.
9. Set the Power Level to **-20 [dBm]**. Save this state as **User Preset** to avoid an over power condition by the factory preset power level (-5 dBm).
10. Turn On the Booster Amplifier.
11. Measure the Coupler Output power, using a power meter.

CAUTION Additional attenuation may be required between the coupler and the power meter to protect the power meter from damage.

Table 8 Amplifier Inputs vs. Outputs

Input From ¹	Maximum Wattage	Power at Ports	Reference Figure
Odd Port SRC OUT	1 Watt	All Odd Ports	See Figure 37 on page 37
Even Port SRC OUT ²	1 Watt	All Even Ports	See Figure 37 on page 37
Port 1 SRC OUT	20 Watts	Port 1	See Figure 38 on page 37
Port 2 SRC OUT ³	20 Watts	Port 2	See Figure 38 on page 37
Port 3 to 12 SRC OUT	20 Watts	Port 3 to 12	See Figure 39 on page 38

1. A 2-Way high power source configuration can be configured for transmission and reverse transmission measurements. Refer to [Figure 55](#) on page 63.
2. The even ports SRC OUT connection and is the similar to the odd ports, although located on the right side of the front panel. Refer to [Figure 37](#) on page 37.
3. The Port 2 SRC OUT connection and is the similar to the odd ports, although located on the right side of the front panel. Refer to [Figure 38](#) on page 37.

Figure 37 Odd Ports (1 Watt)

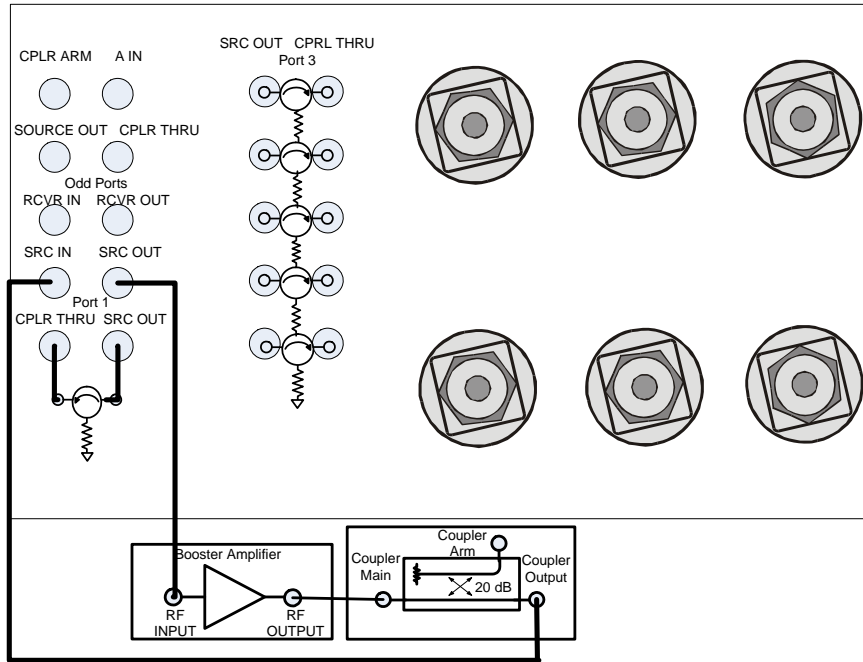


Figure 38 Port 1 (20 Watt)

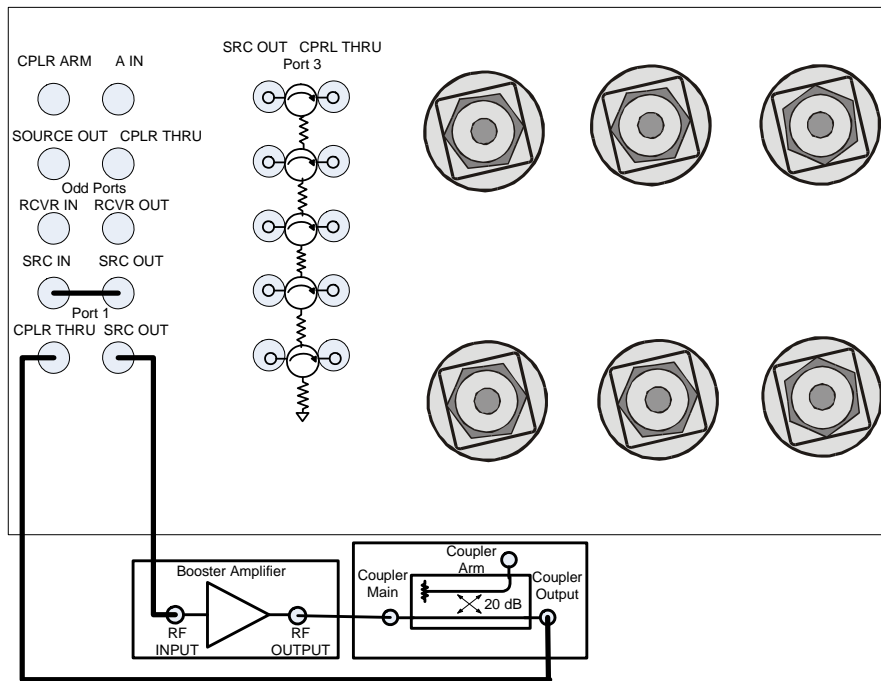


Figure 39 Port 3 (20 Watt)

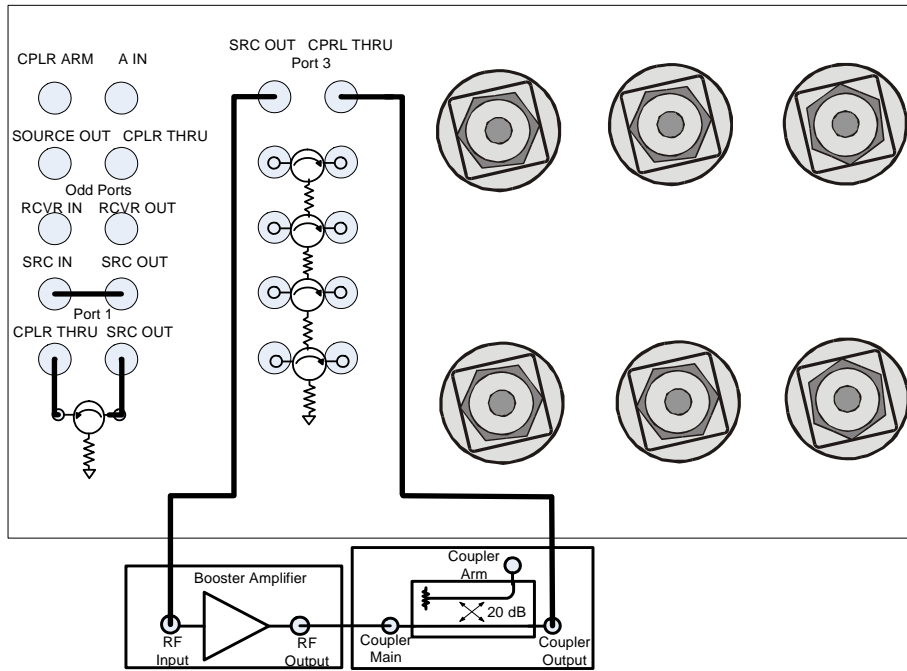
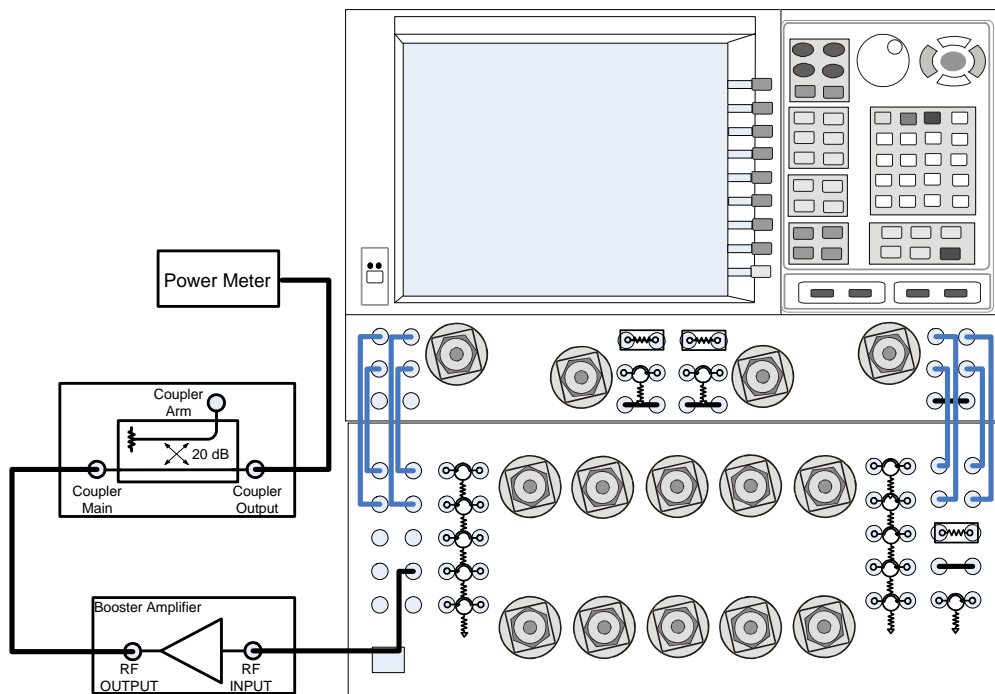


Figure 40 Measuring the Booster Amplifier Gain



12. Verify the gain of the booster amplifier(s). For example; if the PNA-X output power level is -20 dBm and the output power measured from the Output of the coupler is -5 dBm, the gain of the booster amplifier would be $+15$ dB.
13. Verify that the power measured in the previous step is less than $+43$ dBm for the 20 watt configuration, or less than 30 dBm for the 1 watt configuration. Reduce the PNA-X power level if needed. Save this state as **User Preset** to avoid an over power condition. This is the maximum power level setting of the PNA-X.
14. Turn Off the Booster Amplifier.

Setting the Power Level at the Output of the DUT

This procedure determines the required power level to the input and output of the DUT.

1. Connect the external Coupler Output to ODD PORTS, SRC IN or the desired source ports CPLR THRU.
2. Install the isolators inputs to the SRC OUT, and the isolator outputs to the CPLR THRU connector for of all other ports. (If using ports 13 or 14, install isolators as well). This will protect the test set switch loads, and the PNA-X source. The isolators placement is important to ensure that the signal is attenuated into SOURCE IN. The reverse attenuation or isolation factor of the isolator should be 20 dB or greater.
3. Turn On the Amplifier.
4. Select S11 and measure the power at Port 1 on the PNA-X, using the power meter. If you are using another port as the source port, set Sxx to the port desired. Example; S33 would be Port 3. Ensure the power is less than +43 dBm for the 20 watt configuration, or less than 30 dBm for the 1 watt configuration.
5. Reduce the PNA-X power to a minimum.

CAUTION Failure to reduce the input power to the DUT may result in damage.

6. Connect the port source output to the input of the DUT.
7. Measure the power level out of the DUT. Increase the PNA-X power level to determine the DUT's desired input or compression level. This value will be used to determine the receiver input attenuator values. Save this state to recall the power level for the Input power level to the DUT. The power level should not be above the level that was determined in step 13 on [Page 39](#).

Selecting REF Attenuator Value

This procedure will select the attenuator value to be installed in the RCVR R1 IN (REF 1) or RCVR R2 IN (REF 2) paths. The attenuators will be installed from the external coupler ARM and the REF Inputs.

1. Measure the external coupler ARM power.
2. Add attenuator to ensure the power level does not exceed the optimum REF INPUT level. Refer to your PNA-X specifications to optimize power levels to the REF ports.

For example:

- Measured power at the external coupler's ARM –5 dBm
 - The optimum PNA-X receiver power level –15 dBm
3. Calculate the amount of attenuation used between the external CPLR ARM and RCVR R1 IN.

Equation 3 REF IN Attenuation Example

$$(-15dB) - (-5dB) = -10dB$$

4. Connect the 10 dB attenuator (calculated from the example) to the external CPLR ARM. If the power level is less than –15 dB an attenuator is not required.
5. Measure the attenuator output power.
6. Verify that the power measured in the previous step is within the acceptable limits (–15 dBm for the RCVR REF IN).
7. Turn Off the booster amplifier and connect the external coupler ARM to the REF INPUT (RCVR R1 IN or RCVR R2 IN). Refer to [Figure 41](#) and [Figure 42 on page 43](#).

Selecting RCVR A and B Path Attenuators

- Calculate the amount of attenuation needed so that the optimum PNA-X RCVR A/B power level of -15 dBm is not exceeded. Refer to your PNA-X specifications to optimize power levels to the receiver ports.

For example:

- Measured power at the DUT Output $+25$ dBm
 - The optimum PNA-X receiver power level -15 dBm
 - Loss through the Test Set switch and cables is 3 dB
- Calculate the amount of attenuation used between the external RCVR OUT and RCVR A/B IN.

Equation 4 RCVR IN Attenuation Example

$$-15\text{dBm} - 25\text{dBm} = -40\text{dBm}$$

- Connect the 40 dB attenuators to RCVR OUT.
- Connect the RF cable from the DUT Output to the test set port that will be receiver port.
- Select the trace for the source to receiver path. Example; if port 3 is your receiver and port 1 is your source, select S31.
- Turn On the Booster Amplifier.
- Measure the attenuator output power.
- Verify that the power measured, in the previous step, is within the acceptable limits (-15 dBm for the RCVR A/B IN).
- Connect the attenuator outputs to receiver A IN and B IN. If you are using Ports 13 or 14 , connect the same value attenuators from RCVR OUT to RCVR C/D IN.

Figure 41 1 Watt High Power Configuration

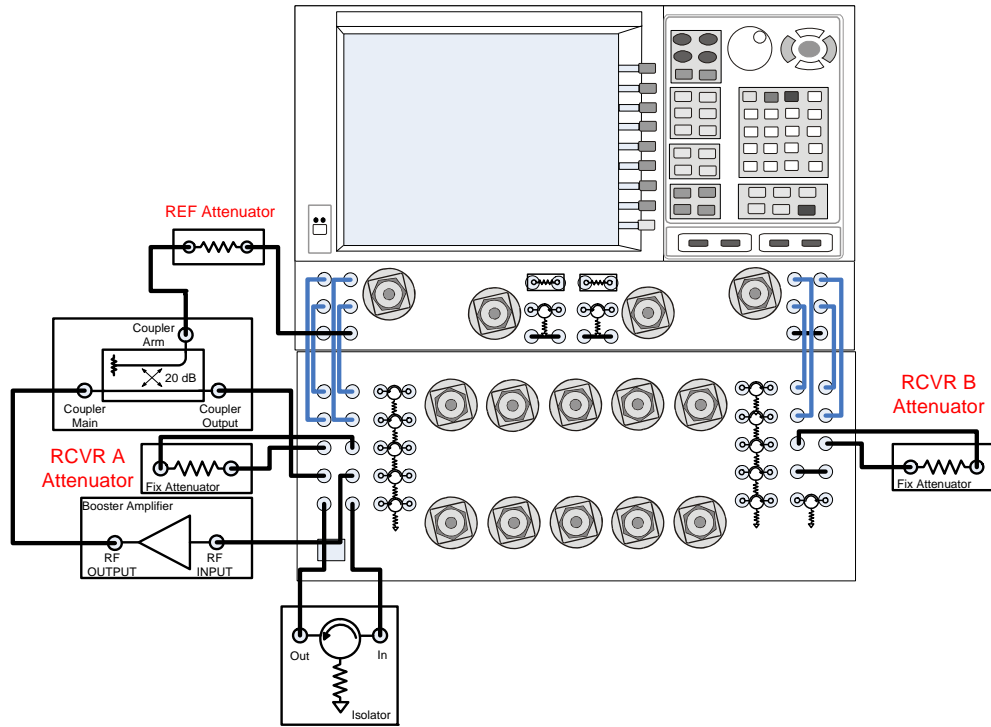
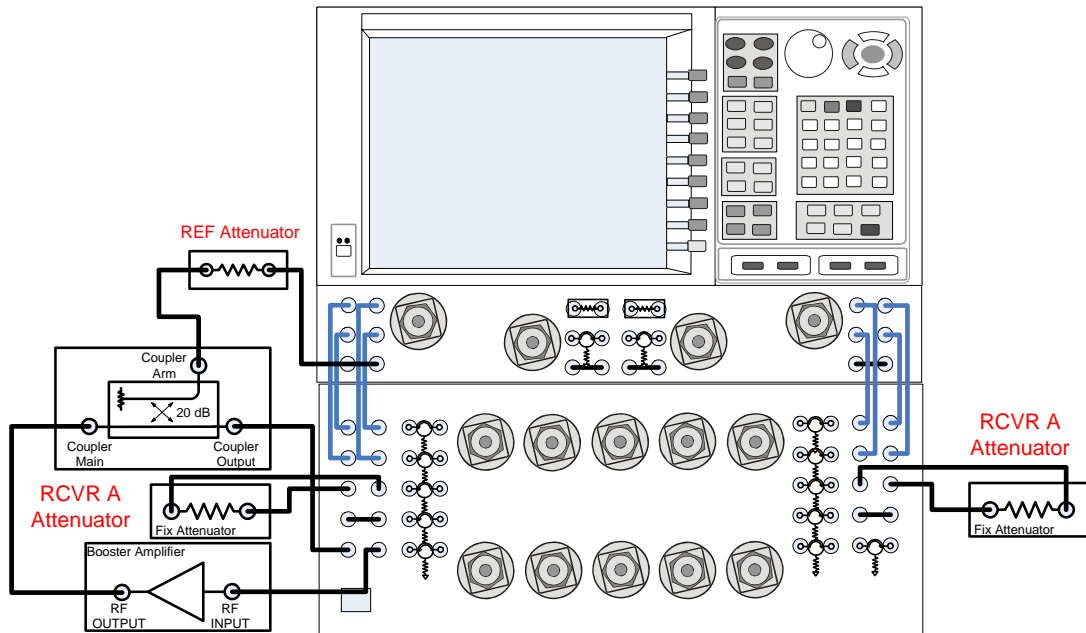


Figure 42 20 Watt High Power Configuration



CAUTION High power isolators should be inserted between the SOURCE OUT and CPLR IN front panel ports on the Test Set if you are measuring a highly reflective device.

NOTE The isolators placement is important to ensure that the signal is attenuated into the U3022AH10 SRC OUT isolator connections for Port 1 and Port 2. The reverse attenuation or isolation factor of the isolator should be 20 dB or greater.

Calibrating the System and Measuring the DUT

CAUTION Do *not* press **Preset** unless you have turned Off the booster amplifier(s) or have saved this state and renamed it to User Preset. Pressing Preset will return the analyzer to its default power level and default internal attenuator settings. The increase in power may result in damage to the DUT or analyzer.

In this procedure you will perform a response calibration.

1. Connect a test port cable to the receiver port.
 2. Connect a test port cable to the source port.
 3. Connect the two test port cables together using an adapter.
 4. Press **[CAL] > Start CAL > Calibration Wizard > Unguided Calibration Use Mechanical Standards > Next > THRU Response > Next**. Follow analyzers window prompts to finish the response calibration.
1. Connection the DUT Input to the source test port cable, and the DUT Output to the receiver test port cable. Turn on the DUT and measure the DUT gain or loss. Set Trace S43 if Port 4 is the receiver and Port 3 is the source.

NOTE An ECal module can be used if the power level is less than +10 dBm, or the ECal module is characterized with attenuators installed to protect all inputs of the ECal module.

2. Remove the DUT and perform a 2-Port or N-Port (all ports) calibration, using mechanical the standards of the ECal.
 - 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, gain of the booster amplifier and attenuator values must be taken into consideration.

NOTE To perform a N-Port calibration the PNA must have Option 551.

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 - D.
- The R channel reference level supplied from the Test Set.
- The source power loss due to the installed isolators.

DUT Control Lines

The 15 pin female D-Sub connector on the front panel provides 8 latched data connections that can be used to control your DUT or Booster Amplifier. An adjustable voltage source (+2 to +5 Vdc) is provided on the front panel. A positive or negative external source can be used. Refer to [Table 11](#) and [Figure 46 on page 50](#).

Setting the DUT Control Interface

This section describes how to control the DUT control lines. Refer to [“Controlling the System with N5242A” on page 20](#). For more information regarding the control lines, see [Table 9 on page 46](#) and [Table 10 on page 47](#).

Table 9 Test Set DUT Control Address and Data

Address	Data	Data AD12-AD0	Description					Bit Data 0= +Voltage 1= -Voltage		
112	0	000000000000	ALL DUT Control Lines set to 0 or + voltage							
112	255	000001111111	ALL DUT Control Lines set to 0 or – voltage							
112	1	00000xxxxxxxB	DUT Control Line 1					0,1		
112	2	00000xxxxxxBx	DUT Control Line 2					0,1		
112	4	00000xxxxxBxx	DUT Control Line 3					0,1		
112	8	00000xxxxBxxx	DUT Control Line 4					0,1		
112	16	00000xxxBxxxx	DUT Control Line 5					0,1		
112	32	00000xxBxxxxx	DUT Control Line 6					0,1		
112	64	00000xBxxxxxx	DUT Control Line 7					0,1		
112	128	00000Bxxxxxxx	DUT Control Line 8					0,1		
Control Lines			Line 8	Line 7	Line 6	Line 5	Line 4	Line 3	Line 2	Line 1
Test Set I/O Bits			AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
Bit Decimal Equivalent			128	64	32	16	8	4	2	1
Example 1 Data = 0			0	0	0	0	0	0	0	0
Example 2 Data = 21			0	0	0	1	0	1	0	1
X indicates unknown user bit state										
B indicates bit of interest										
To select a test set DUT control line configuration, all 8 DUT control lines must be set. To do this you must add AD7 to AD0 binary number and convert this to a decimal equivalent.										

NOTE All DUT control lines must be set with each command sent. Logic 0 = high

Figure 43 DUT Control Line Pin Assignment

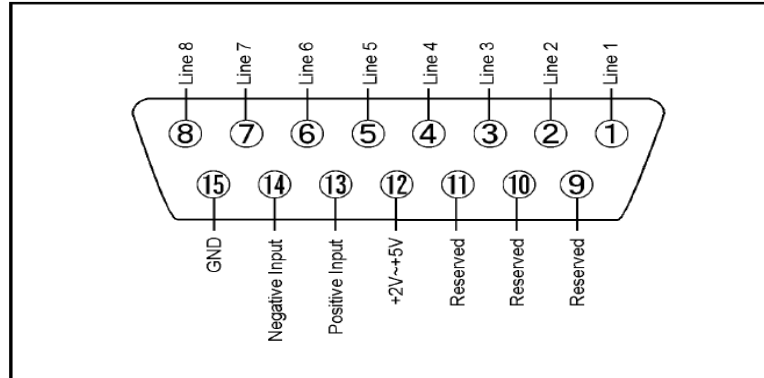


Table 10 DUT Control Line Pin Assignment

Pin Number	Signal Name	Description
1	Line 1	Output port of line 1
2	Line 2	Output port of line 2
3	Line 3	Output port of line 3
4	Line 4	Output port of line 4
5	Line 5	Output port of line 5
6	Line 6	Output port of line 6
7	Line 7	Output port of line 7
8	Line 8	Output port of line 8
9		Not used
10		Not used
11		Not used
12	+2 V to +5 V	The voltage input to pin 13. (The voltage can be varied by rotating the voltage adjustment trimmer on the front panel).
13	Positive Input	Input a signal that is outputted when each line is high from pin 12 or external dc power supply.
14	Negative Input	Input a signal that is outputted when each line is low from the external dc power supply. Able to output 0 V as low from the each line by connecting to pin 15.
15	Gnd	ground terminal

Setting the Variable Source Voltage

The output voltage of pin 12 can be varied from +2 to +5 V. Perform the following procedure to set the voltage:

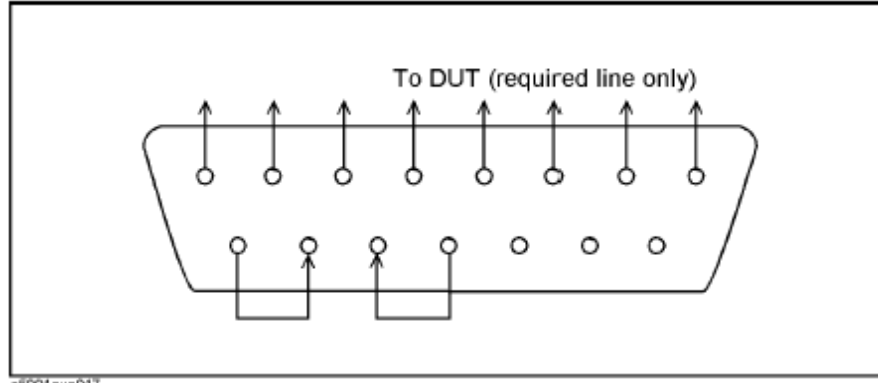
1. Turn On U3022AH10.
2. Measure the voltage between pin 12 and 15 using a multimeter.
3. Rotate the voltage adjustment trimmer on the front panel until the multimeter indicates the appropriate voltage.

Connecting to the DUT Control Lines

Figure 44 illustrates an example of the connection between the DUT and the U3022AH10 *without* an external dc power supply. Connect pin 12 to pin 13 for +5 V, and pin 14 to pin 15 to provide the ground path. Connect each DUT control line to the external device under test.

CAUTION You may only connect pin 12–13, and pin 14–15. Damage may result if any other path is short-circuited.

Figure 44 Control Line Connector



Using an External Power Supply

Figure 44 illustrates an example of the connection between the DUT and the U3022AH10 *with* an external dc power supply. Input the High and Low signals from the external power supply to the Positive Input and Negative Input respectively, and connect each line to the control terminal of the DUT.

Turning On the U3022AH10 using an External Power Supply.

1. Turning On the U3022AH10.
2. Connect the DUT.
3. Turn On the external power supply.

Turning Off the U3022AH10 using an External Power Supply.

1. Turning Off the Power Supply.
2. Turning Off the U3022AH10.
3. Disconnect the DUT.

Figure 45 U3022AH10 to the DUT and External DC Power Supply

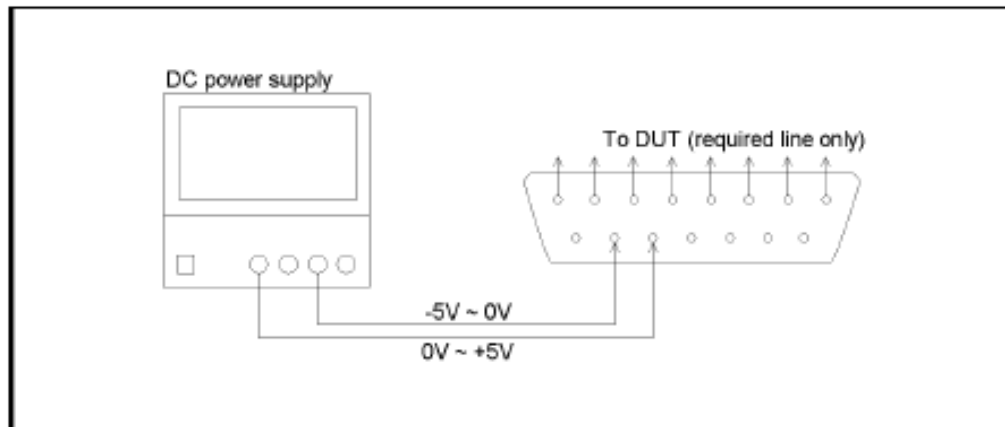
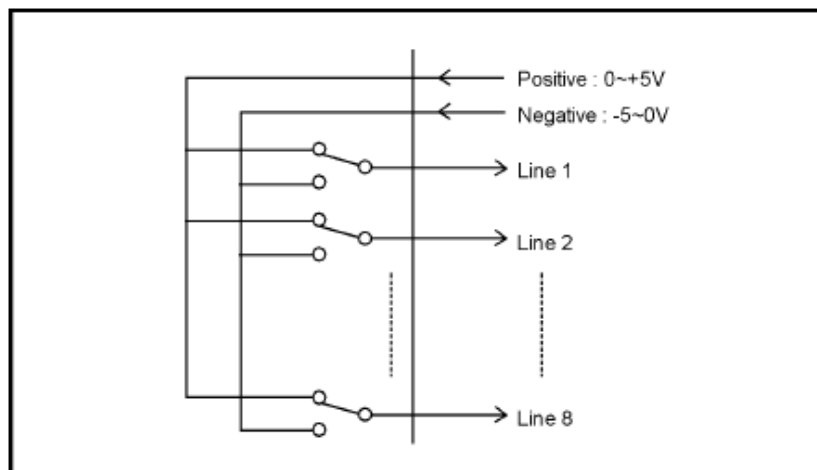


Table 11 DUT Control Specifications

Item	Specifications
Connector Shape	15-pin female D-Sub
Voltage Range:	
Positive Input	0 to +5 V
Negative Input	-5 to 0 V
Maximum Current	100 mA (in total of each line)
Impedance	< 10 Ω
Range of Variable Voltage	+2 to +5 V

Figure 46 Block Diagram of DUT Control

Operational Check

This section provides the test calibration procedure to confirm the U3022AH10 operational performance. The operation verification limits provided ensure that your system is operating properly. The operational check is performed with the system configured as in “RF Cable Connections for the PNA-X Standard Power Configuration (12-Port or 14-Port)” on page 16. The operational check configuration does not apply to the high power devices.

Verification Limits

Specifications for the U3022AH10 Multiport Test Set are typical. System performance for the PNA and Test Set are only characteristic and intended as non warranted information. A functional certificate is provided for the U3022AH10 only.

It is recommended that you return your instrument to Agilent Technologies for servicing or repair if the Test Set and PNA performance exceed the operational verification limits. “Contacting Agilent” on page 73.

NOTE Typical specifications are based on 1 to 2 units performance.

Table 12 Operation Verification Limit for Reflection Tracking¹ (Ports 1-12)

Frequency	N5242A and Test Set
10 MHz to 4 GHz	-5.5 dB
4 GHz to 6 GHz	-6.0 dB
6 GHz to 10 GHz	-7.0 dB
10 GHz to 15 GHz	-8.5 dB
15 GHz to 20 GHz	-10.0 dB
20 GHz to 26.5 GHz	-15 dB

1. Reflection Tracking takes into account Source Loss, Receiver Loss, Margin, and PNA Mixer Cal.

Equipment Required

The Agilent U3022AH10 requires that the user be familiar with the equipment and components listed in [Table 13](#).

This section provides an equipment list and setup of the PNA and Test Set.

Table 13 Equipment List

Description	Qty
N5242A 4-Port Network Analyzer (Option 400 and 551) <i>or</i> N5242A 2-Port Network Analyzer (Option 200 and 551)	1
N4691A 3.5 mm ECal Module 10 MHz - 26.5 GHz (Option 00F or M0F) <i>or</i> N4691B 3.5 mm ECal Module 300 kHz - 26.5 GHz (Option 00F or M0F) <i>or</i> Mechanical cal kit 85052B or 85052D	1
Set of interconnect cables (PNA and Test Set), see Table 7 on page 17 .	1

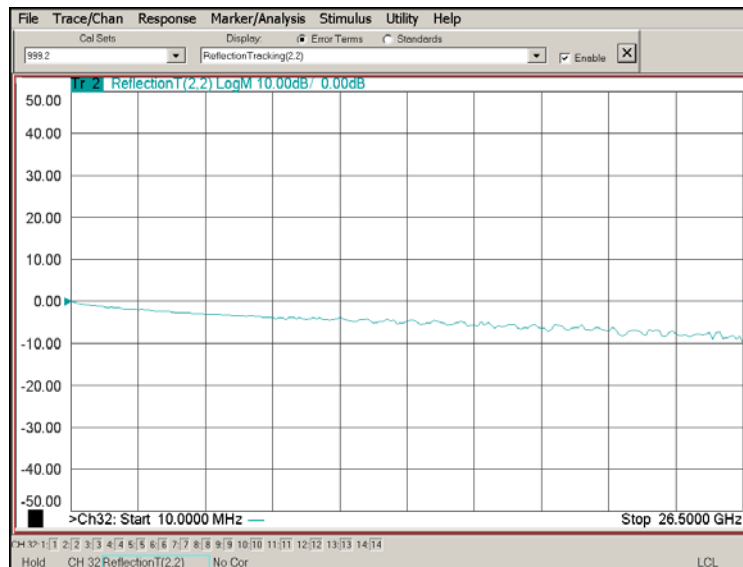
Operational Check Procedure

The sequence of this procedure is very important and must be followed or the performance accuracy and results may vary from the reference plots provided. Ensure that the test set is not connected to the network analyzer if you are performing a network analyzer Operator's Check. The network analyzer will indicate false failures if the test set is connected.

NOTE In this procedure (when using with the PNA-X System) Ports 13 and 14 are not connected to the test set, therefore not verified.

NOTE If you suspect that your 12 or 14-Port configuration is not operating properly, ensure that all front RF jumper interconnect cables are correctly attached.

Figure 47 PNA-X and Test Set Reflection Tracking Trace (Port 1 - 12)



Preparing the N5242A 12-Port System

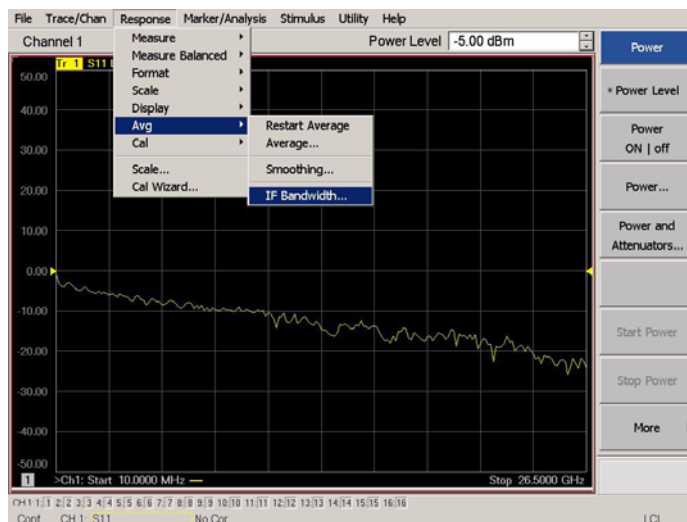
1. Connect the Test Set to the 2-Port N5242A as shown in [“RF Cable Connections for the PNA-X Standard Power Configuration \(12-Port or 14-Port\)”](#) on page 16.
2. Turn On the Test Set.
3. On the N5242A press **Response > CAL > Manage CALS > CAL Set**. Delete or Rename any Cal Sets titled “999.1” thru “999.12” (12-Port), although it is unlikely that you will find Cal Sets with these names.
4. Verify that the PNA is in 12-Port. See the bottom of the measurement window.
 - a. If only four S-Parameters are listed, press **Utility > System > Configure > Multiport Capability**. On the Multiport Restart dialog, select **Restart as multiport PNA with this test set**. Select **U3022AH10** (12-Port).
5. Press **Preset**.
6. Verify that the **[Stop Frequency]** is set to **[26.5 GHz]**.
7. Verify that the **[Start Frequency]** is set to **[10 MHz]**.
8. Verify that the **[Power]** is to set to **[-5 dBm]**.
9. Select **Response > Avg > IF Bandwidth > 100 Hz**. See [Figure 48](#).
10. Select **Stimulus > Sweep > Number of Points > 401**.
11. Connect the ECal module to the network analyzer USB port on the front or rear panel. This procedure assumes you are using a ECal. If you are not, see [“Operational Check Procedure for a N5242A System”](#) step 2.
12. Allow the ECal module, Test Set and PNA to warm up for a minimum of 30 minutes.

Preparing the N5242A 14-Port System

NOTE In this procedure (when using with the 4-Port PNA-X System) Ports 13 and 14 are not connected to the test set, therefore not verified.

1. Connect the Test Set to the N5242A 4-Port as shown in [“RF Cable Connections for the PNA-X Standard Power Configuration \(12-Port or 14-Port\)”](#) on page 16.
2. Turn On the Test Set.
3. On the N5242A, press **Response > CAL > Manage CALS > CAL Set**. Delete or Rename any Cal Sets titled “999.1” thru “999.12” (12-Port), although it is unlikely that you will find Cal Sets with these names.
4. Verify that the PNA is in 14-Port. See the bottom of the measurement window.
 - a. If only four S-Parameters are listed, press **Utility > System > Configure > Multiport Capability**. On the Multiport Restart dialog, select **Restart as multiport PNA with this test set**. Select **U3022AH10** (12-Port).
5. Press **Preset**.
6. Verify that the **[Stop Frequency]** is set to **[26.5 GHz]**.
7. Verify that the **[Start Frequency]** is set to **[10 MHz]**.
8. Verify that the **[Power]** is to set to **[-5 dBm]**.
9. Select **Response > Avg > IF Bandwidth > 100 Hz**. See [Figure 48](#).
10. Select **Stimulus > Sweep > Number of Points > 401**.
11. Connect the ECal module to the network analyzer USB port on the front or rear panel. This procedure assumes you are using a ECal. If you are not, see [“Operational Check Procedure for a N5242A System”](#) step 2.
12. Allow the ECal module, Test Set and PNA to warm up for a minimum of 30 minutes.

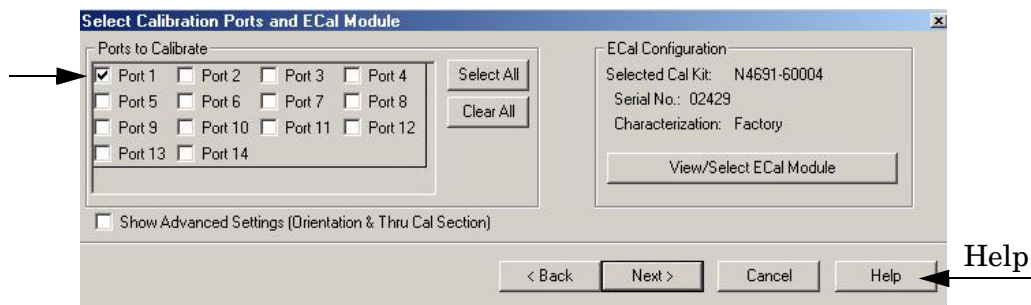
Figure 48 Setting the IF Bandwidth



Operational Check Procedure for a N5242A System

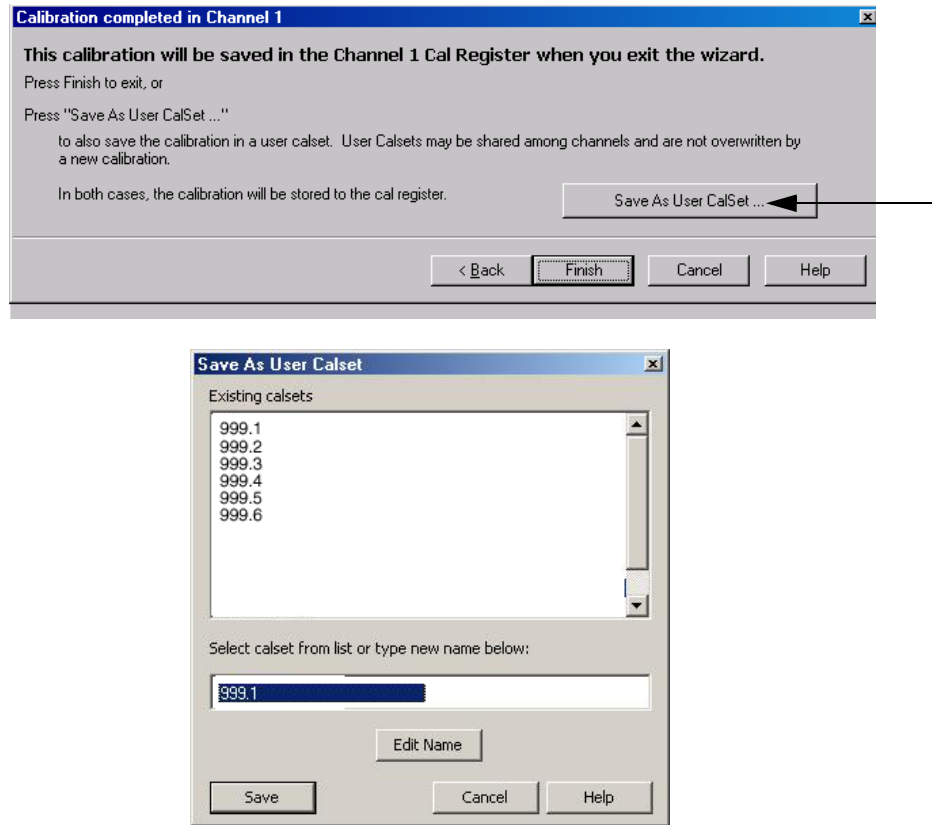
1. Connect the ECal or the mechanical cal kit to Port 1 or the port you are testing. Torque to 8 in-lb. For more information press the **Help** button, see [Figure 49](#).
2. Perform a 1-Port Calibration on Port 1. On the PNA, press **Response > CAL > Start Cal > Calibration Wizard**.
 - a. If using a mechanical cal kit, select **SmartCal**.
 - b. If using an ECal module, select **ECal**.
3. Continue following the Cal Wizard prompts. In the “Select Calibration Ports and ECal Module” window, press **Clear All** and select **Port 1**, then press **Next**.

Figure 49 1-Port Calibration



4. Continue to follow the prompts until the “Calibration Completed” window appears.
5. At the Calibration Completed prompt, select **Save As User Calset** and type the name **999.1**. Overwrite the Calset if it already exists. Press **Save**.

NOTE If you do not have a key board, select **Save As User Calset > Edit Name** and save as **999.x**. X is the port number you are calibrating. See [Figure 50](#). Use the numeric keypad on the PNA front panel to enter “999.1.”

Figure 50 Calibration Complete

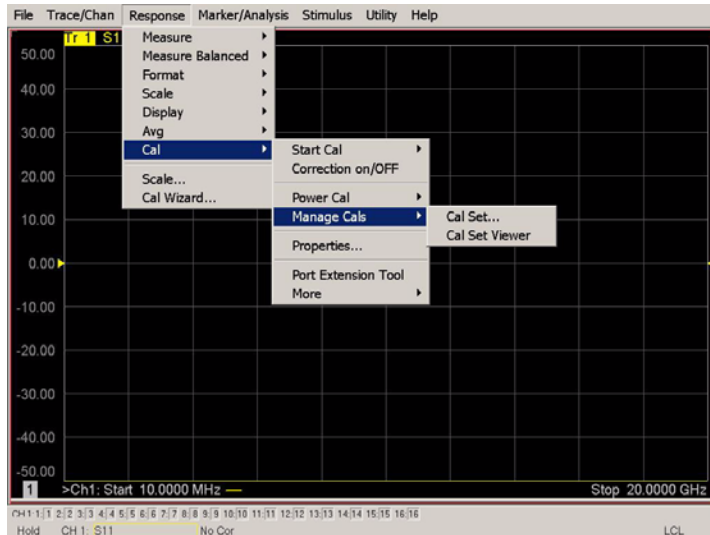
6. Repeat [step 1](#) thru [step 5](#) for Ports 2 thru 12. When finished, there should be twelve Cal Sets saved with the titles “999.1” thru “999.12” (12-Port).

If you are using an ECal module you can verify the individual port calibration by selecting **Response > CAL > More > ECAL > ECAL Confidence Check**. For further information refer to the system **Help** menu.

7. Press **Trace/Chan > Trace > Delete Trace**. There should be no traces on the PNA screen.

- To launch the Cal Set Viewer toolbar. Select **Response > CAL > Manage CALS > CAL Set Viewer**.

Figure 51 Calibration, Cal Set Viewer



- From the Cal Sets drop-down menu, select **999.1** and check **Enable**. Select the **Reflection Tracking(1,1)** term in the center drop-down menu and ensure that the **Enable** and **Error Terms** are selected.

NOTE You may also create a table on the network analyzer and enter the limit line stimulus and response values. Select **Limit Test ON** and **Limit Line ON**, and select **Show Table**. See [Figure 52](#).

Figure 52 PNA-X Setting the Test Limits

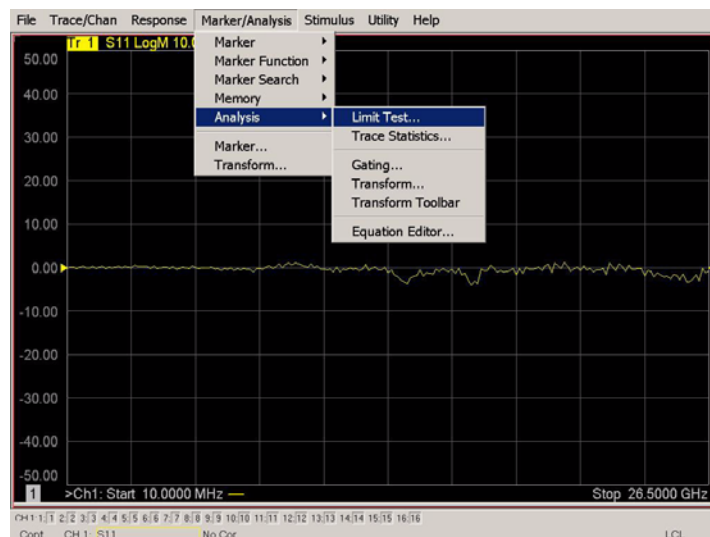
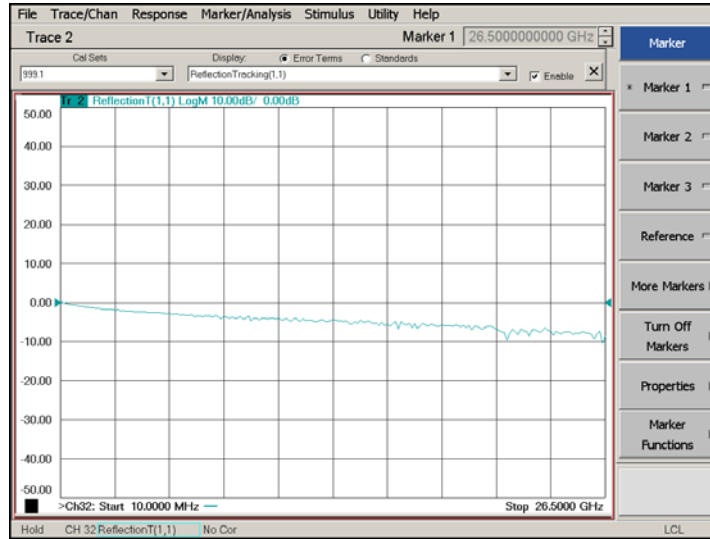


Figure 53 Reflection Tracking Trace (Port 1-12)

10. Compare the Reflection Tracking (1,1) trace to the appropriate limits in [Table 12 on page 51](#). This can be done using Limit Lines (press **Marker/Analysis > Analysis > Limit Test**). The trace should be above the limit. PASS will be displayed on the screen if the limit lines are used.

11. Repeat [step 9](#) and [step 10](#) for Cal Sets “999.1” thru “999.12” (12-Port).

Troubleshooting Operational Check Failures

If your test results fail the Operational Check limits, verify following:

1. Insure that the test set is turned on and connected properly to the PNA.
2. Check all appropriate network analyzer and test set connectors for damage, cleanliness, and proper torque.
3. Repeat the relevant 1-Port calibrations.
4. Verify that the stand-alone network analyzer is operating properly and meeting its published specifications. Refer to [“Network Analyzer Requirement” on page 3](#).

Interconnect Cable Verification

1. Connect the Test Set to the PNA and select Multiport mode. See [“Controlling the System with N5242A”](#).
2. Verify the Source Interconnect RF cables (Source Out and CPLR THRU).
 - a. Remove the Receiver and CPLR ARM interconnect cables and install the standard PNA jumpers.
 - b. Connect an RF cable from Port 1 to Port 2 on the PNA.
 - c. Set the PNA to measure Trace S12 and S21 and verify that there are no power holes. If S12 has a power hole check the Port-2 Source interconnect cables and test set connectors for damage. If S21 has a power hole check the Port-1 Source interconnect cables and test set connectors for damage.
3. Verify the Receiver Interconnect RF cables (Receiver A IN or B IN and CPLR ARM).
 - a. Re-install the Receiver and CPLR ARM interconnect cables.
 - b. Remove the Source Out and CPLR THRU interconnect cables and install the standard PNA jumpers.
 - c. Connect an RF cable from Port 1 to Port 2 on the PNA.
 - d. Set the PNA to measure Trace S12 and S21, and verify that there are no power holes. If S12 has a power hole check the Port-1 Receiver Interconnect cables and test set connectors for damage. If S21 has a power hole check the Port-2 Receiver Interconnect cables and test set connectors for damage.
4. If the problem still exists, connect the standard jumpers to the PNA (Source and Receiver) and verify the Source Out to CPLR THRU and A/B IN to CPLR ARM switch paths.
 - a. Set the PNA to measure trace S12.
 - b. Connect Port-1 to Source Out and Port-2 to CPLR THRU connectors on the test set. If a power hole still exists refer to [“Contacting Agilent” on page 73](#).
 - c. Connect Port-1 to Receiver A IN or B IN and Port-2 to CPLR ARM connectors on the test set. If a power hole still exists refer to [“Contacting Agilent” on page 73](#).

Theory of Operation

The following is a description of the operation of the U3022AH10. Reference the U3022AH10 block diagrams shown in [Figure 54 on page 62](#). This section assumes the user has a general understanding of couplers, switches, and network analyzers.

RF Switch Components

S102, S202, S302 and S401 are all mechanical switches. The frequency range is DC to 26.5 GHz. The switches select the RF paths from the PNA source and receiver through interconnect cables to test set port paths 3 - 12. Ports 3 - 12 are couplers that provide 20 watt input power handling capability.

S102 - Source to Odd Ports (1-11)

Switch 102 provides control of the Source path to PNA Port 1 and the test set odd ports (3 - 11). In the state shown in the block diagram, switch 102 routes the RF source back to the PNA Port 1 and all unused test set odd ports (3 - 11) source paths are terminated.

S202 - Source to Even Ports (2-12)

Switch 202 provides control of the Source path to PNA Port 2 and the test set even ports (4 - 12). In the state shown in the block diagram, switch 202 routes the RF source back to the PNA Port 2 and all unused test set even ports (4 - 12) source paths are terminated.

S302 - Receiver to Odd Ports (1-11)

Switch 302 provides control of the A Receiver path to PNA Port 1 and the test set odd ports (3 - 11). In the state shown in the block diagram, switch 302 routes the coupler arm from the PNA Port 1 to the A Receiver and all unused test set odd ports (3 - 11) coupler arm paths are terminated.

S402 - Receiver to Even Ports (2-12)

Switch 402 provides control of the B Receiver path to PNA Port 2 and the test set even ports (4 - 12). In the state shown in the block diagram, switch 402 routes the coupler arm from the PNA Port 2 to the B Receiver and all unused test set even ports (4 - 12) coupler arm paths are terminated.

RF Coupler Components

Test set ports (3 - 12) provide the signal separation of the source and receiver paths. The test set ports can either stimulate or receive a signal to the DUT.

System Block Diagram

Figure 54 12 Port Standard Configuration

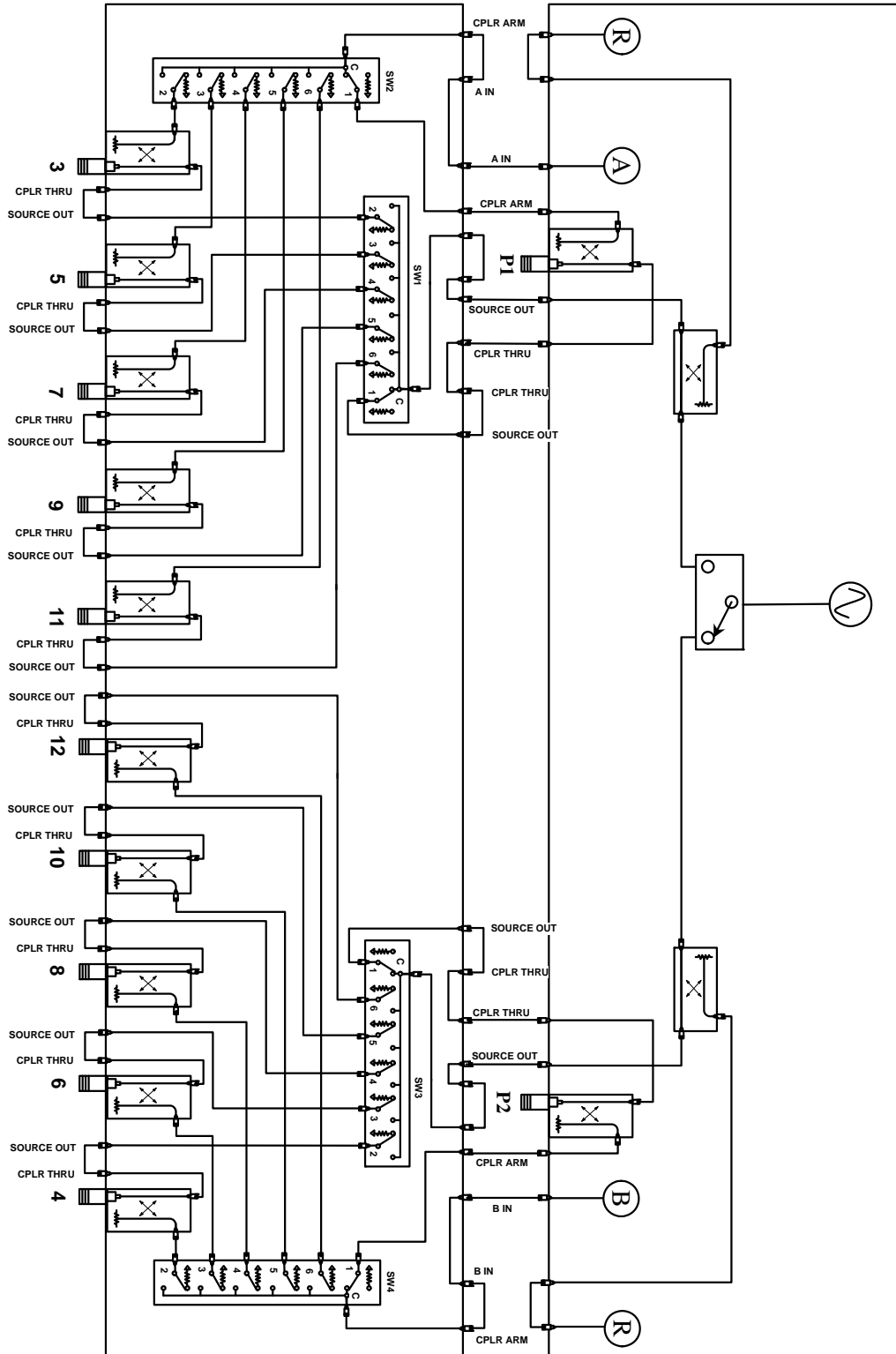


Figure 55 2-Way Power Configuration (1 Watt)

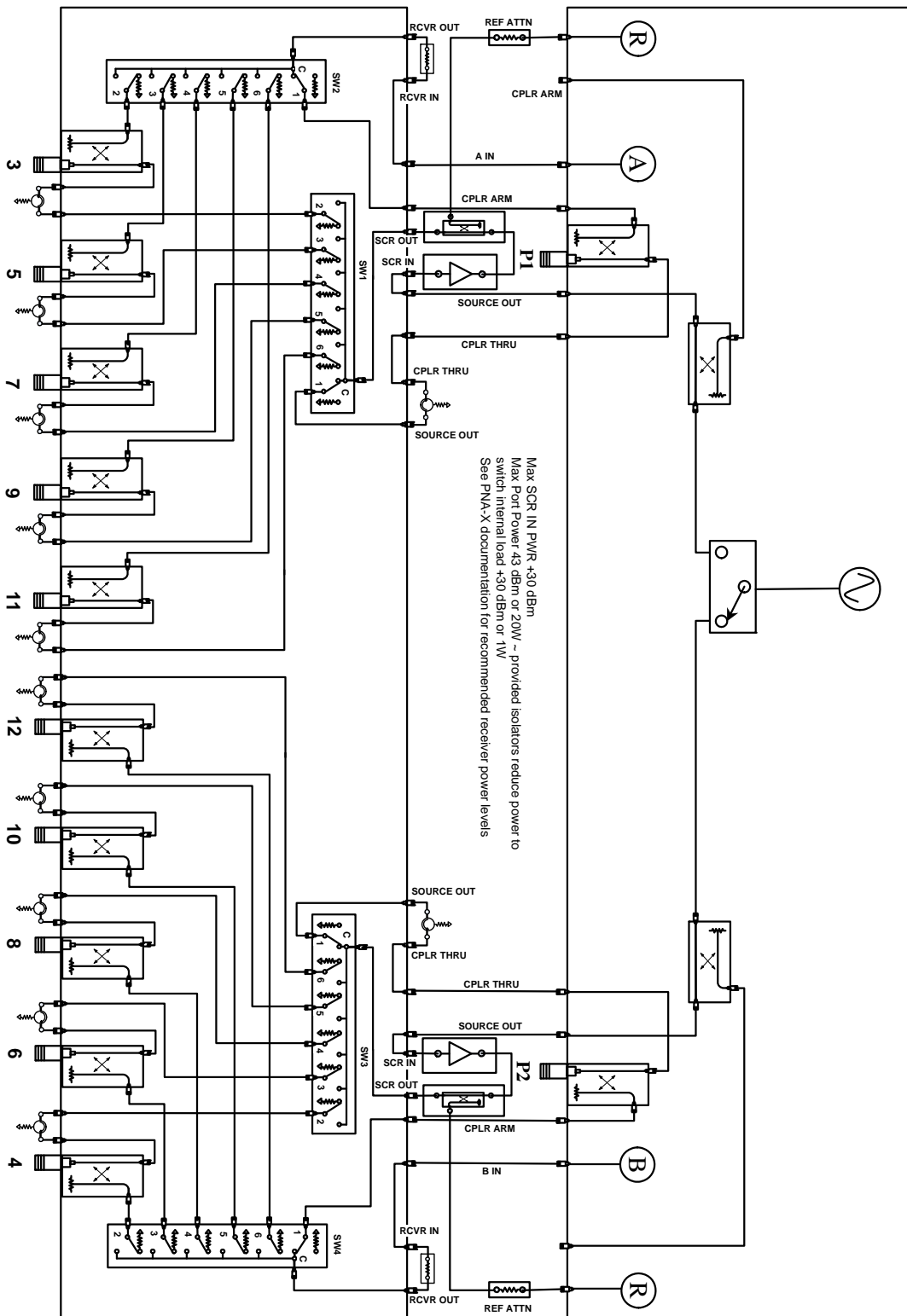


Figure 56 Odd Port High Power Configuration (1 Watt)

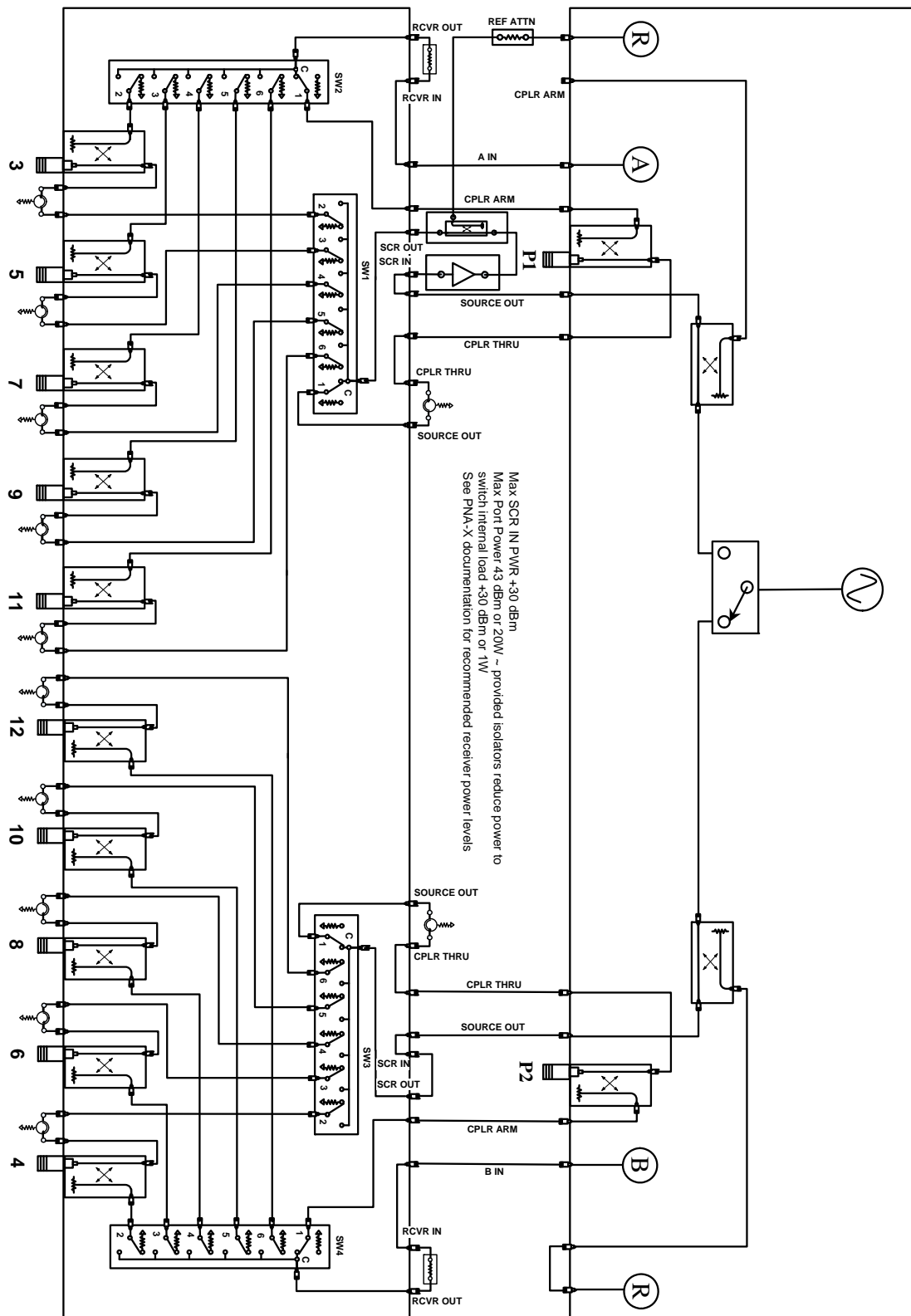
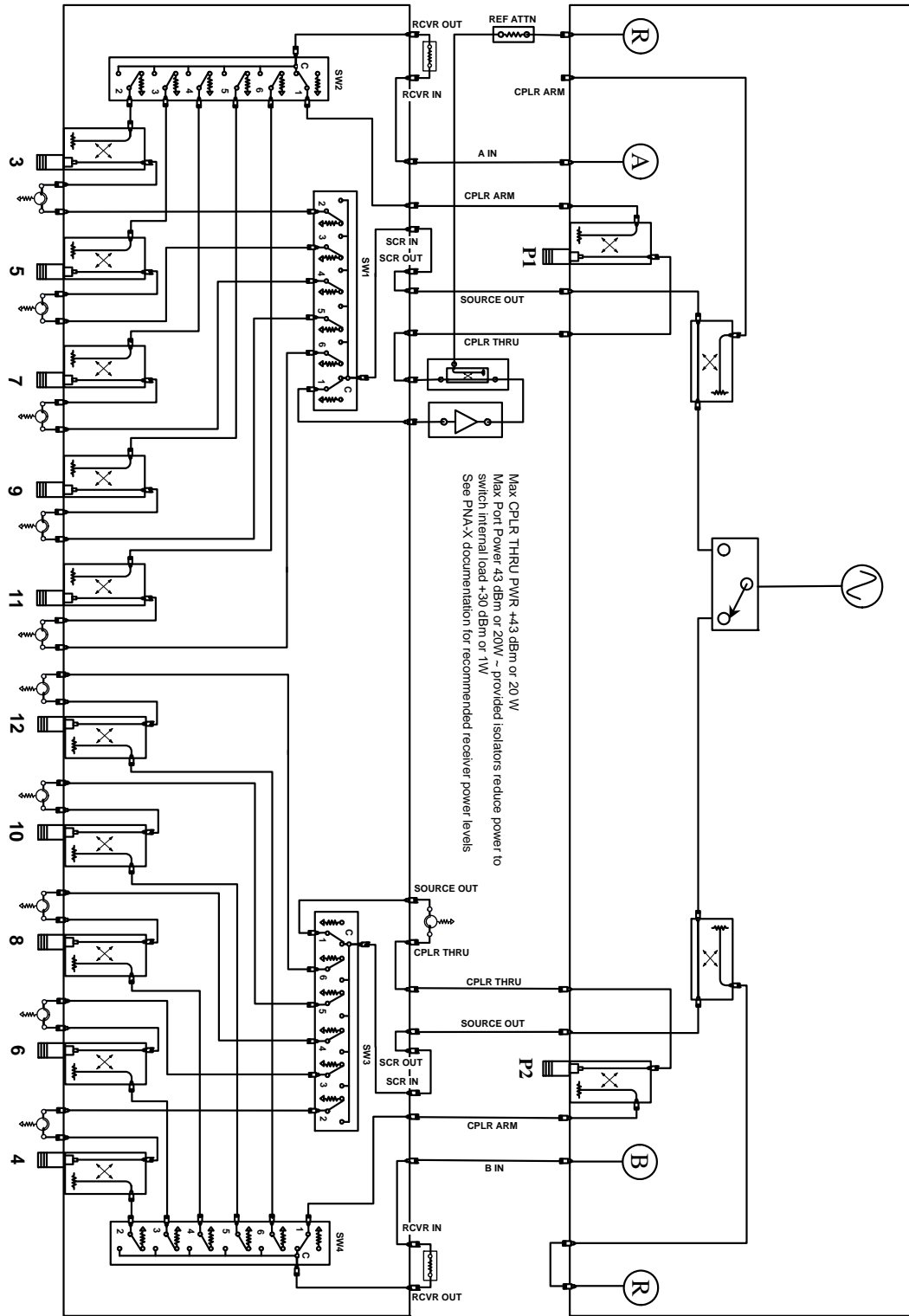


Figure 57 Port 1 High Power Configuration



Service Information

The analyzer's standard warranty is a one-year return to Agilent Technologies service warranty. Refer to [“Contacting Agilent” on page 73](#).

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.

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

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.**

Replaceable Parts

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

Description	Agilent Part Number
User's Guide (U3022A Option H10)	U3022-90001
Interconnect Cable	8120-6818
PNA, PNA-L or PNA-X Locking Feet	5023-0132
Option 042 Cables (12 or 14-Port)	
N5242-20138	Rear Locking Link (right)
N5242-20139	Rear Locking Link (left)
U3022-80002	Label (Port 13)
U3022-80003	Label (Port 14)
Z5623-20418	Semi-rigid RF Cable
Z5623-20418	Semi-rigid RF Cable
U3022-20091	Semi-rigid RF Cable
U3022-20092	Semi-rigid RF Cable
U3022-20093	Semi-rigid RF Cable
U3022-20094	Semi-rigid RF Cable
0515-3317	Screw

Safety and Regulatory Information

Introduction

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. 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 **To prevent electrical shock, disconnect the [Agilent Technologies U3022AH10](#) 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.**

Connector Care and Cleaning

If alcohol is used to clean the connectors, the power cord to the instrument must be removed. All cleaning should take place in a well ventilated area. Allow adequate time for the fumes to disperse and moist alcohol to evaporate prior to energizing the instrument.

WARNING **Keep isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. It is extremely flammable. In case of fire, use alcohol foam, dry chemical, or carbon dioxide; water may be ineffective.**

Declaration of Conformity

A declaration of conformity is on file for the PNA-X models, and a copy 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 IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

Compliance with Canadian EMC Requirements

This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme a la norme NMB du Canada.

Compliance with German FTZ Emissions Requirements

This product complies with the German FTZ 526/527 Radiated Emissions and Conducted Emission requirements.

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 Maschinenlaermverordnung-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.

Safety Information

Complies with European Low Voltage Directive 2006/95/EC

- IEC/EN 61010-1, 2nd Edition
- Canada: CSA C22.2 No. 61010-1-04
- USA: UL Std. No. 61010-1 (2nd Edition)

Warnings

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

Warnings applicable to this instrument are:

WARNING **For continued protection against fire hazard replace line fuse only with same type and rating. Fuse: 5A/250V, Part Number 2110-0709
The use of other fuses or material is prohibited.**

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 instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.**

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

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 **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.**

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).**

Cautions

CAUTION The CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, which if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

Cautions applicable to this instrument are:

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 instrument has autoranging line voltage input; be sure the supply voltage is within the specified range.

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.

CAUTION This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 61010-1:2000, and 664 respectively.

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.



This symbol indicates that the instrument requires alternating current (ac) input.



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.

ISM1-A

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

ICES/NMB-001

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



Direct Current.



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.



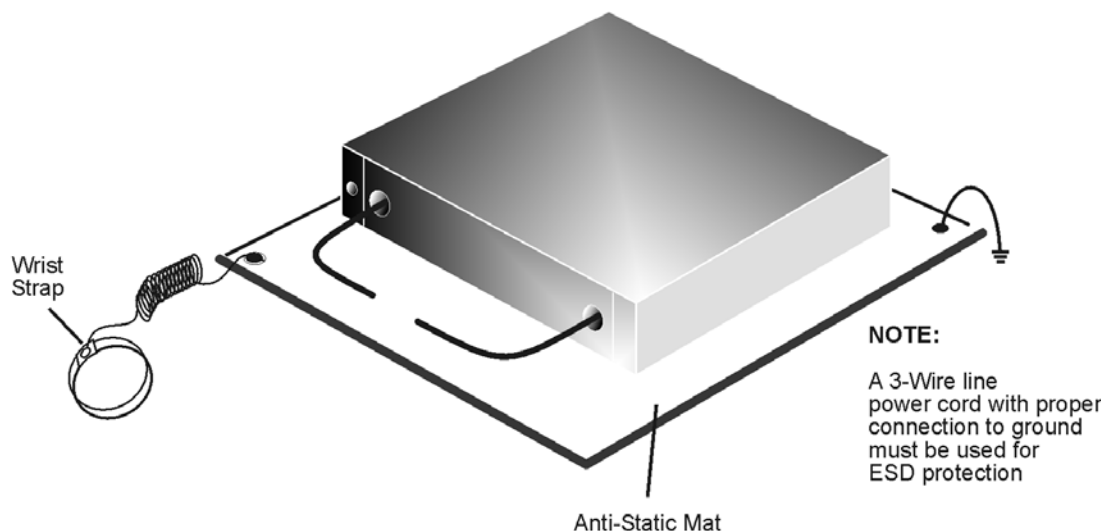
This symbol indicates compliance with the China RoHS regulations for paper/fiberboard packaging.

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 Ω 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 14 ESD Protection Setup



ku310b

Agilent Assistance

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 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 73](#).

Shipping Your Analyzer to Agilent for Service or Repair

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.

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.

