Keysight Technologies U3022AH10 Multiport Test Set

For serial number US47450118 and above

Notice: This document contains references to Agilent. Please note that Agilent's Test and Measurement business has become Keysight Technologies. For more information, go to www.keysight.com.

Use this manual with the following document: PNA Series Network Analyzer On-line Help System.

KEYSIGHT TECHNOLOGIES

User's and Service Guide

Notices

Manual Part Number

U3022-90002

Edition

Edition 6: December 2020
Supersedes: August 2020

Printed in USA

Published by:
Keysight Technologies
1400 Fountaingrove Parkway
Santa Rosa, CA 95403

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT WILL CONTROL.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

U.S. Government Rights

The Software is "commercial computer software," as defined by Federal Acquisition Regulation ("FAR") 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement ("DFARS") 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at http://www.keysight.com/find/sweula. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in 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.

WARNING

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

What's Changed

In this document the terms "master" and "slave" have been replaced with "primary" and "secondary."

Table of Contents

U3022AH10

Introduction 8
Description 10
Measurement Application Notes. 10
Low Loss DUT Measurements. 10
Switch Configuration Command Speed 10
Verifying the Shipment 10
Network Analyzer Requirements. 12
Definitions 12
Available Options. 13
General Specifications. 14
Power Requirements 14
Environmental Requirements 15
Environmental Tests 15
Equipment Heating and Cooling. 15
Required Conditions for Accuracy Enhanced Measurements 15
Dimensions and Space Requirements 15
Frequency Range and Maximum Power Levels 16
Front and Rear Panel Features 18
PNA-X Interconnect Ports - 3.5 mm (female) to SMA (female) 18
Access Ports for External High Power Devices. 19
Test Ports - 3.5 mm Bulkhead (male) 19
Test Port LEDs 19
Active LED 19
Standby Switch 19
Control Lines and Voltage Adjust 20
Test Set Interface 20
Pass Through Interface 20
Line Module. 20
Available Fuses 21

Table of Contents

System Configurations 22
System Setup N5242A PNA-X 23
Preparing the PNA-X Network Analyzer 23
System Setup, 12/14 Port RF Cable Configuration 26
System Operational Checks 28
Equipment Setup. 28
Verify Results. 28
Controlling the System with N5242A/B 32
Typeface Key Conventions 32
PNA-X Multiport Mode with Option 551 32
12/14 Port System with N5242A/B 33
External Test Set Control Feature 34
Trace Measure S-Parameter 36
New Trace Measure S-Parameter. 37
Balanced Tab. 38
Receiver Tab 38
RF Path Configuration Check for Analyzers with Option 029 39
Sweep Setup for Multiport and Standalone PNA-X Modes. 40
PNA-X N52xxA Models 40
PNA-X N52xxB Models 40
N-Port Calibration with N5242A/B. 41
Interface Control Mode 42
Overview of the Interface Control 42
How to Access Interface Control Settings 43
Using Interface Control Mode. 44
SCPI Control Mode 46
Overview of the SCPI Control 46
How to Access the Command Processor 46
SCPI Command Processor Console 47
Option 129 External Source Path 49

Table of Contents

Address and Data Values 51
Setting the Test Port Paths with Address and Data 51
DUT Control Lines 56
Setting the DUT Control Interface 56
Setting the Variable Source Voltage. 58
Connecting to the DUT Control Lines. 58
Using an External Power Supply. 59
High Power Measurements 61
Getting Started 61
Measuring Booster Amplifier Gain 62
Setting the Power level at the Output of the DUT 65
Calibrating the System and Measuring the DUT 69
Service Information 70
Replaceable Parts 71
Theory of Operation. 76
RF Switch Components. 76
RF Coupler Components. 76
System Block Diagrams 77
Troubleshooting the Test Set. 81
Non-RF Malfunctions 82
RF Switching Malfunctions 83
Source and Receiver Path Test 84
Source Signal Path Insertion Loss Test. 86
Receiver Signal Path Insertion Loss Test 87
Safety and Regulatory Information 89
Introduction 89
Safety Earth Ground 89
Declaration of Conformity 89
Statement of Compliance 89
Before Applying Power 90
Servicing 91

Connector Care and Cleaning Precautions. 91
Electrostatic Discharge Protection 92
Instrument Markings 93
Battery 94
EMC 94
South Korean Class A EMC Declaration 94
Safety 94
Acoustic Statement (European Machinery Directive) 94
Keysight Support, Services, and Assistance 95
Service and Support Options 95
Contacting Keysight 95
Shipping Your Product to Keysight for Service or Repair. 95

U3022AH10

U3022AH10 (Standard)

U3022AH10 (Option 129)

Introduction

This document describes how to use the Keysight U3022AH10 Multiport Test Set.

Figure 1 N5242A PNA-X with U3022AH10 (Standard)

Figure 2 N5242A PNA-X with U3022AH10 (Option 129)

Description

The Keysight U3022AH10 is a 10-Port Multiport Test Set Extension designed to be configured for high power measurements in either a 12 or 14 port network analyzer measurement system. The Keysight U3022AH10 has the following key features:

- Capable of handling one watt of RF power (refer to "High Power Measurements" on page 61)
- 10 Test Ports (3.5 mm male connectors)
- Low loss mechanical RF switching
- Frequency range of operation (10 MHz to 26.5 GHz)
- A Keysight PNA-X with Option 551 is required with a rear panel Test Set I/0 interface for operational control. An external personal computer is not required.

NOTE **The Keysight PNA-X Network Analyzers will be referred to throughout this document as the Analyzer. The U3022AH10 will be referred to as the Test Set.**

Measurement Application Notes

Low Loss DUT Measurements

Low loss trace ripple is a product of switch repeatability and calibration technique. Low insertion loss measurements exhibiting a 0.1 dB uncertainty ripple residing on the measurement response is not uncommon.

Switch Configuration Command Speed

When writing address and data values to the test set directly, include a 15ms wait before issuing another address and data set. The delay of 15ms is required for the test set internal switches to settle. Failure to add the delay could cause the test set internal switches to stick or cause intermittent failures.

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 Keysight” on page 95. Keep the damaged shipping materials (if any) for inspection by the carrier and an Keysight representative.

Table 1 U3022AH10 Accessories

Keysight PN	Description	Qty
U3022AH10 Included Accessories		
85052-60007	Short, coax 3.5 MM female	1
N4011-21002	Cable assembly, I/0 Test Set	1
N5222-20091	RF cable, semi-rigid, front panel jumper	16
U3022-90002	User's and Service Guide	1
U3022AH10 Option 129 Included Accessories		
N5242-20206	RF Locking Link, Opt 129 (right)	1
N5242-20207	Rear Locking Link, Opt 129 (left)	1
N3022-20238	RF cable, semi-rigid, ECal jumper	1
U3022AH10 Option 042 Accessories (Purchased Separately)		
0515-2317	Screw, metric (T15, M3.5, 12 mm long)	2
5023-0132	Locking feet, rear	1
N5242-20138	Rear Locking Link (right)	1
N5242-20139	Rear Locking Link (left)	1
U3022-20091	RF cable, semi-rigid	2
U3022-20092	RF cable, semi-rigid	2
U3022-20093	RF cable, semi-rigid	2
U3022-20094	RF cable, semi-rigid	2
U3022-80002	Label (Port 13)	1
U3022-80003	Label (Port 14)	1

Network Analyzer Requirements

For multiport operation (N-Port error correction and measurement capability), all "A" model network analyzers require Option 551 and all "B" model analyzers require Software Application S93551B. For "B" models in which the system is configured with more than 8 test ports it is recommended to use PLTS Software, N1930B, to manage/control any advanced network analyzer measurement applications and their large data files.

Table 2 provides a listing of other network analyzer option requirements. The analyzer's frequency range must be equal to or exceed that of the test set so that the measurement system covers the full frequency range of the test set.

The test set files indicated in Table 2 must be installed into this network analyzer file directory location: **C:/Program Files (x86)/Agilent/Network Analyzer/TestSets**. For the "B" model PNA-X: **C:/Program Files (x86)/Agilent/Keysight/Network Analyzer/Keysight/TestSets**.

Table 2 PNA-X Configuration Requirements

12 Port Network Analyzer System	Options	Test Set File	System Figure
N5241/2A/B PNA-X	200	u3022ae10_pnax_p2.tsx[1]	
14 Port Network Analyzer System			
N5241/2A/B PNA-X	400	u3022ae10_pnax_p4.tsx[1]	1
N5242A/B PNA-X	400	u3022ah10_pnax_p4.tsx[2]	2

1. For use with STD Test Set only
2. For use with Option 129 Test Set only

Definitions

NOTE **The Test Set files indicated in Table 2 must be installed into this network analyzer file directory: c:\Program Files\Keysight\Network Analyzer\testsets**

- *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.

Available Options

Test Set Options

The U3022AH10 has two available options (refer to "System Block Diagrams" beginning on page 77):

Option 129 adds an external source path for Ports 1, 3, 5, 7, 9, and 11. The instrument cabinet is 498 mm deep and 221.5 mm high.

Option 700 is the standard model. The instrument cabinet is 421.6 mm deep and 177 mm high.

Rack Mounting Kits

Use the **U3022AH10-1Cx** for the Standard (700) model and the **U3022AH10-2Cx** for the Option 129 model.

U3022AH10-1CM, Rack Mount Kit without Handles (1CM114A*) 5063-9216
U3022AH10-1CN, Front Handle Kit (1CN103A*) 5063-9229
U3022AH10-1CP, Rack Mount Kit with Handles (1CP106A*) 5063-9236

U3022AH10-2CM, Front Rack Mount Kit without Handles 1CM130A*
U3022AH10-2CN, Front Handle Kit without Handles 1CN105A*
U3022AH10-2CP, Front Rack Mount Kit with Handles 1CP126A*

* New dark color version (Keysight Palette 2015)

Network Analyzer Interface Kit Options

NOTE **The U3022AH10 requires the following kit to interface the test set with your analyzer. The interface kit model option includes the hardware Lock-Link and cable kit listed in Table 3.**

Table 3 Interface Kit Options

12/14 Port Network Analyzer System	Interface Kit Option	Hardware Lock-Link	Cable Kit, Connector Type
N5242A/B PNA-X	U3022AH10 Opt 042	U3021-60002[1]	U3021-60096[2], SMA m/m

1. "System Setup N5242A/B PNA-X" on page 23.
2. "System Setup, 12/14 Port RF Cable Interface Configuration" on page 27.

General Specifications

Specifications for the U3022AH10 Multiport Test Set are characteristic for the System performance of the PNA-X and Test Set. Actual performance of the system is based on the customers PNA-X 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-X, 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-X and reduces dynamic range. The test port power, indicated by the PNA-X, 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 before installing the Test Set to the PNA-X.

- 100/120/220/240 VAC (50/60Hz)
- The instruments can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.
- Air conditioning equipment (or other motor–operated equipment) should not be placed on the same ac line that powers the Test Set and PNA-X.
- Table 4 contains the maximum wattage for all instruments. This table can be use to determine the electrical and cooling requirements.

Table 4 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

Refer to the PNA-X series standard documentation for environmental requirements.

Environmental Tests

The Test Set complies with all applicable safety and regulatory requirements for the intended location of use.

- Pressure Altitude (Operation)
  3,000 meters (~10,000 feet)
- The instrument can safely operate in a relative humidity of 80% for temperatures to 31 degrees C, decreasing linearly to 50% relative humidity at 40 degrees C.

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 4.

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.**

Required Conditions for Accuracy Enhanced Measurement

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

Dimensions and Space Requirements

Standard installation of the Test Set and PNA-X includes configuration and installation on a customer provided lab bench or table top of adequate size and strength. For weight, dimensions and space requirements, refer to the network analyzer documentation that is used to configure the Test Set.

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 (20.0 in)
U3022AH10	11.4 kg (25 lb)	19.1 cm (7.5 in)	42.5 cm (16.7 in)	42.6 cm (17.0 in)
U3022AH10 Option 129	14.4 kg (31.7 lb)	22.9 cm (9.0 in)	42.5 cm (16.7 in)	50.8 cm (20.0 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, Noise Source In/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 61.
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)

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

Typical Reflection Tracking

Performance for the test set is typical. System performance for the analyzer and test set are only characteristic and are intended as non-warranted information.

NOTE Typical performance is based on 1 to 2 units performance. Refer to Table 7 below.

Table 7 Typical Reflection Tracking[1] (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-X Mixer Cal.

Front and Rear Panel Features

Figure 3 Front Panel, Standard

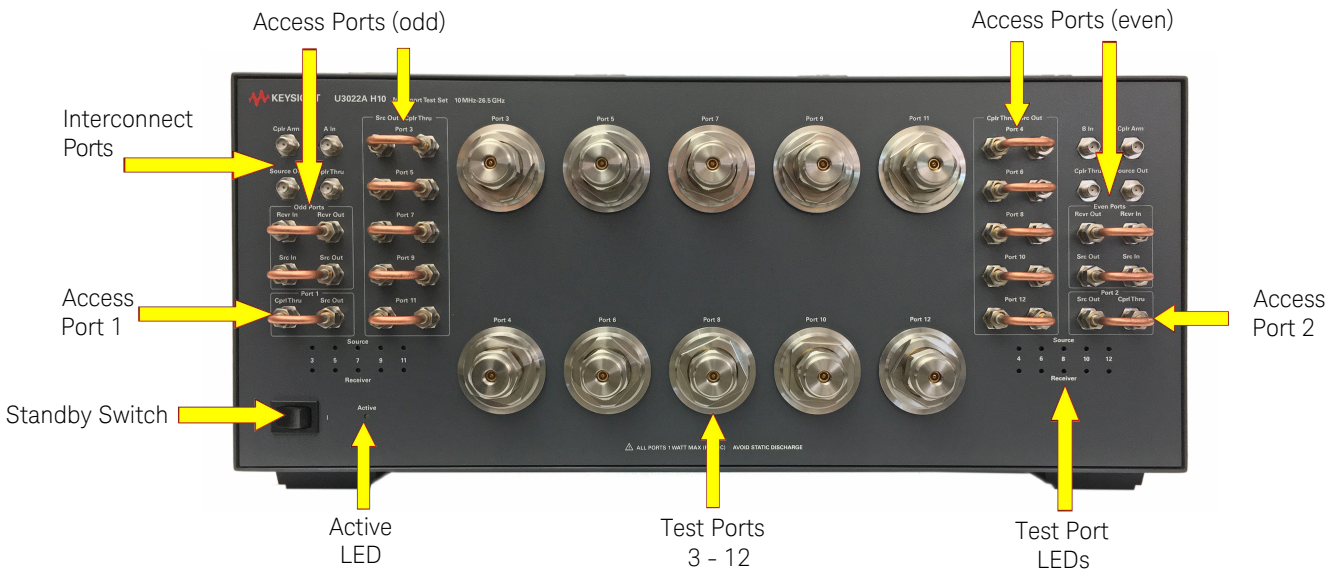
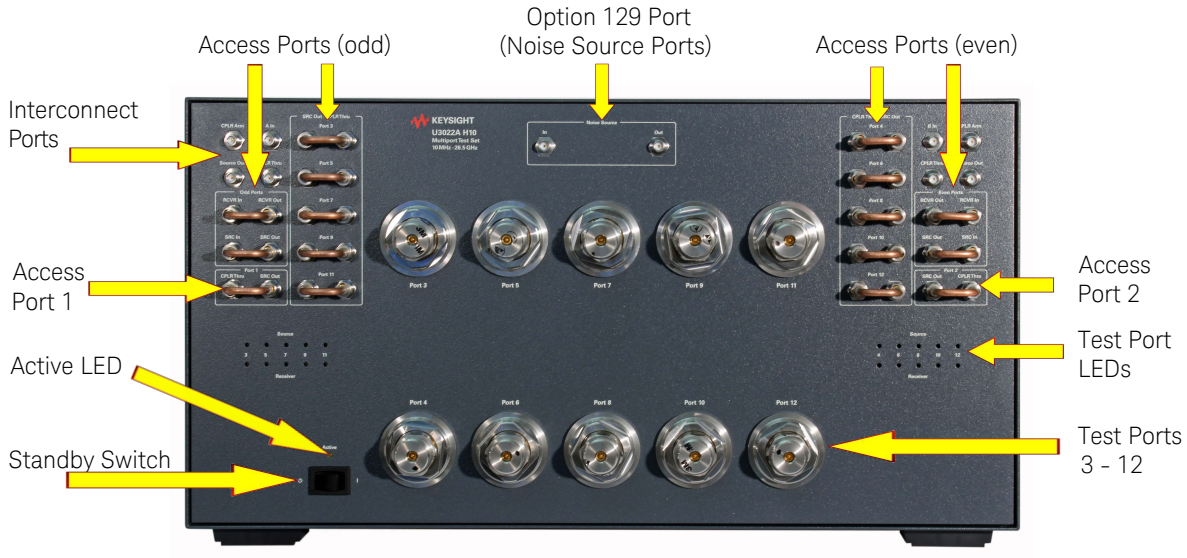


Figure 4 Front Panel, Option 129



PNA-X Interconnect Ports – 3.5 mm (female) to SMA (female)

- CPLR ARM PNA-X coupler ARM connection to Test Set
- A IN - B IN PNA-X RCVR A or B connection to Test Set
- SOURCE OUT Source from PNA-X
- CPLR THRU PNA-X coupler connection to Test Set

Access Ports for External High Power Devices

The front panel jumpers (E8356-20072) to (N5222-20091) are included in the shipment, but not installed.

- 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.
- Ports 3 - 12
  - SRC OUT - CPLR THRU, Jumper can be removed to install the amplifiers and isolators.
- Option 129 Port
  - NOISE SOURCE PORTS, In and OUT (SMA female).

Test Ports – 3.5 mm Bulkhead (male)

- Port 3–12

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-X is active.
- If all of the even numbered ports are Off, Port 2 of the PNA-X is active.

Active LED

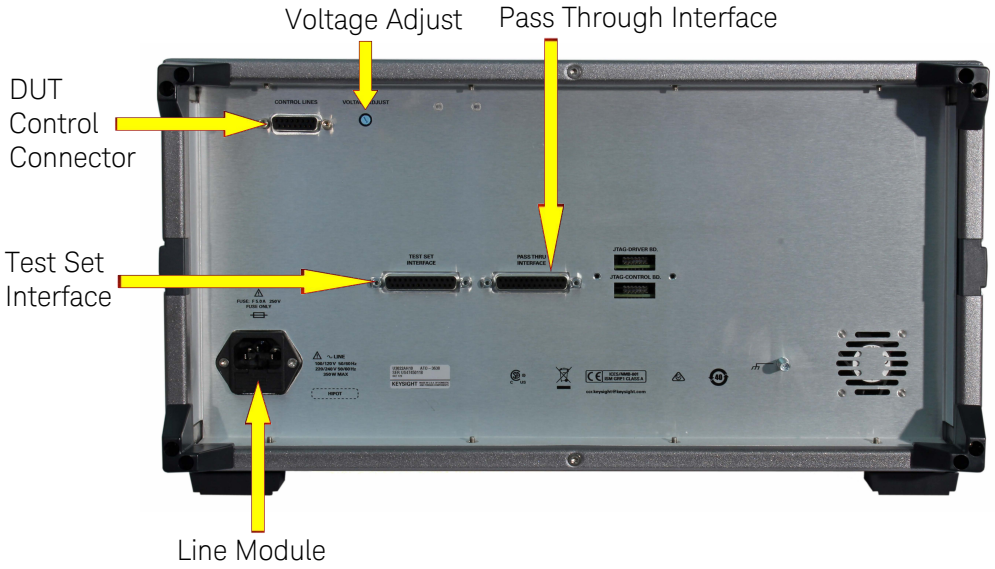
- When the Test Set power switch is On and is connected and addressed by a PNA-X, the LED is On (illuminated).
- The LED is Off (not illuminated) when the Test Set power switch is in Standby, or not addressed by a PNA-X.

NOTE **When the two test sets are connected together, as in the multi-Test Set system, the first test set connected to the PNA-X will never have an "ON" Active LED. Instead, the last test set in the I/O chain will be the test set showing the "Active LED" status for all.**

Standby Switch

Note that this switch is Standby only, not a line switch. To disconnect the mains from the instrument, remove the power cord.

Figure 5 Rear Panel (Multiport Test Set)



Control Lines and Voltage Adjust

For further information pertaining to control lines and voltage adjustments see “DUT Control Lines” on page 56.

Test Set Interface

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

Pass Through Interface

Connection to another Test Set.

Line Module

The line fuse, as well as a spare, reside within the line module. Figure 6 on page 21 illustrates where the fuses are located and how to access them.

Available Fuses

- 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. The use of other fuses or material is prohibited.**

Figure 6 Line Fuse

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

System Configurations

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

- "System Setup, 12/14 Port RF Cable Interface Configuration" on page 26.
- Figure 52, “1 Watt High Power Configuration” on page 68.
- Figure 53, “20 Watt High Power Configuration” on page 68.

Refer to “High Power Measurements" on page 61.

NOTE The internal firmware of the Keysight N5242A/B 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, found on page 61.

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-X 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 16.

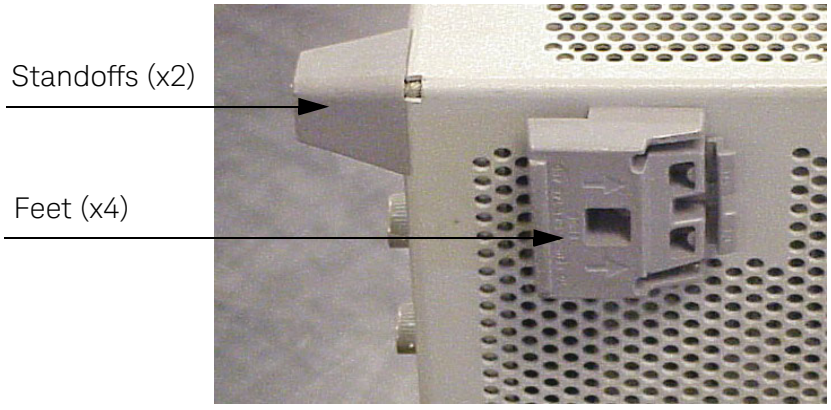
System Setup N5242A/B PNA-X

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-X Network Analyzer

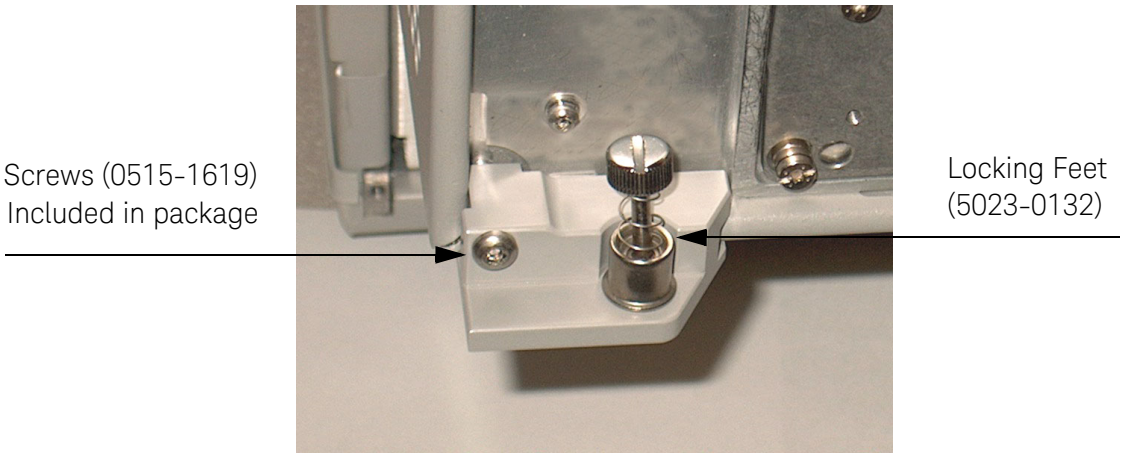
1. Remove the feet from the bottom of the network analyzer. Refer to Figure 7.

Figure 7 Rear Bottom Feet



2. Remove the two lower standoffs and screws (0515-1619) from the rear panel on the network analyzer.
3. Install the two rear locking feet (5023-0132) using the included screws (0515-1619), where the standoffs were removed. Refer to Figure 8.

Figure 8 Install Locking Feet

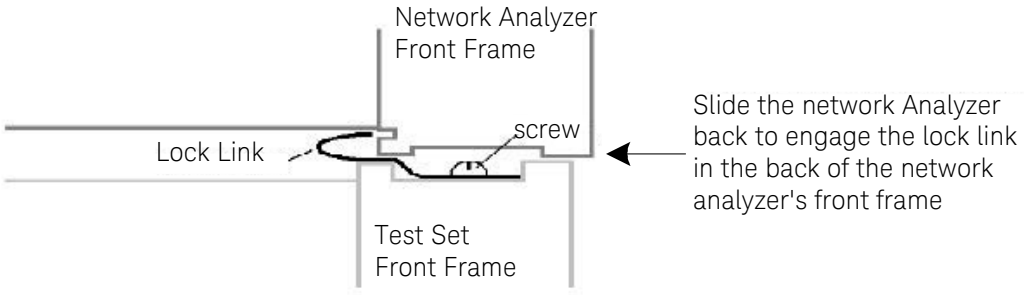


4. Install the two rear locking feet onto the U3022AH10. Looking at the front panel, the N5242-20138 (for Std) or N5242-20206 (for Opt 129) is the right foot and the N5242-20139 (for Std) or N5242-20207 (for Opt 129) is the left foot. Two screws (0515-2317) are included with these rear feet.

Figure 9 Install Locking Feet on U3022AH10 (STD shown)

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 Lock-Links (shown in Figure 10 below) that are attached to the Test Set. Slide the network analyzer back so the locks engage the front frame of the analyzer.

Figure 10 Locking the Analyzer to the Test Set



NOTE The Lock-Links are pre-installed on the Test Set at the factory.

6. 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 11. 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 11 Locking Feet Screws (STD shown)

NOTE

There are two Lock-Feet kits available. Refer to "Contacting Keysight" on page 95 for ordering information.

- PNA – 5023-0132 (Kit includes locking feet and screws)
- Test Set (STD) – N5242-20138 and N5242-20139 are the rear lock feet
- Test Set (Opt 129) - N5242-20206 and N5242-20207 are the rear lock feet (provided)
- Screw – 0515-2317

System Setup, 12/14 Port RF Cable Interface Configuration

Figure 12 and Figure 13 on page 27 illustrate the interface cable configuration of the U3022AH10 Multiport Test Set and how it should be configured to the N5242A/B 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. If not already installed, connect the 16 front panel jumpers (N5222-20091), as shown in Figure 12 on page 27.
3. Connect the RF cables from the N5242A/B Network Analyzer to the Test Set. Torque each cable to 8 in-lb. Refer to Table 8 below, Figure 12 and Figure 13 on page 27.

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

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/B Option 400 (4-Port). Refer to Figure 12 on page 27.
   - Port 13 over Port 3 (U3022-80002)
   - Port 14 over Port 4 (U3022-80003)
5. Connect the cable (N4011-21002) from the PNA-X Test Set I/O to the U3022AH10 Test Set I/O on the rear panel. See Figure 13 on page 27.
6. The 2-digit numbers in Figure 12 on page 27 refer to the corresponding cable number (last two digits) listed in Table 8. Install the eight semi-rigid cables in the recommended sequence (please note that it might be necessary to reform the semi-rigid cable slightly to fit in place). Tighten to 8 in-lbs torque.

Table 8 PNA-X to Test Set RF Cable Interface Connections

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

Figure 12 System Setup, 12/14 Port RF Cable Interface Configuration

Figure 13 Rear Panel I/O Cable Configuration (Option 129)

System Operational Checks

The following procedure will confirm that the RF interface cables between the Test Set and analyzer are installed and the system is working correctly.

Before beginning this procedure complete the following steps:

- Stack the analyzer system for the 12/14-Port System.
- Install the Test Set I/O cable on the U3022AH10 and PNA-X rear panels.
- Install all of the RF interface cables as shown in Figure 12.
- Install the included female 3.5 mm short to Port 1 on the analyzer.

Equipment Setup

- Turn on the test sets and analyzer.
- Preset the analyzer and make the following settings:
  - Set to Multi-Port Mode. Use Test Set file:
    U3022AH10_pnax_p4 (Option 129) or U3022AE10_pnax_p4 (STD)
- – Frequency range: 10 MHz to 26.5 GHz
  - IFBW: 1 kHz
  - Scale: 20 dB/Div
  - Set the PNA to measure S11
  - Ensure the RF path of the analyzer is in Default mode. Refer to Figure 30, "RF Path Configuration" on page 39.

Verify Results

The 3.5 mm short will be relocated to each Test Port and an uncorrected reflection response trace should be displayed that resembles the following plots indicated in the tables that follow. If you suspect an RF signal path problem, refer to the RF cable diagram and check the interface cables associated with this signal path for proper installation.

Table 9 Reflection Response Results

Reflection Port	Response Trace	Cable Path Diagram
PNA-X Port 1	Figure 14 on page 29	Figure 15 on page 29
PNA-X Port 2	Figure 14 on page 29	
Test Set Ports 1, 3, 5, 7, 9, 11	Figure 16 on page 30	Figure 18 on page 31
Test Set Ports 4, 6, 8, 10, 12	Figure 17 on page 30	

NOTE Measured plots for the Standard and Option 129 are similar.

Figure 14 Typical Reflection Response Port 1 and 2

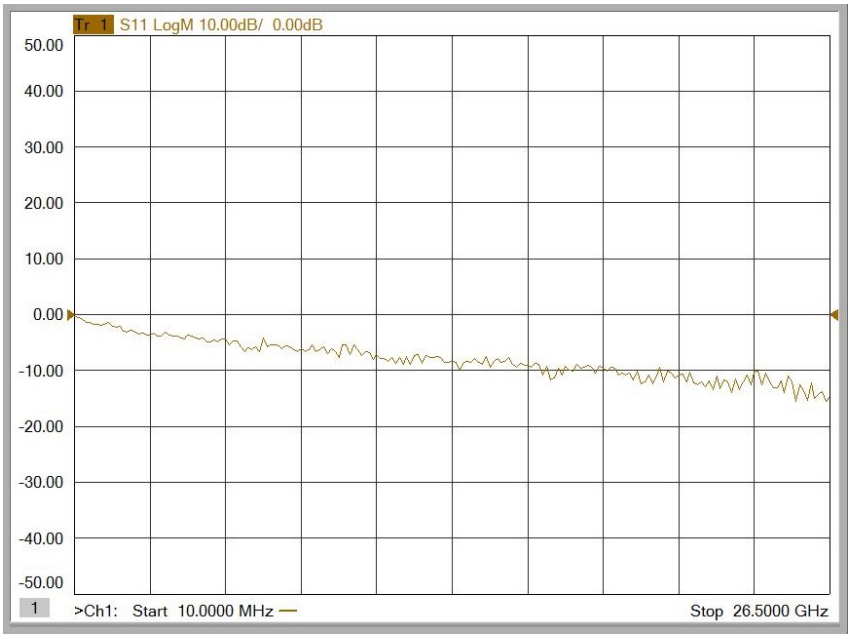


Figure 15 Port 1 and 2, RF Path Diagram (Option 129 shown)

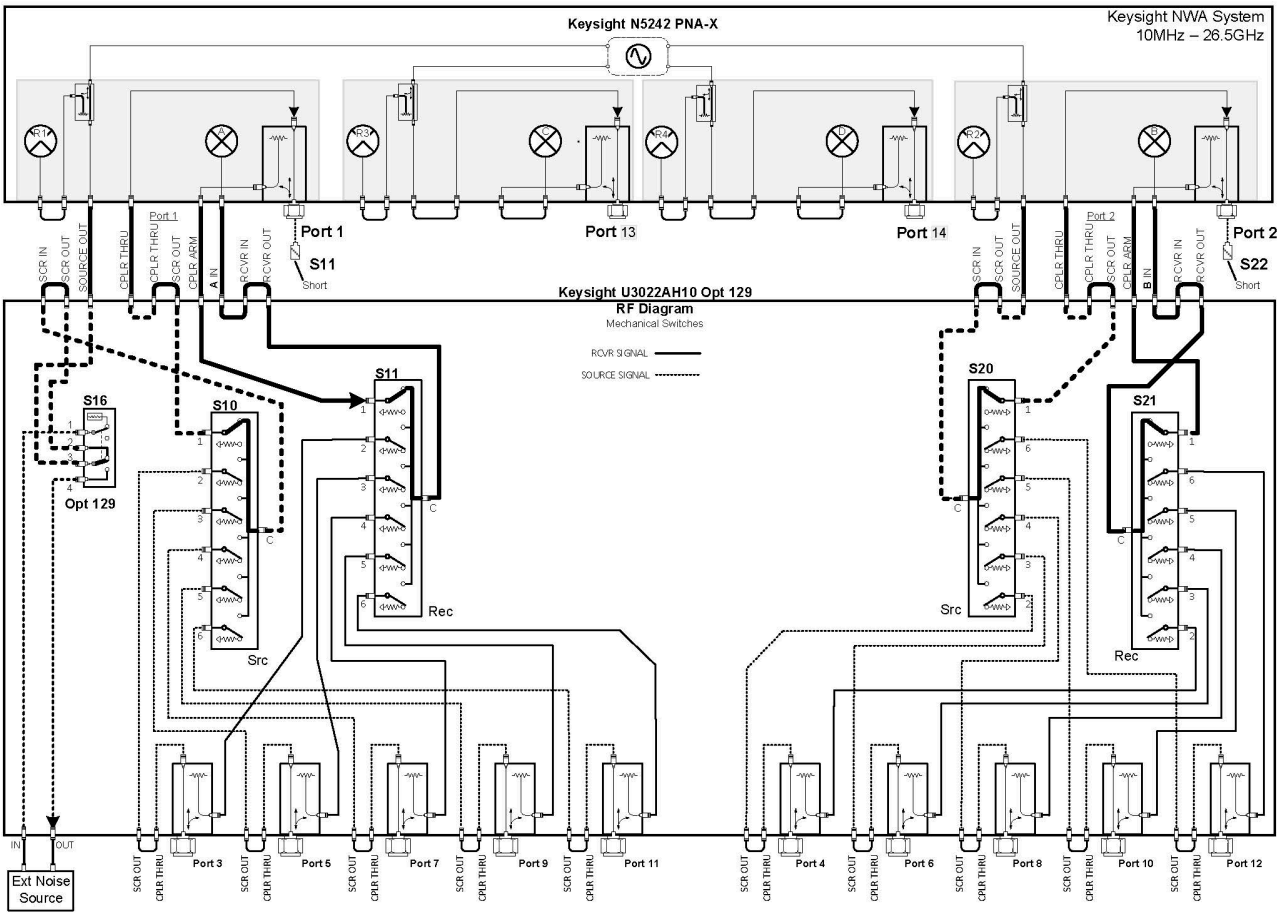


Figure 16 Typical Reflection Response Test Set (Odd Ports)

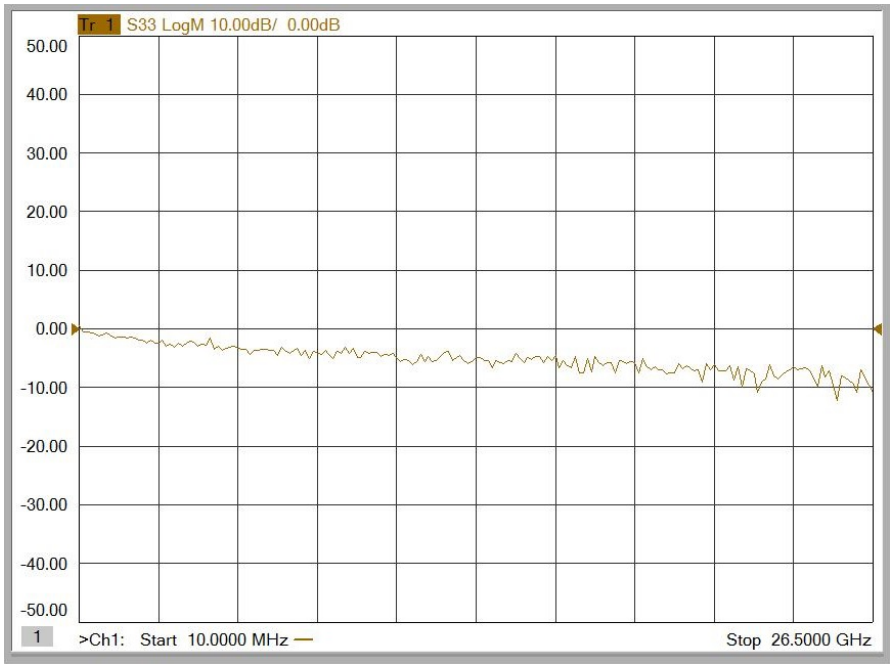


Figure 17 Typical Reflection Response Test Set (Even Ports)

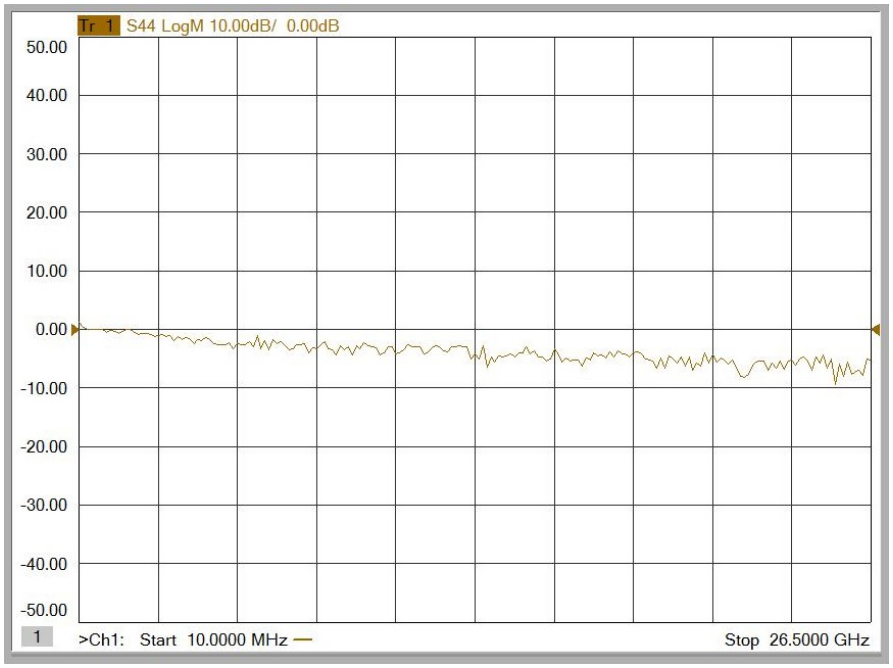
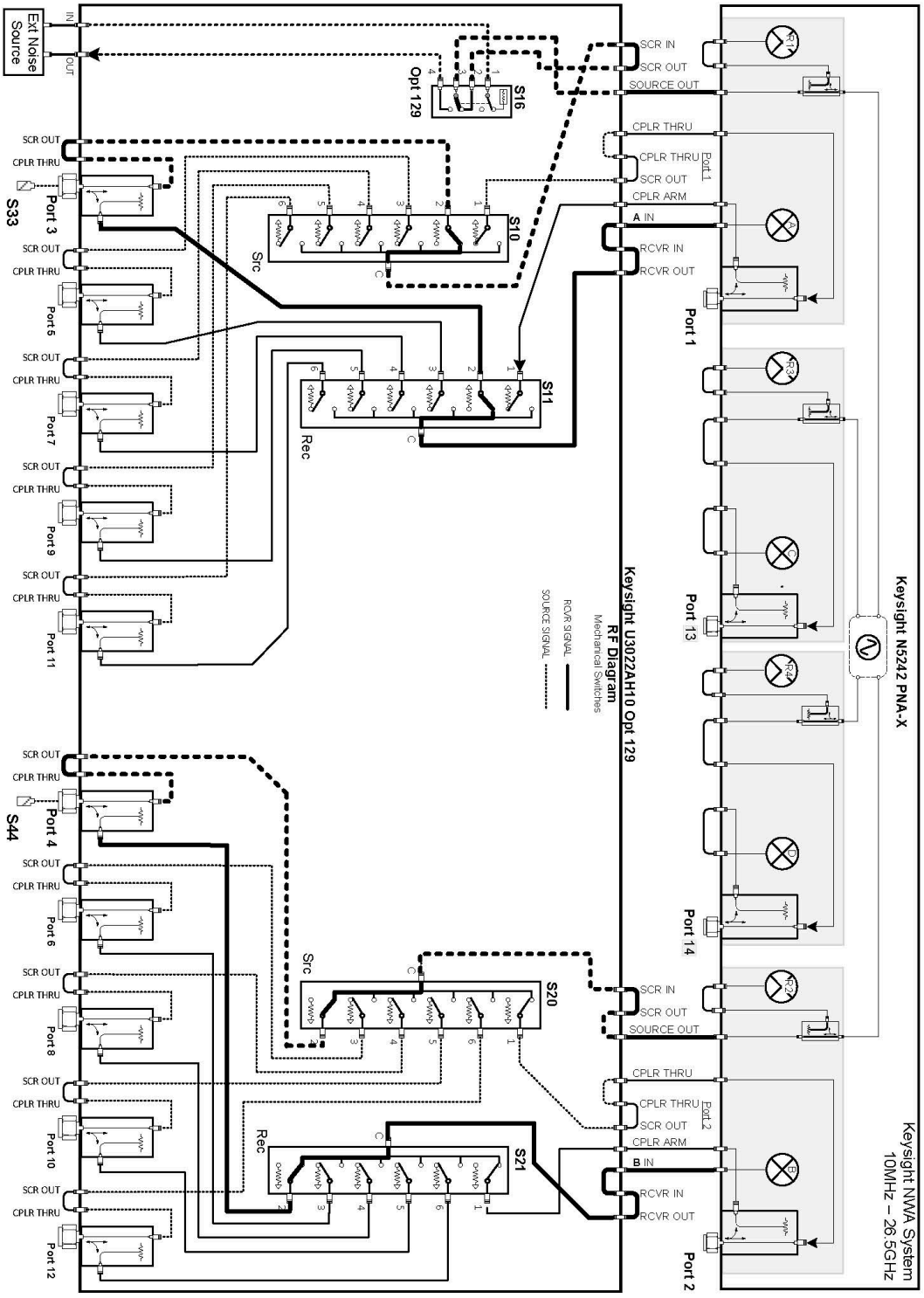


Figure 18 Test Set RF Path Diagram (Option 129 shown)



Controlling the System with N5242A/B

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

The U3022AH10 Multiport Test Set is considered a “secondary” instrument. The N5242A/B 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-X Multiport Mode Option 551 requires firmware revision ≥ A.07.50.13. From the PNA-X drop-down menu select **Help** > **About Network Analyzer** to see the options installed at the installed firmware revision.

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

2-Port PNA-X requires Test Set file:	u3022ae10_pnax_p2.tsx
4-Port PNA-X requires Test Set file:	u3022ae10_pnax_p4.tsx
Option 129 Test Set requires Test Set file:	u3022bh10_pnax_p4.tsx

- PNA-X Interface Control
- PNA-X GPIB Command Processor

Visit our website for firmware revision and downloads.
http://na.support.keysight.com/pna/firmware/firmware.html
http://na.support.keysight.com/multiport (see test set files link)

NOTE **The internal firmware of the Keysight N5242A/B 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.**

Typeface Key Conventions

The following are key conventions used in this document:

- **[HARDKEYS]** are labeled front panel keys
- **SOFTKEYS** are indicated on the instrument display
- ***(Italicized in parenthesis)*** are menu paths for the 'B' Model analyzer

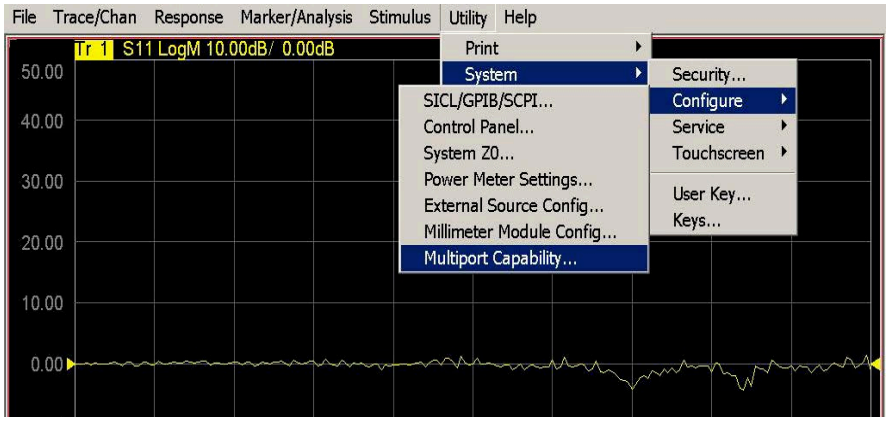
PNA-X Multiport Mode with Option 551

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

12/14 Port System with N5242A/B

The N5242A Option 551 must be installed for Multiport capability. To access the multiport application select [Utility] > System > Configure > Multiport Capability -OR- *(Instrument > Setup > External hardware > Multiport > Multiport Configuration...).*

Figure 19 Multiport Configuration



Select U3022AE10 or U3022AH10 (Opt129) from the Test Set drop-down menu and select **Restart as a multiport PNA with this testset.** Press OK. The PNA-X will restart the network application with the U3022AH10 Multiport Test Set interface features.

Figure 20 Test Set File Selection (12-Port System)

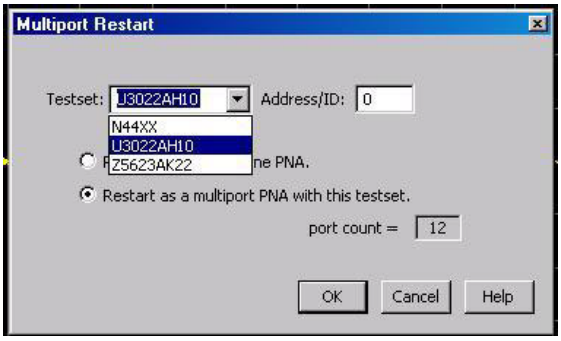
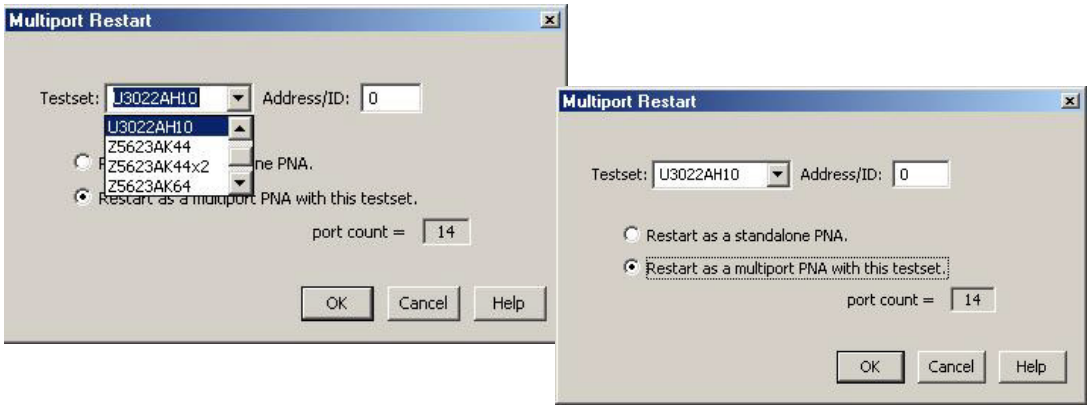


Figure 21 U3022AH10 Selection (14-Port System)

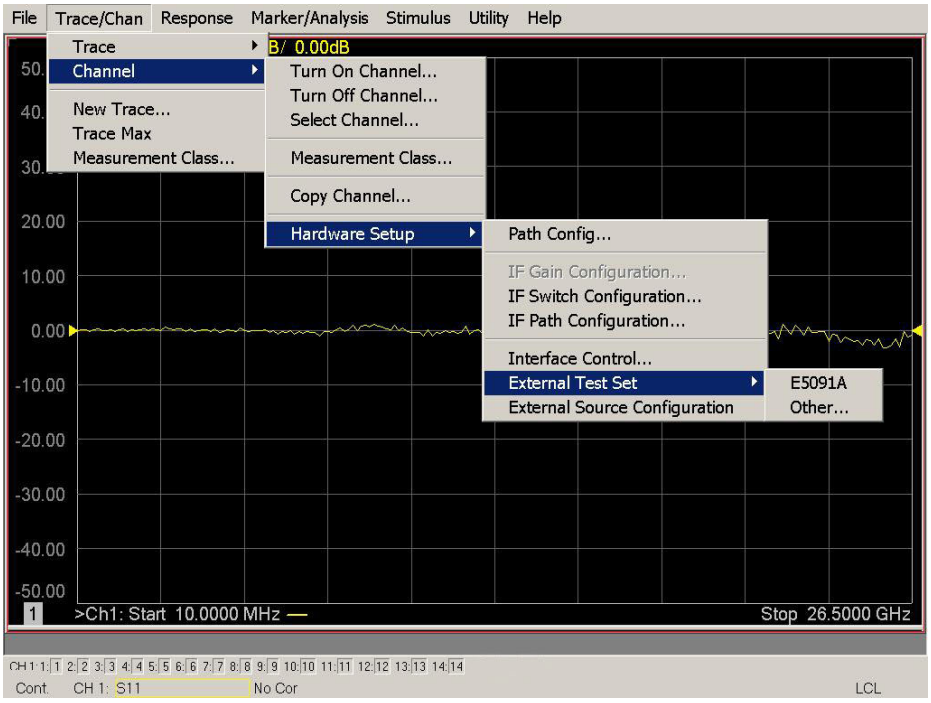


External Test Set Control Feature

To verify that the network application has the U3022AH10 interface features, select **Channel** > **External Test Set** > **Other** -OR-
(Instrument > *Setup* > *External Hardware* > *External Device...* > *Multiport* > *Other Test Set Setup...)*.

The U3022AH10 will be displayed as **External Test Set Control-U3022AH10**.

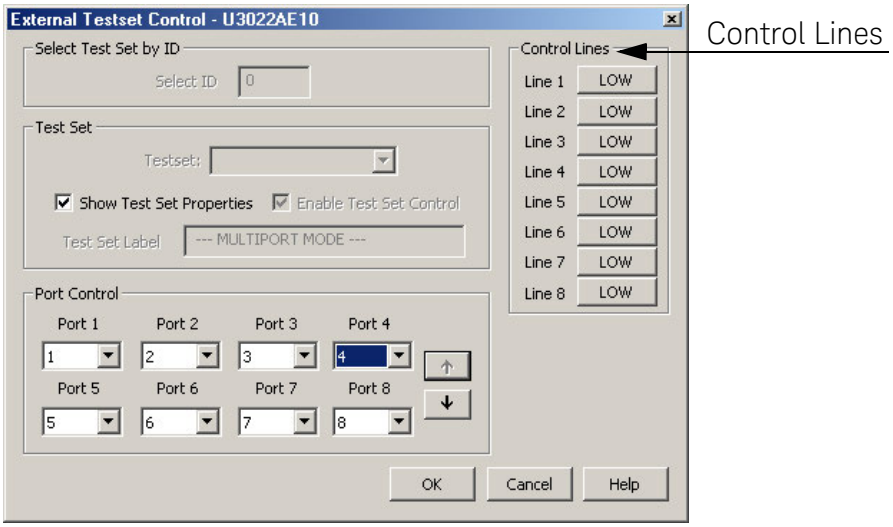
Figure 22 External Test Set Control



The following 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.

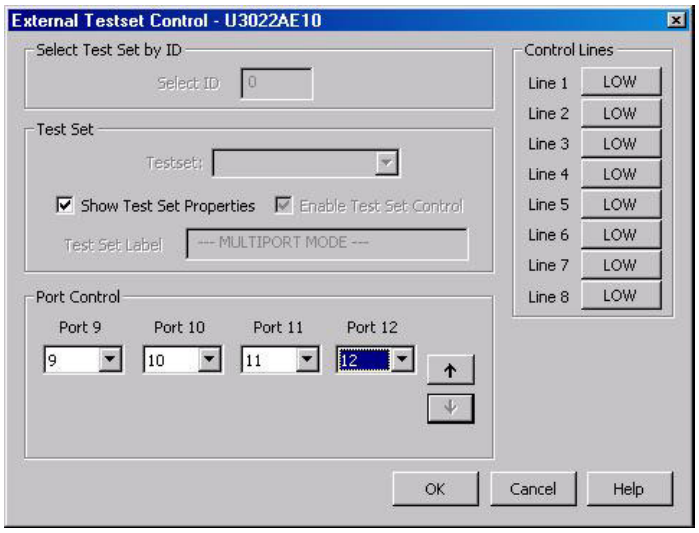
The **External Test Set Control - U3022AH10** also allows control of the DUT control lines, refer to "DUT Control Lines" on page 56. To change the state from LOW to HIGH, select the graphical user interface (GUI for the specific Control Line 1 through 8) and then press **OK**. Each line can be controlled separately, as shown in Figure 23.

Figure 23 External Test Set U3022AH10 (Port 1 - 8)



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

Figure 24 External Test Set U3022AH10 (Port 9 - 12)

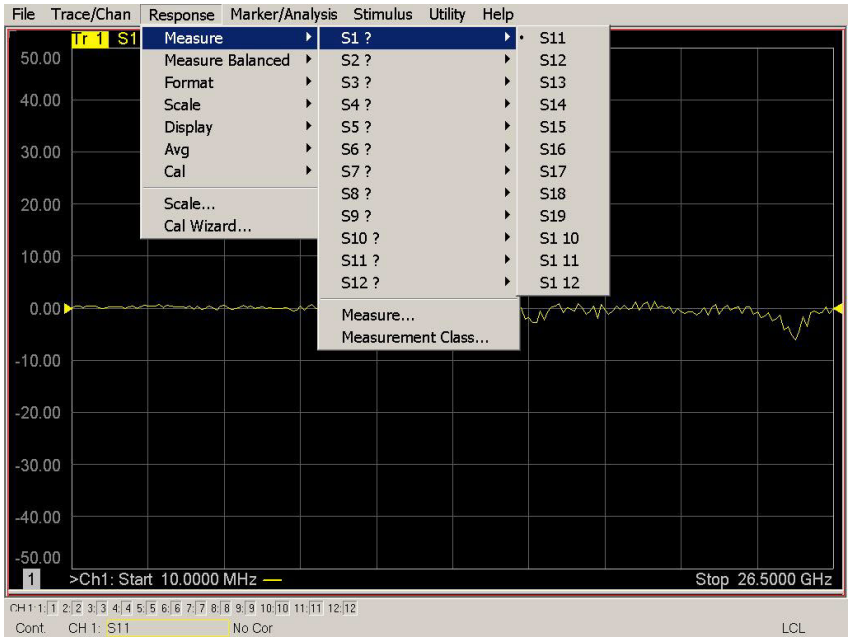


Trace Measure S-Parameter

S-Parameter selection can be accomplished using **Response Measure** menu. Select **TRACE > Measure**. Use the drop-down menus to select S-Parameters for the 12-Port system, as shown in Figure 25. 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.

The 'B' Model analyzer S-Parameter selections are done by using the front keypad. For example, to select S25: **MEAS [MEAS] > Enter S-Parameter > [2][.][5] [Enter]**

Figure 25 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** > **NewTrace** -OR- *(Instrument > Trace > NewTrace)*.

Figure 26 Selecting PNA-X New Trace Measure

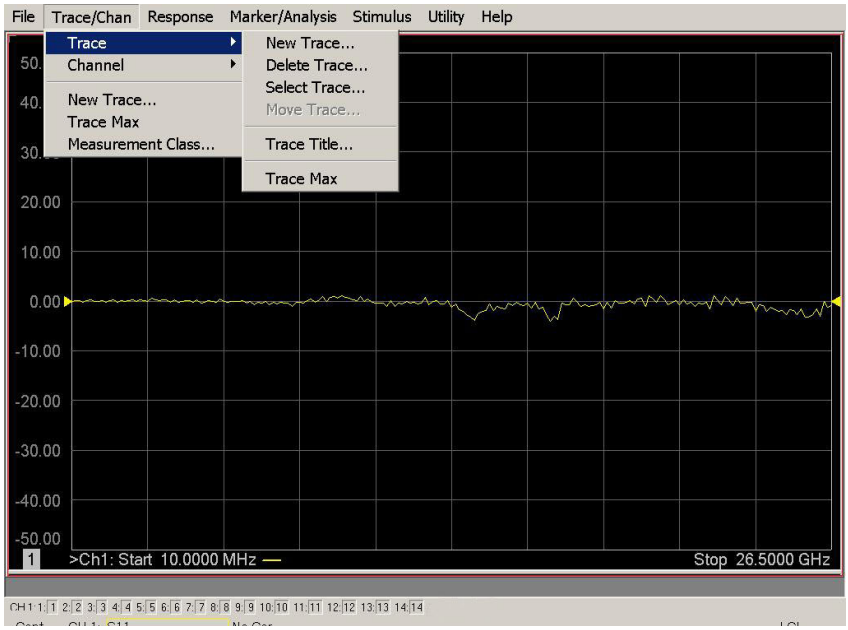


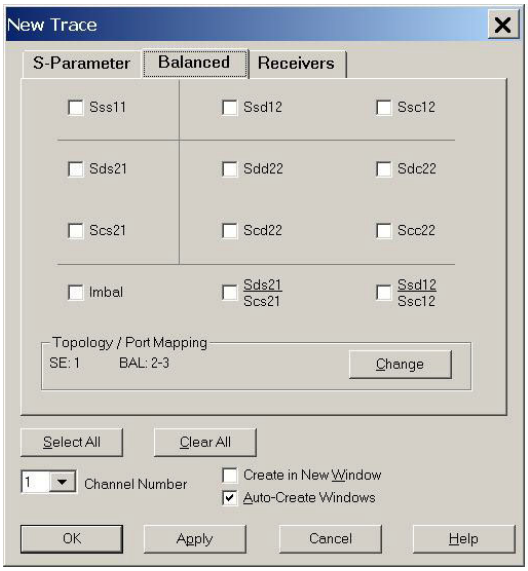
Figure 27 New Trace Selection

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.keysight.com. In the search menu type in “Multiport and Balanced.”

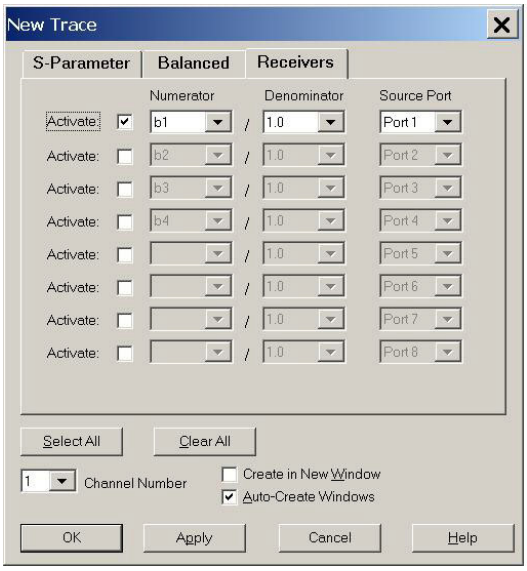
Figure 28 Balanced



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 29 Receiver Ports



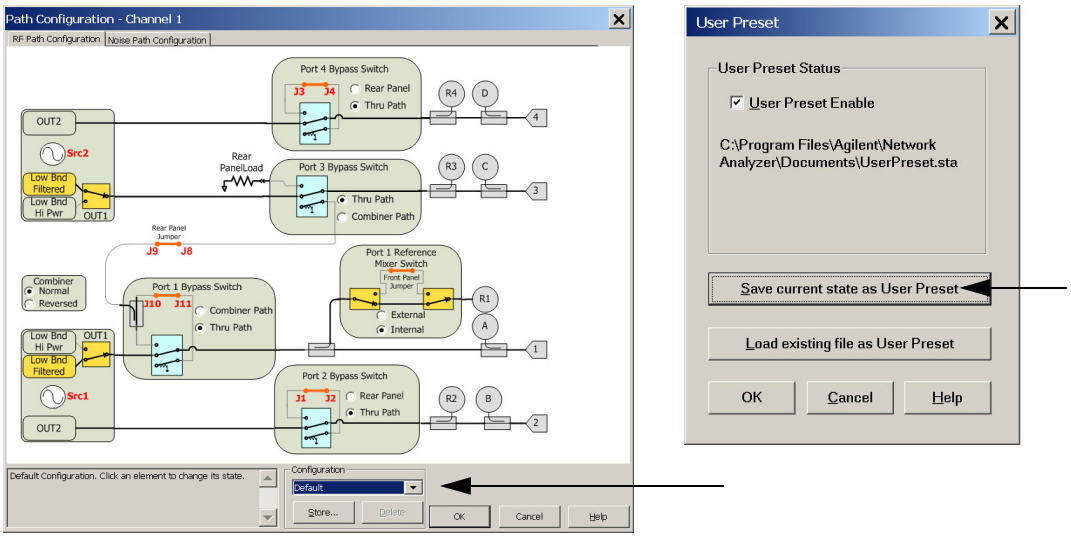
RF Path Configuration Check for Analyzers with Option 029

If the analyzer has Option 029 or H29 (noise figure capability) verify that the path configuration is set to Default. If it is not in Default configuration, Port 3 will not operate correctly.

1. Select **Trace/Chan > Channel > Hardware Setup > Path Cong...** -OR-
   (Instrument > Setup > Internal Hardware > RF Path Config...) and in the drop-down menu select **Default** > **OK**. Save this configuration as a User Preset by selecting **Save** > **User Preset > Save current state as User Preset**.
   Do not use the factory Preset (User Preset Off), as this will return the analyzer to the Option 029 path configuration.

2. Verify that the Port 1 Noise Tuner Switch is set to external. Select **Utilities System**> **Configure** > **Preferences** -OR-
   (Utility > System > System Setup > Preferences > User Preset).
   If not, select **Meas: Port 1 Noise Tuner Switch is set to external**.

Figure 30 RF Path Configuration



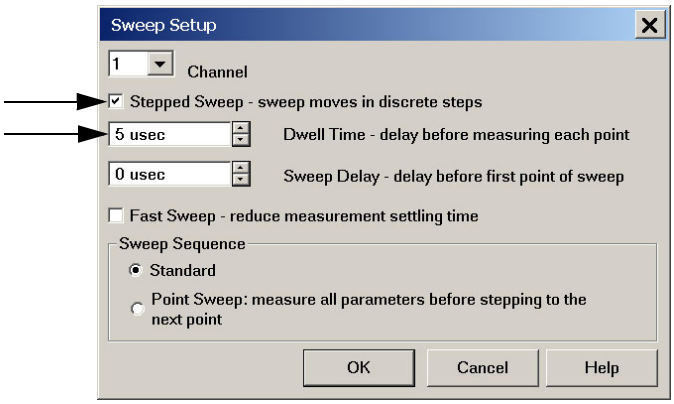
Sweep Setup for Multiport and Standalone PNA-X Modes

When the Test Set is connected to the PNA-X, it is recommended that the analyzer's Sweep Setup be configured to Stepped Sweep before calibrating. This is slower than the Analog Sweep, but is more accurate due to the extra electrical length of the Test Set and test port cables. Only Stepped Sweep is available on all PNA-X models.

PNA-X N52xxA Models

1. On the PNA-X select **STIMULUS** > **Sweep** > **Sweep Setup**.
2. Select **Stepped Sweep**.
3. Set the **Dwell Time** to **5 µs** > **OK**.

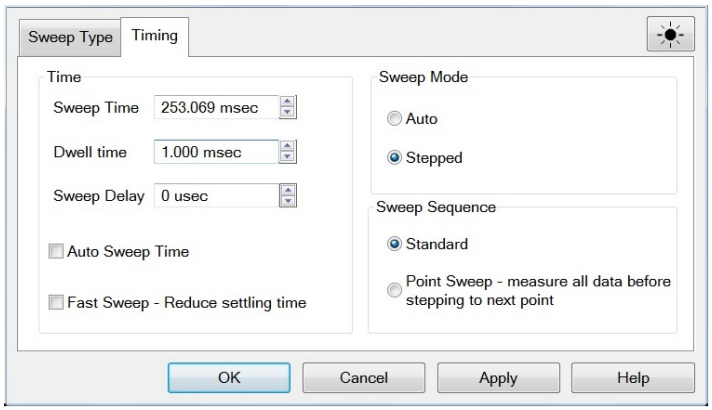
Figure 31 Sweep Setup, N52xxA



PNA-X N52xxB Models

1. Select **[Sweep]** > **Sweep Setup** > **Timing**.
2. Select **Timing** tab.
3. Select **Sweep Mode: Stepped**.
4. Deselect **Time: Auto Sweep Time**.
5. Set **Dwell Time** > **Apply** > **OK**.

Figure 32 Sweep Setup, N52xxB

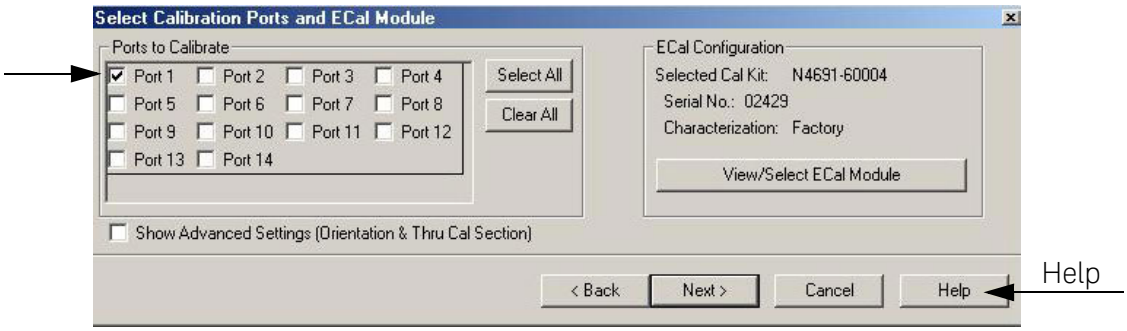


N-Port Calibration with N5242A/B

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

1. On the network analyzer select **Response** > **Calibration Wizard** -OR- *(Response > Cal > Other Cals > ECal...)* and follow the prompts.
   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 33 1-Port Calibration Selection



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.**

Interface Control Mode

NOTE Interface Control mode will not function properly when using multiport mode. Multiport mode will reset the switch path commands of the interface control. It is recommended that the analyzer be restarted in stand-alone mode if the interface control is being used.

Overview of the Interface Control

The Interface Control feature allows you to send data and remote commands to control external equipment using the GPIB, Handler I/O, Test Set I/O, Dwell After Command and Aux I/O without needing to create a remote program. Refer to PNA Help menu, “Rear Panel Tour.”

- A unique set of control data can be sent for each channel. In addition, a unique set of control data can be sent before the channel sweep starts and after the sweep ends.
- Interface Control settings can be saved and recalled from the Interface Control dialog box or with Instrument State Save and Recall.
- Interface Control settings can be copied to other channels using Copy Channels.
- Control data can only be WRITTEN to the interfaces, NOT READ from the interfaces.
- Control data is sent in the following order and this order cannot be changed:
  Refer to the PNA Help menu.
  1. GPIB Commands - BEFORE
  2. Handler I/O Control
  3. Test Set I/O Control (addr.data)
  4. Dwell After Command
  5. Aux I/O Output Voltage

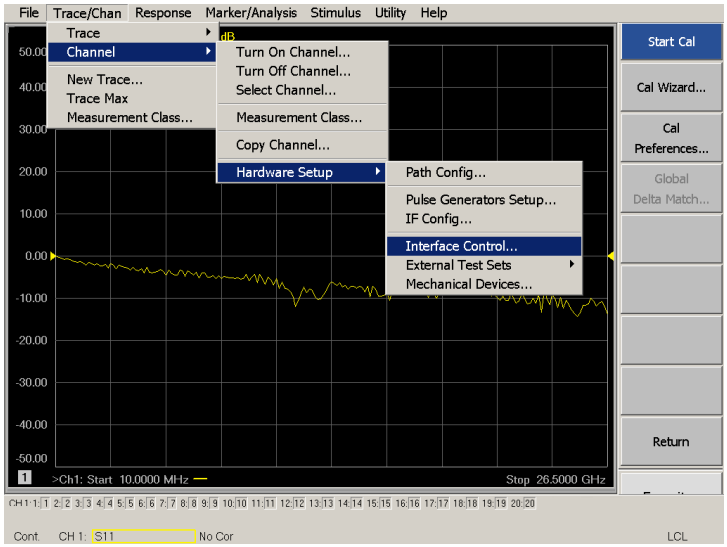
How to Access Interface Control Settings

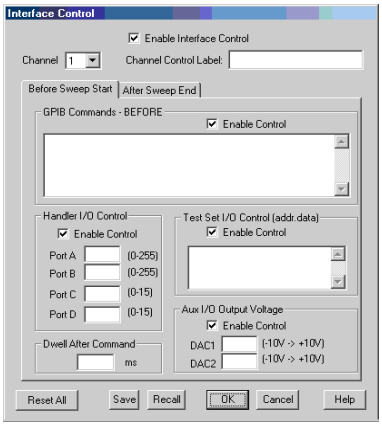
This section describes how to configure and operate the test set with the PNA.

1. To access the Interface Control mode, select
   Trace/Chan > Channel > Hard ware Setup > Interface Control -OR-
   (Instrument > Setup > Internal Hardware > Interface Control...) in
   the drop-down menu, and select Enable Interface Control.

NOTE The PNA Series Network Analyzer comes with the Interface Control application. Please review this application before connecting the test set to the PNA. Information regarding this application can be found in the PNA Help menu, Interface Control. The application is shown in Figure 34 below.

Figure 34 Interface Control Application



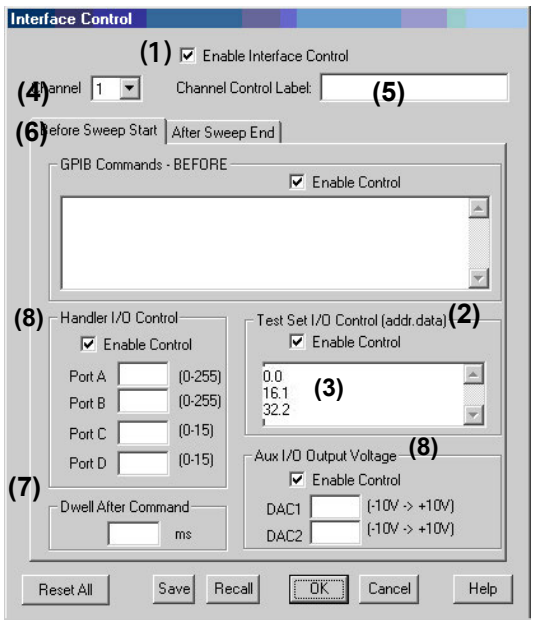


Using Interface Control Mode

An Instrument Preset will reset all of the fields to their default settings.

NOTE If an error is encountered when sending Interface Control data, an error message is displayed on the analyzer's screen and the Channel Trigger State is set to Hold. You must fix the condition that caused the error, then change the Channel Trigger State to its original setting.

Figure 35 Interface Control



Enable Interface Control: (1)

Enables and disables ALL Interface Control communication. When cleared (default setting) Interface Control is disabled and NO data is sent. To send data, the individual interfaces must also be enabled.

Test Set I/O Control (addr.data): (2)

Provides control of the Test Set I/O Interface on the rear panel of the analyzer. Used to control your test set. Only positive integers are allowed to select switch positions or states of DUT control interface lines. Refer to "Address and Data Values" on page 51.

Address and data integers must be separated by a period. Each set of entries should be separated by a new line, or carriage return. The front panel Enter key can be used to insert a new line into the field. The quantity of test set I/O entries that can be entered is limited by the available memory of the analyzer.

Address and Data example: addr.data (3)

0.0
16.1
32.2

Channel: (4)

Specifies the channel number for dialog settings. Each channel is configured individually. The drop-down list illustrates the channels that currently have measurements. There must be at least one displayed trace for the test set I/O Interface to function.

Channel Control Label: (5)

Specifies the label to be displayed on the analyzer's screen during the channel sweep.

Before Sweep Start – After Sweep End Tabs: (6)

Commands (GPIB, I/Os and Dwell) can be sent Before Sweep Start and After Sweep End. However, they are configured and enabled separately on the "Interface Control" dialog box. For example; to send a command before and after a PNA sweep, the "Enable Interface Control" check box must be selected and commands entered in both the Before Sweep Start and After Sweep End tabs. The Before Sweep Start data is sent before the first trace on the channel begins sweeping. The After Sweep Start data is sent after the last trace on the channel sweep is completed.

Dwell After Command: (7)

Specifies a wait time, in milliseconds, after all commands to all interfaces are sent. Any positive integer is allowed. This is used to allow all external devices to settle before beginning a measurement. An erratic trace could indicate that more settling time is necessary.

Handler I/O Control and Aux I/O Output Voltage: (8)

Provides I/O interface control through the rear panel of the PNA. Refer to the PNA Help menu for further information.

Reset All:

Sets all fields on all channels to their default values.

Save and Recall:
Saves and recalls the contents of the dialog box. If the "Interface Control" dialog box is populated with settings during an Instrument State Save, the settings are automatically recalled with the instrument state settings. Interface control uses an *.xml file type. An example file is stored on the PNA hard drive. You can recall it into the dialog, or you can open and edit it with a word processor, such as Word Pad.

OK:

Applies the settings and closes the dialog box.

Cancel:

Does not apply changes that were made and closes the dialog box.

Help:

Provides additional information for using the interface control application.

SCPI Control Mode

The Command Processor feature allows you to send remote commands and data to the analyzer's rear-panel GPIB connector and Test Set I/O connector. More information regarding the Command Processor can be found in the Help menu.

Overview of the SCPI **Control**

The Command Processor allows you to send address and data to control an external test set without creating a remote program. The user is required to manually input address and data using the Command Processor Console in the Help menu.

- Command Processor settings can not be saved or recalled.
- Address and data can be *written* from the Command Processor.

How to Access the Command Processor

1. To access the Command Processor select
   Utility > System > Configure > SICL/GPIB/SCPI
   -OR-
   (System Setup > Remote Interface > SCPI Monitor Input > Show SCPI Parser Console),
   and check SCPI Command Processor Console box.

Figure 36 Command Console for 'A' Model Analyzers

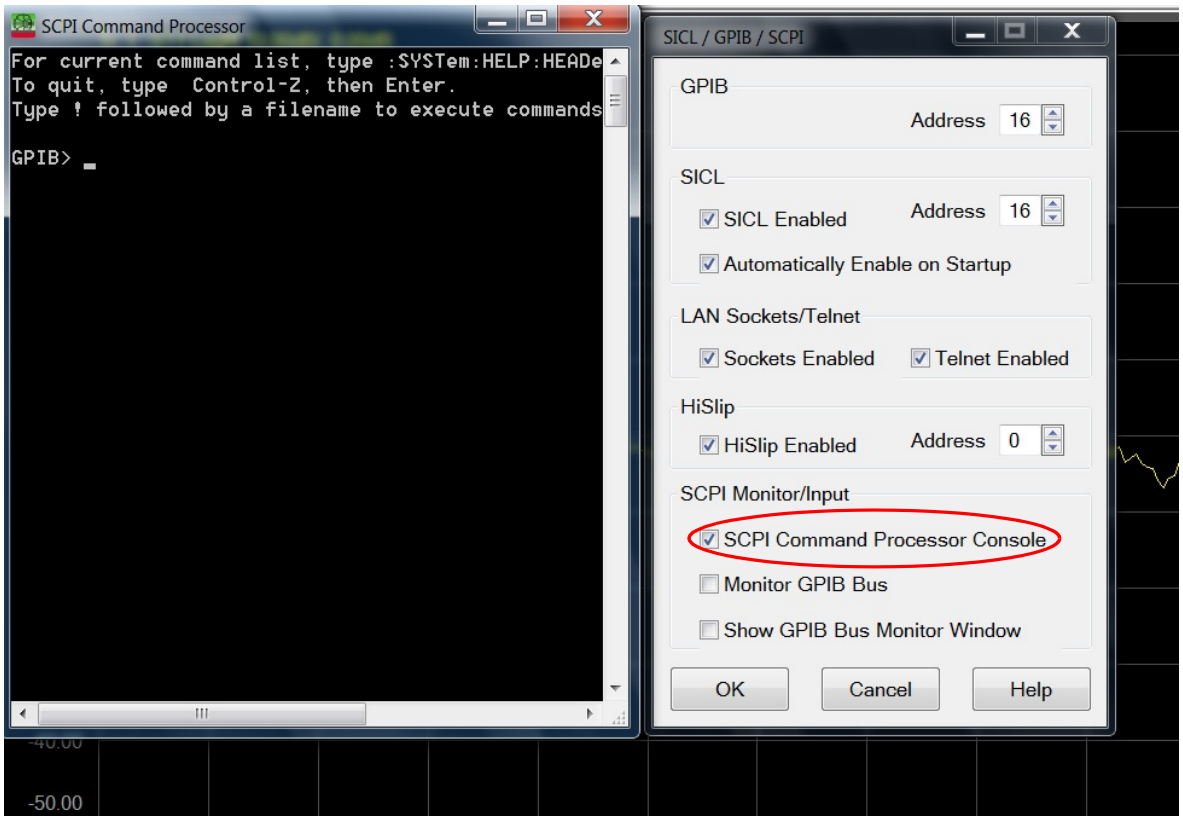
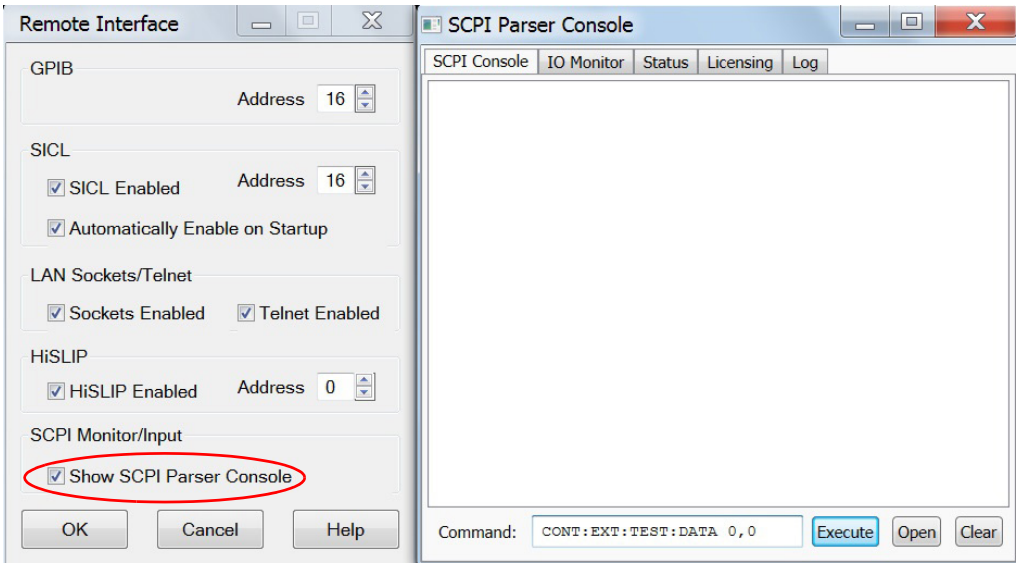


Figure 37 Command Console for 'B' Model Analyzers



SCPI Command Processor Console

There are two methods in which the PNA-X Command Processor Console can be used to control the Test Set internal switches to configure the Multiport system for S-Parameter measurements.

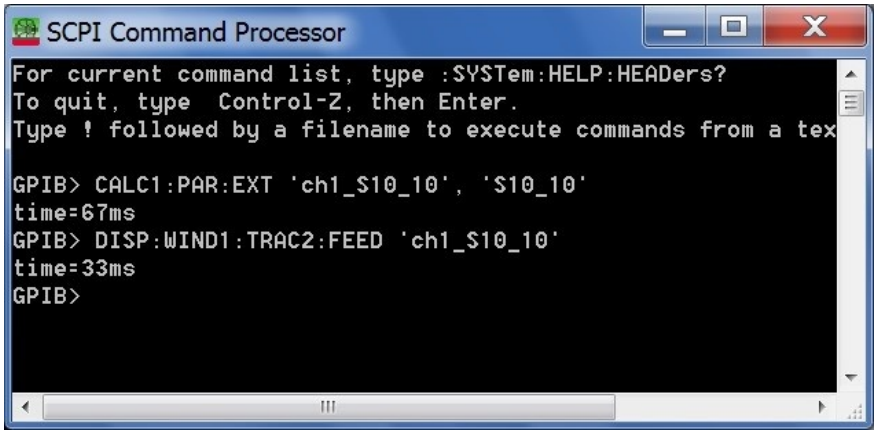
Method 1 - Using GPIB/SCPI Command Values

This method is available while the system is in Multiport mode only.

The Test Set internal switch settings are programmed into the Test Set firmware; they are configured by the PNA-X S-parameter values. Method 1 provides more PNA-X control capability than Method 2.

The following example shows two executable commands needed to create an S-parameter measurement on your Multiport system.

Figure 38 Method 1 - Using GPIB/SCPI Command Values



This first command creates a new S10_10 measurement on channel 1 of the PNA-X, named “ch1_S10_10,” and configures the internal Test Set RF switches.

CALC1:PAR:EXT 'ch1_S10_10', 'S10_10'

This second command feeds the newly created measurement named “ch1_S10_10” to trace 2 on the PNA-X so that it will be displayed on the PNA-X screen.

DISP:WIND1:TRAC2:FEED 'ch1_S10_10'

NOTE: Here are syntax format examples for single digit S-parameters:

'ch1_S99' 'ch1_22' 'ch1_S9_10' 'ch1_S10_9'

Method 2 - Using the Test Set Address and Data Values

This method is available while the system is in Standalone mode only.

The Address and Data values for the Test Set can be found in the “Address and Data Values” section on page 51.

The Test Set internal switch settings are programmed into the firmware of the Test Set and can be controlled with the specific Address and Data values. Each Address and Data value pair sets the Source or Receiver switch paths. For an S-parameter measurement, two pairs of Address and Data values will be needed.

Address and Data values are separated by a comma. Commands should be separated by a new line, or carriage return.

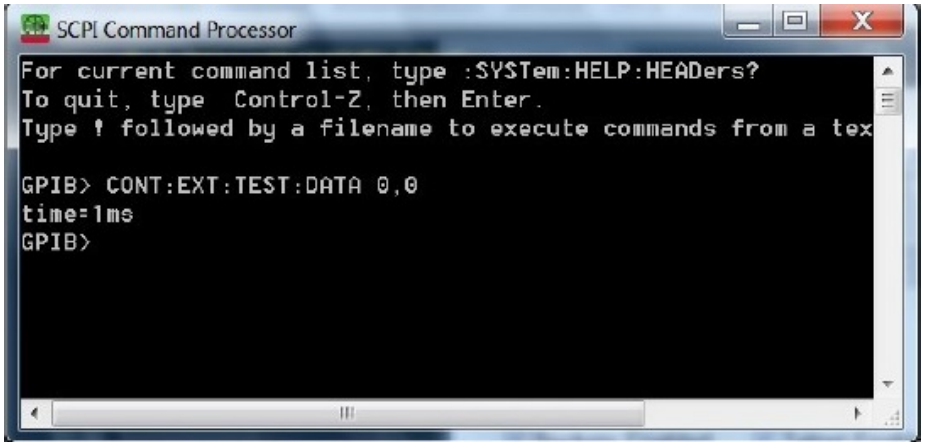
For example:

CONT:EXT:TEST:DATA <address>,<data>

CONT:EXT:TEST:DATA 0,0

Example: CONT:EXT:TEST:DATA 0,0

Figure 39 Method 2 - Using Test Set Address and Data Values



Option 129 External Source Path

The U3022AH10 with Option 129 allows an external ECal module, or noise source, to be switched into the Source path of Ports 1, 3, 5, 9, or 11. Only one port can be the active source. The front panel EXT NOISE SOURCE IN is switched to the Output port, and the front panel EXT NOISE SOURCE OUT is switched to the Test Set SOURCE IN (connected to the PNA-X SOURCE OUT with a jumper cable) when the command is sent. Refer to Table 13 on page 55 and Figure 41 on page 52.

NOTE **The test set will not operate in multiport mode. Interface or SCPI control mode is required to set the Noise Source Path.**

System Configuration

Figure 40 illustrates the PNA-X with the Test Set and N4691B Option M0F. The cable (U3022-20238) provided with Option 129 is intended to be used with the N46xx series ECal modules. The ECal module with Option M0F is recommended.

1. Connect the ECal module to the NOISE SOURCE IN on the test set.
2. Connect the provided cable (U3022-20238) from the NOISE SOURCE OUT on the test set to the ECal module.
3. Connect the ECal modules USB cable to one of the PNA-X USB ports.

Figure 40 U3022AH10 Option 129 with ECal Module

Setting Option 129 Source Path

1. Restart the PNA to Standalone Mode, if it is in Multiport Mode. Refer to Figure 21 on page 33.
2. Send command 0.0 and [Preset] the PNA-X.
3. Refer to "Interface Control Mode" on page 42. Use the values listed in Table 10 to set Port 1, 3, 5, 7, 9, or 11 as the noise source path.

NOTE The test set will not operate in multiport mode. Interface or SCPI control mode is required to set the Noise Source Path.

Table 10 Option 129 Source Path Test Set I/O Commands

Address Data	Source Path
0.0	Standard Port 1 (Option 129 is not enabled)
0.8	Noise Source Port 1
0.9	Noise Source Port 3
0.10	Noise Source Port 5
0.11	Noise Source Port 7
0.12	Noise Source Port 9
0.13	Noise Source Port 11

NOTE An 8 is added to the Data Value to activate the Option 129 switch, as indicated in Table 10.

Address and Data Values

Setting the Test Port Paths with Address and Data

Refer to Table 11, Table 12, and Table 13 on page 55 and Figure 41 and Figure 42 for information to set the internal switch paths of the Test Set.

The address is the first value in the Test Set I/O control or GPIB data command. The second value controls the source and receiver paths of the ports. To select a Test Set port configuration, both switches must be set to complete the source and receiver paths. To do this, you must add the data values together to determine the data command value for each port, which is the second number in the Test Set I/O or GPIB command. Refer to "Interface Control Mode" on page 42 and to "SCPI Control Mode" on page 46.

Example 1: (Option 129) Refer to Figure 41 on page 52.

If the ports have different addresses, two separate address commands are needed.

Port 3 is the Source (with Noise Source Path) and Port 4 is the Receiver.

Source Port 3 = address 0, data 9, and Receiver Port 4 = address 16, data 16.

Two separate commands must be sent. You may use the same dialog box. The entry will be 0.9 in one command line, and 16.16 in the second line.

Example 2, 2b: (STD or Option 129) Refer to Figure 42 on page 53 and Figure 43 on page 54.

If the ports have the same address, only one command is needed.

Port 3 is the Source and Port 7 is the Receiver.

Source Port 3 = address 0, data 1, and Receiver Port 7 = address 0, data 48.

The data values are added together, for an entry of 0.49.

For more information, refer to the PNA-X Help menu.

Figure 41 **Example 1 U3022AH10 Option 129 Block Diagram**

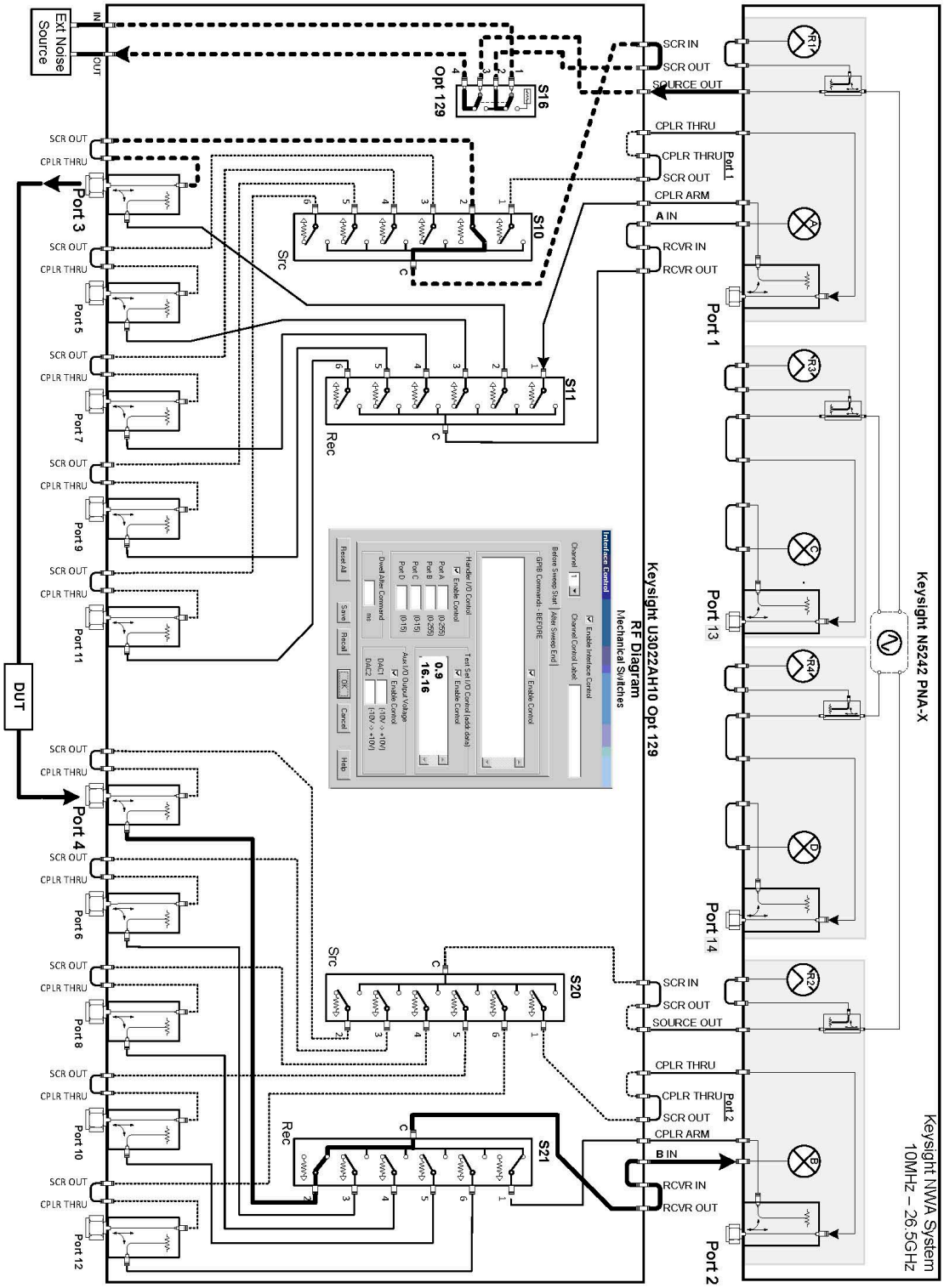
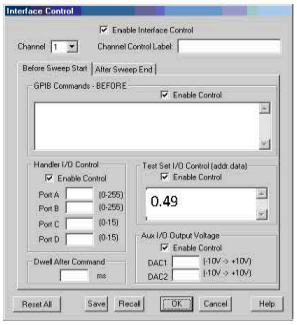
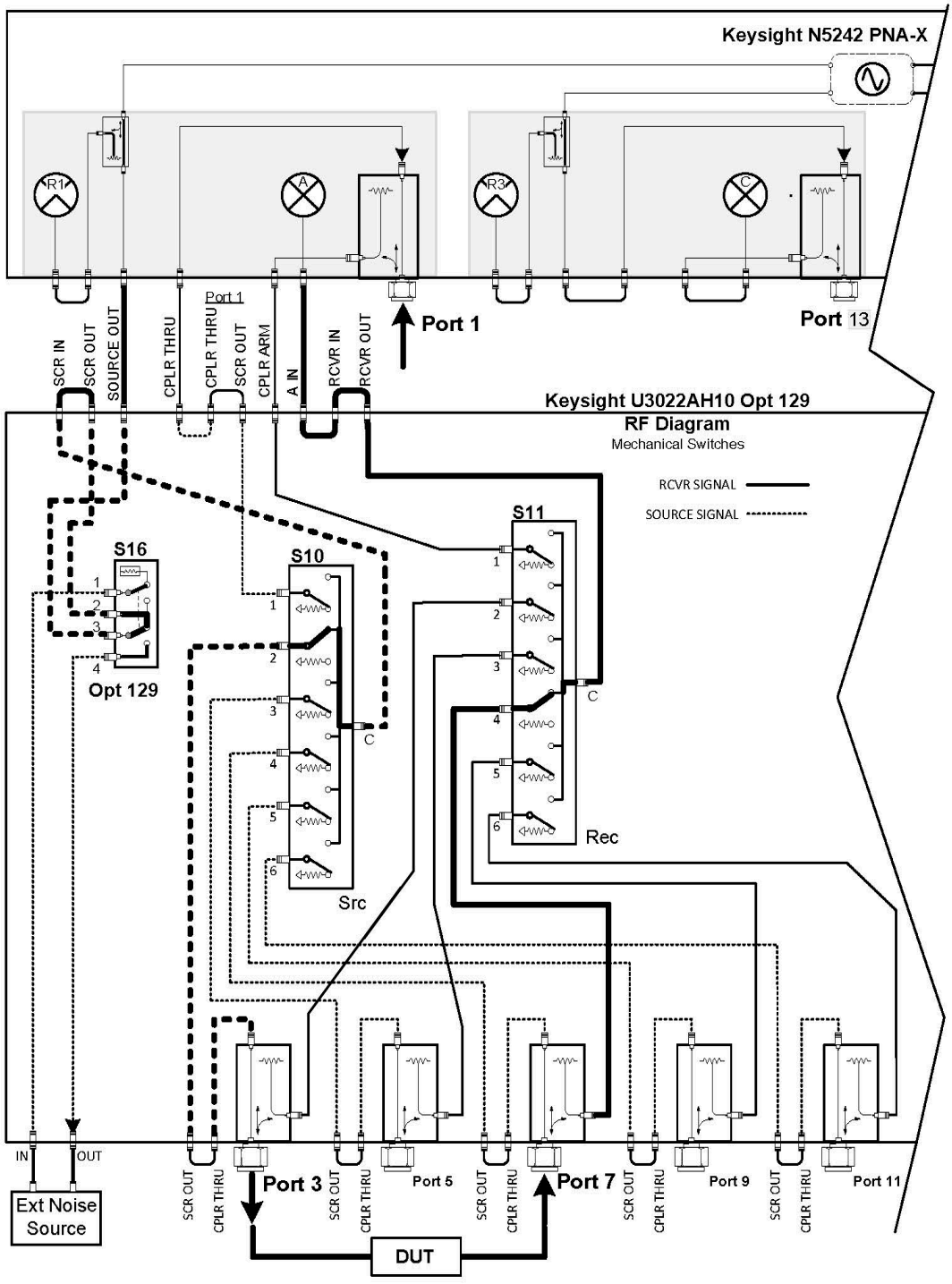


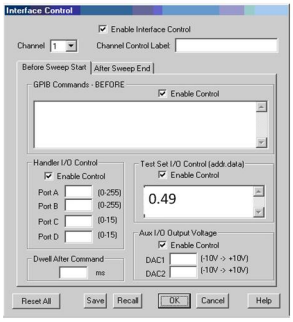
Figure 42 **Example 2 U3022AH10 Option 129 Block Diagram**

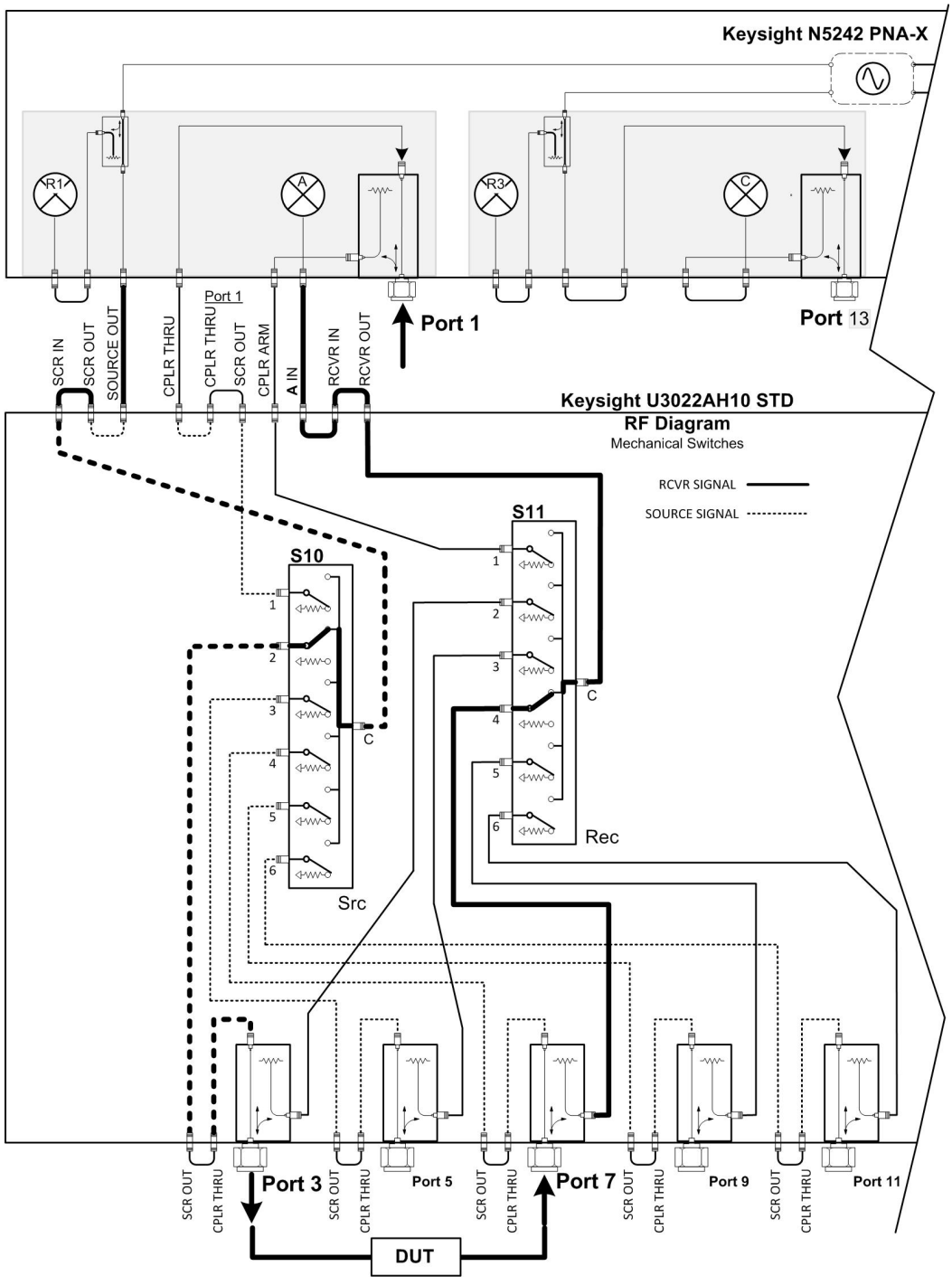




NOTE S-Parameter measurements are not possible in this example.

Figure 43 **Example 2b U3022AH10 STD Block Diagram**





NOTE S-Parameter measurements are not possible in this example.

Table 11 Address and Data Values, Standard

Source Ports								Receiver Ports					
Address	Data →	0	1	2	3	4	5	0	16	32	48	64	80
0	Ports	1	3	5	7	9	11	1	3	5	7	9	11
16	Ports	2	4	6	8	10	12	2	4	6	8	10	12

Table 12 Address and Data Values, Option 129

Noise Source Path: **Disabled**[1]		Source Ports						Receiver Ports					
Address	Data →	0	1	2	3	4	5	0	16	32	48	64	80
0	Ports	1[1]	3[1]	5[1]	7[1]	9[1]	11[1]	1	3	5	7	9	11
16	Ports	2	4	6	8	10	12	2	4	6	8	10	12
Noise Source Path: **Enabled**[2]		Source Ports											
Address	Data →	8	9	10	11	12	13						
0	Ports	1[2]	3[2]	5[2]	7[2]	9[2]	11[2]						

NOTE Ports 13 and 14 are not connected to the Test Set, therefore do not require address data values.

Table 13 S-Parameter Address and Data Values for Option 129

Address	Data	Description
0	0	Selects STD Source Path to Port 1 (S11) Noise Source Path Disabled
0	8	Selects Noise Source IN and OUT paths for Port 1 (Sx1)
0	9	Selects Noise Source IN and OUT paths for Port 3 (Sx3)
0	10	Selects Noise Source IN and OUT paths for Port 5 (Sx5)
0	11	Selects Noise Source IN and OUT paths for Port 7 (Sx7)
0	12	Selects Noise Source IN and OUT paths for Port 9 (Sx9)
0	13	Selects Noise Source IN and OUT paths for Port 11 (Sx11)
0	8	Selects Noise Source IN and OUT paths and Receiver for Port 1 (S11)
0	25	Selects Noise Source IN and OUT paths and Receiver for Port 3 (S33)
0	42	Selects Noise Source IN and OUT paths and Receiver for Port 5 (S55)
0	59	Selects Noise Source IN and OUT paths and Receiver for Port 7 (S77)
0	76	Selects Noise Source IN and OUT paths and Receiver for Port 9 (S99)
0	93	Selects Noise Source IN and OUT paths and Receiver for Port 11 (S1111)

Refer to "System Block Diagrams" starting on page 77 for in-depth RF path information.

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 16 and Figure 47 on page 60.

Setting the DUT Control Interface

This section describes how to control the DUT control lines. Refer to "Controlling the System with N5242A/B" on page 32. For more information regarding the control lines, see Table 14 below and Table 15 on page 57.

Table 14 Test Set DUT Control Address and Data

Address	Data	Data AD12–AD0	Description	Bit Data 0= +Voltage 1= –Voltage
112	0	0000000000000	ALL DUT Control Lines set to 0 or + voltage	
112	255	0000001111111	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 44 DUT Control Line Pin Assignment

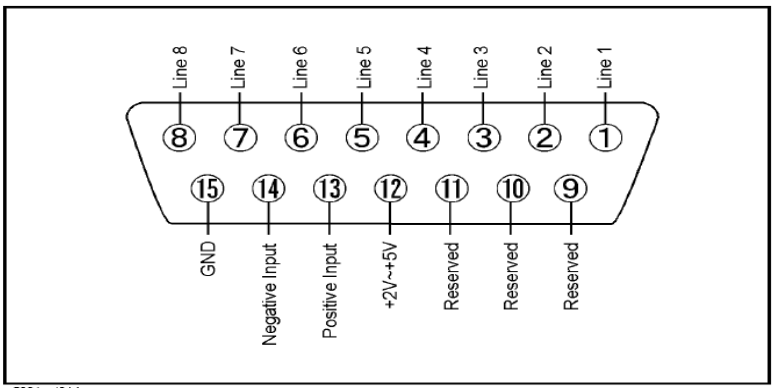


Table 15 DUT Control Line Pin Assignment

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:

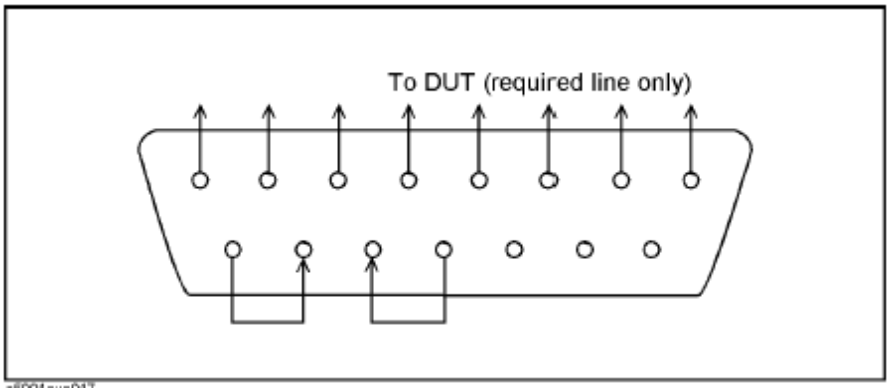
1. Turn On U3022AH10.
2. Measure the voltage between pin 12 and 15 using a multimeter.
3. Rotate the voltage adjustment trimmer on the front panel until the multimeter indicates the appropriate voltage.

Connecting to the DUT Control Lines

Figure 45 below 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 45 Control Line Connector



Using an External Power Supply

Figure 46 below 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 46 U3022AH10 to the DUT and External DC Power Supply

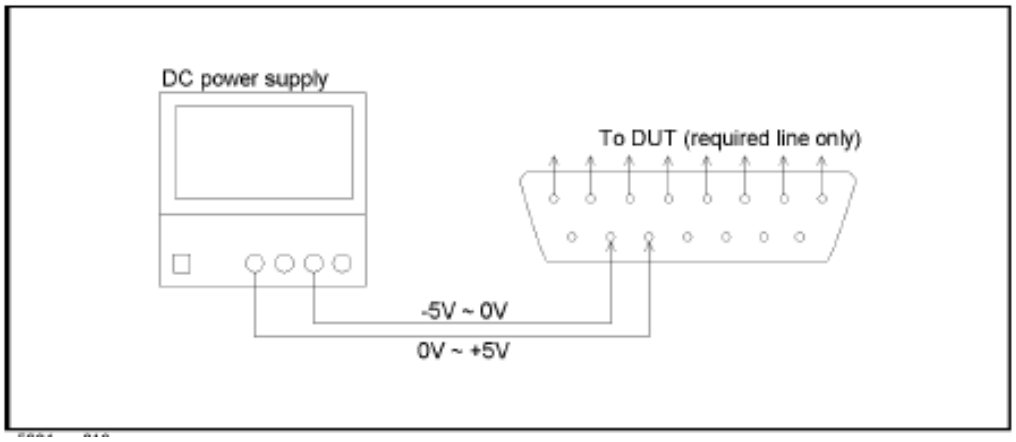
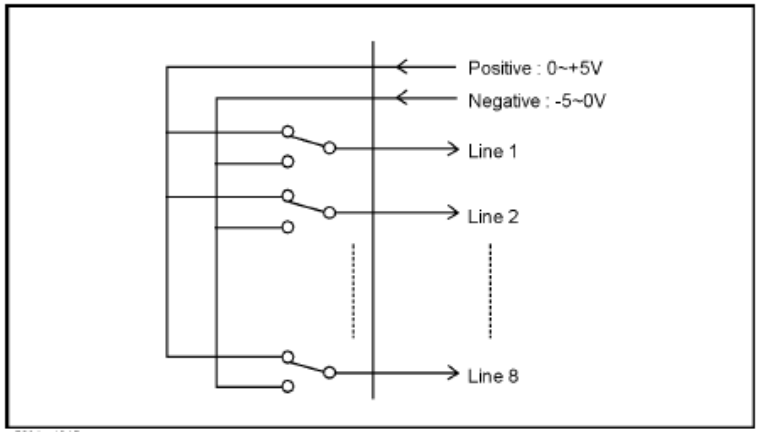


Table 16 DUT Control Specifications

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 47 Block Diagram of DUT Control



High Power Measurements

The Test Set and the N5242A PNA-X can be configured to measure high power devices. This ability is useful if the required power for the DUT 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 Test Set and components. An eight isolator and cable kit for the U3022AH10 is available (order Keysight U3020AK37).
- 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 16.**

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 12, "System Setup, 12/14 Port RF Cable Interface Configuration" on page 27. Used for the "System Operational Checks" on page 28.
   - Figure 48, "Odd Ports (1 Watt)" on page 63.
   - Figure 49, "Port 1 (20 Watt)" on page 63.
   - Figure 59, "2-Way Power Configuration (1 Watt)" on page 78.
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 62.
5. Set the power level out of the DUT. Refer to "Setting the Power Level at the Output of the DUT" on page 65.
6. Select the attenuator values for optimum PNA-X receiver and REF Inputs.
7. Configure the system for DUT measurement. Refer to "Calibrating the System and Measuring the DUT" on page 69.

Measuring Booster Amplifier Gain

1. Connect the Test Set to the PNA-X. See "System Setup N5242A/B PNA-X" on page 23 and Figure 50 on page 64.
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 33, Figure 48, and Figure 49, as well as the block diagrams shown in Figure 58 and Figure 59.
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 17, Figure 48, and Figure 49.
6. Turn On the PNA-X and U3022AH10 Test Set.
7. Select multiport mode. Refer to "Controlling the System with N5242A/B" on page 32.
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 required between the coupler and the power meter to protect the power meter from damage.**

Table 17 Amplifier Inputs vs. Outputs

Input From[1]	Maximum Wattage	Output Power Port	Reference Figure
Odd Port SRC OUT	1 Watt	All Odd Ports	See Figure 48 on page 63
Even Port SRC OUT[2]	1 Watt	All Even Ports	See Figure 48 on page 63
Port 1 SRC OUT	20 Watts	Port 1	See Figure 49 on page 63
Port 2 SRC OUT[3]	20 Watts	Port 2	See Figure 49 on page 63
Port 3 to 12 SRC OUT	20 Watts	Port 3 to 12	See Figure 50 on page 64

1. A 2-Way high power source configuration can be configured for transmission and reverse transmission measurements. Refer to Figure 59 on page 78.
2. The even ports SRC OUT connection is similar to the odd ports, although located on the right side of the front panel. Refer to Figure 48 on page 63.
3. The Port 2 SRC OUT connection is similar to the odd ports, although located on the right side of the front panel. Refer to Figure 49 on page 63.

Figure 48 Odd Ports (1 Watt)

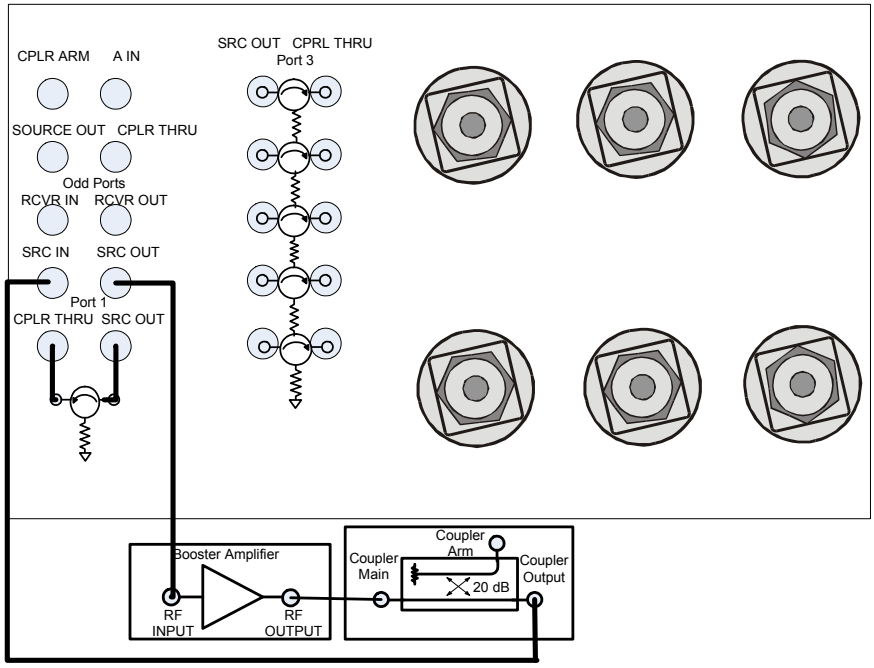


Figure 49 Port 1 (20 Watt)

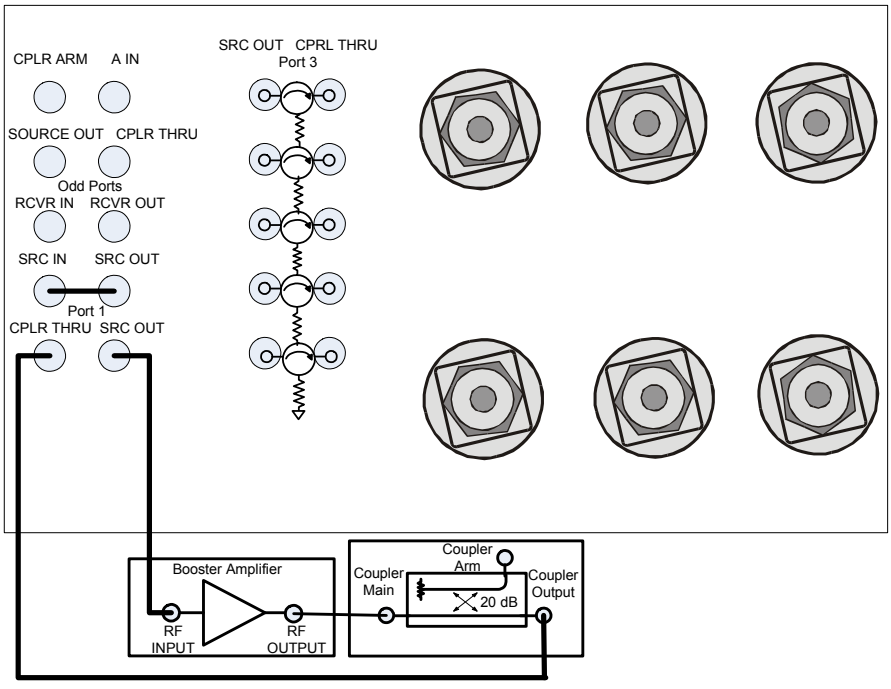


Figure 50 Port 3 (20 Watt)

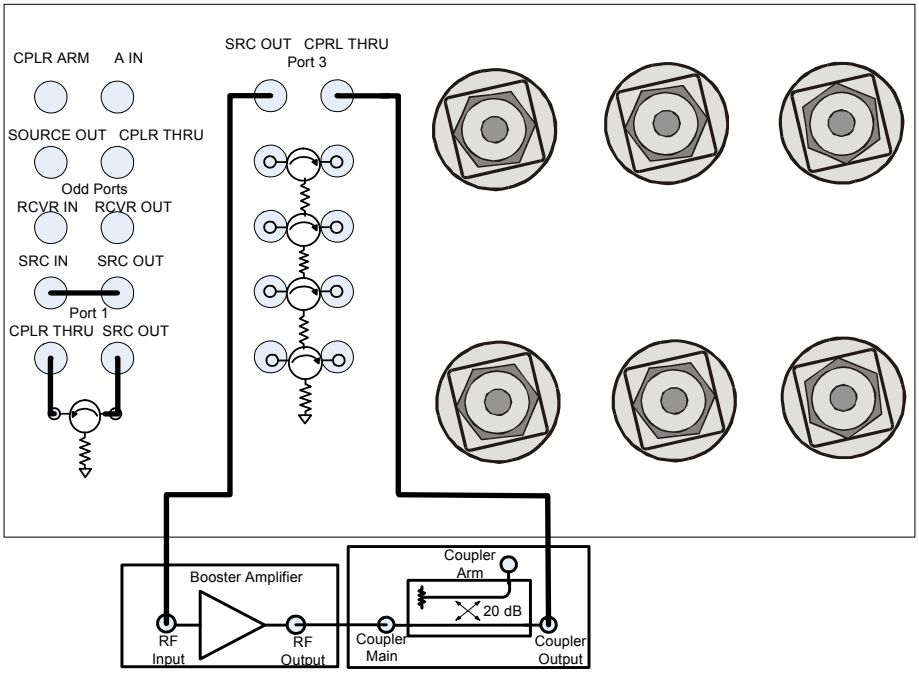
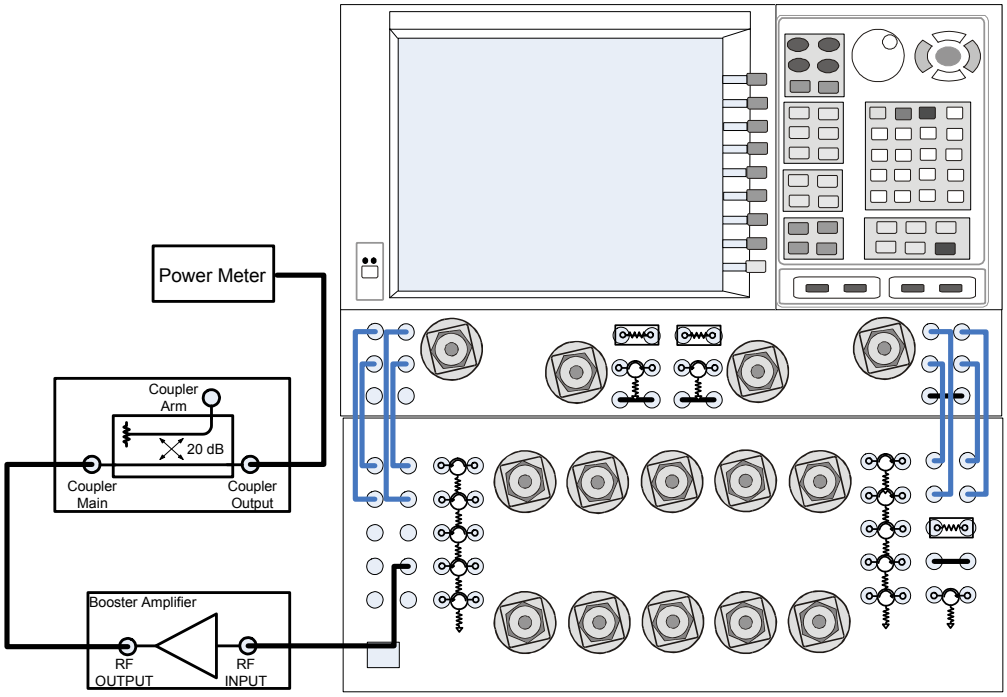


Figure 51 Measuring the Booster Amplifier Gain



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. For 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 above.

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 52 and Figure 53 on page 68.

Selecting RCVR A and B Path Attenuators

8. 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

9. Calculate the amount of attenuation used between the external RCVR OUT and RCVR A /B IN.

Equation 4 RCVR IN Attenuation Example

$$-15dBm - 25dBm = -40dBm$$

10. Connect the 40 dB attenuators to RCVR OUT.
11. Connect the RF cable from the DUT Output to the Test Set port that will be receiver port.
12. Select the trace for the source to receiver path. Example, if port 3 is your receiver and port 1 is your source, select S31.
13. Turn On the Booster Amplifier.
14. Measure the attenuator output power.
15. Verify that the power measured, in the previous step, is within the acceptable limits (–15 dBm for the RCVR A/B IN).
16. 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 52 1 Watt High Power Configuration

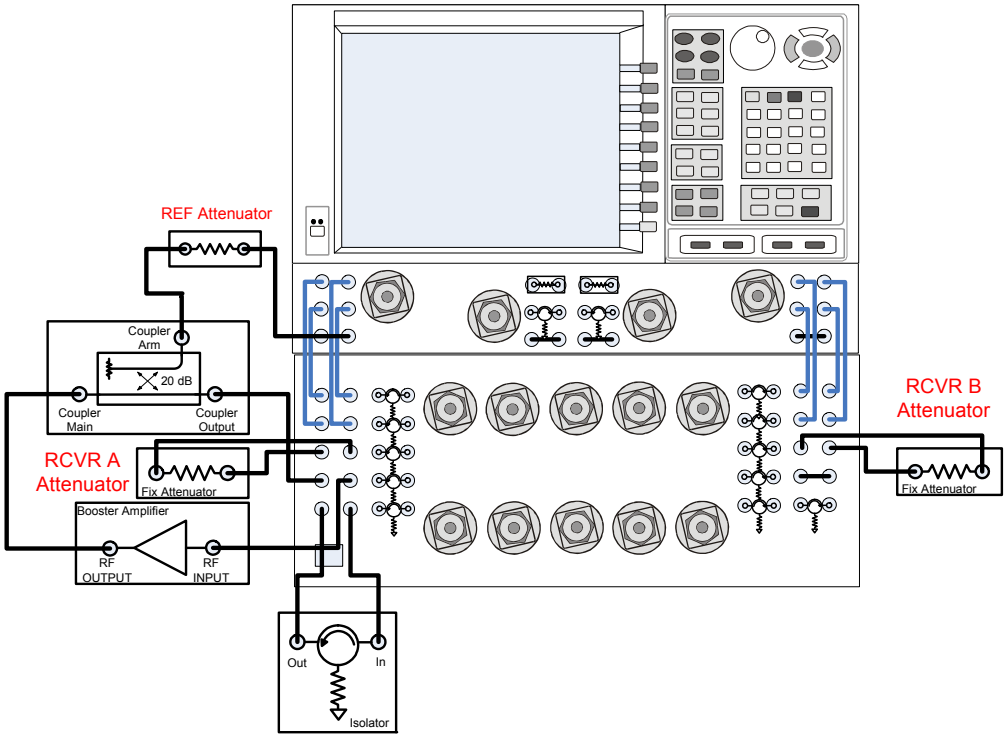
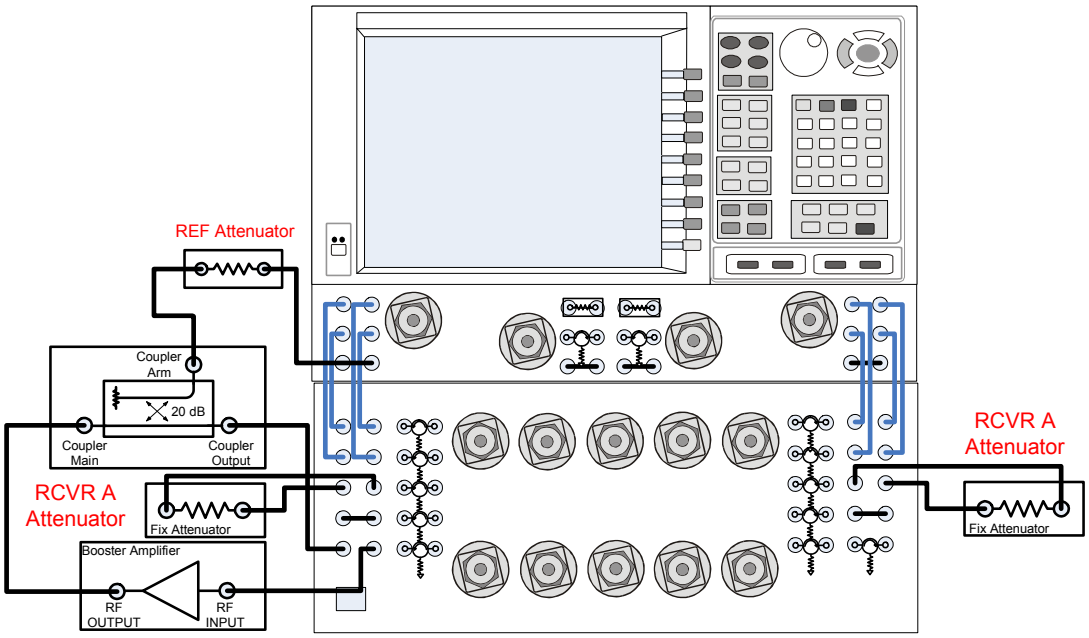


Figure 53 20 Watt High Power Configuration



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-X must have Option 551.

If no calibration has been performed or if the instrument is in an uncalibrated 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.

Service Information

This section provides information to troubleshoot and repair the U3022AH10 Test Set. Refer to "Keysight Support, Services, and Assistance" on page 95 for information on returning your test set to Keysight Technologies.

NOTE

In June 2016, the U3022AH10 Test Set, serial number US47450118 and above, underwent a significant RF switch drive control change. The solid state switch driver board was made programmable to accommodate the implementation of the Option 129. This change will now be implemented on all future Standard and Option 129 versions as well. With the new switch driver board, U3025-63068, the RF switch connections and reference designators have changed. Be careful not to use pre-2016 switch driver board and reference diagrams during service operations.

The User's and Service Guide for the earlier versions of the Standard is available at http://na.support.keysight.com/multiport.

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

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

Table 18 Replaceable Parts

Description	Keysight Part Number
User's Guide (U3022A Option H10)	U3022-90002
Interconnect Cable	N4011-21002
PNA, PNA-L or PNA-X Locking Feet	5023-0132
RF Switch SP6T, 26.5 GHz	87106-60065
SW Interface Board (programmed)	U3025-60068
RF Switch DPDT, 26.5 GHz (Option 129)	N1811-60027
Front Panel LED Board	N5261-60005
Test Set Control Board (programmed)	N5261-60006

Figure 54 Top View (Standard)

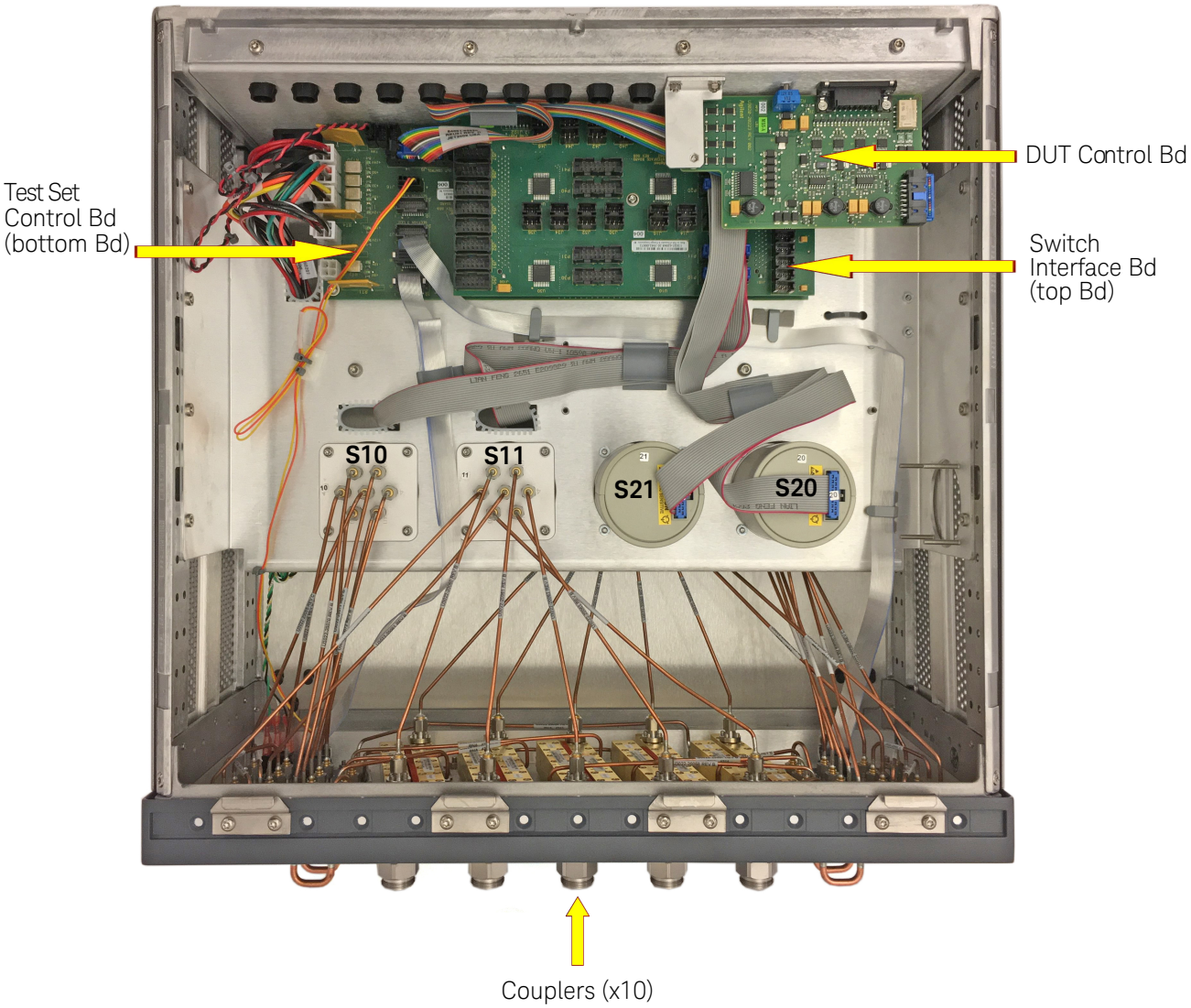


Figure 55 Bottom View (Standard)

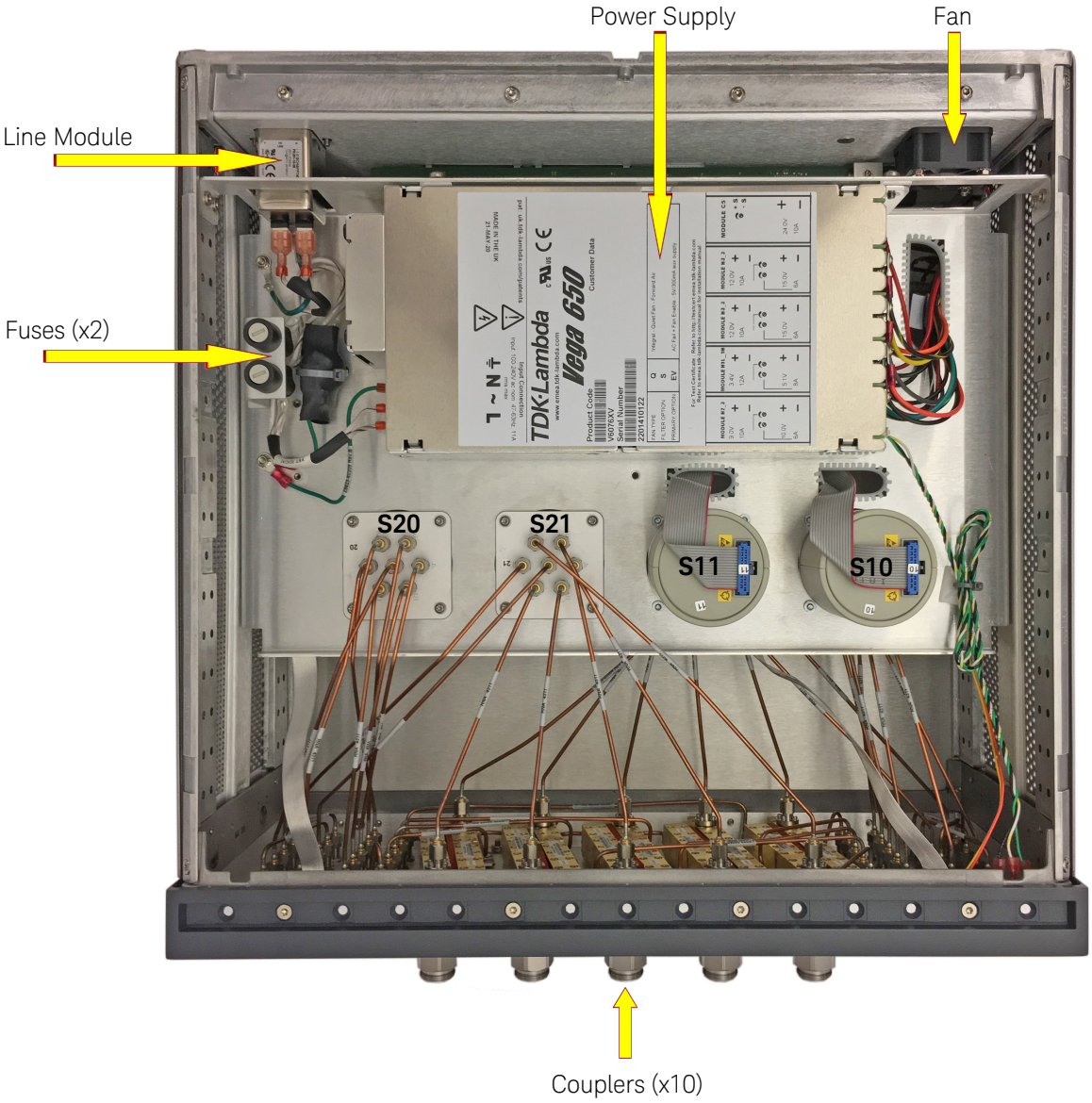


Figure 56 Top View (Option 129)

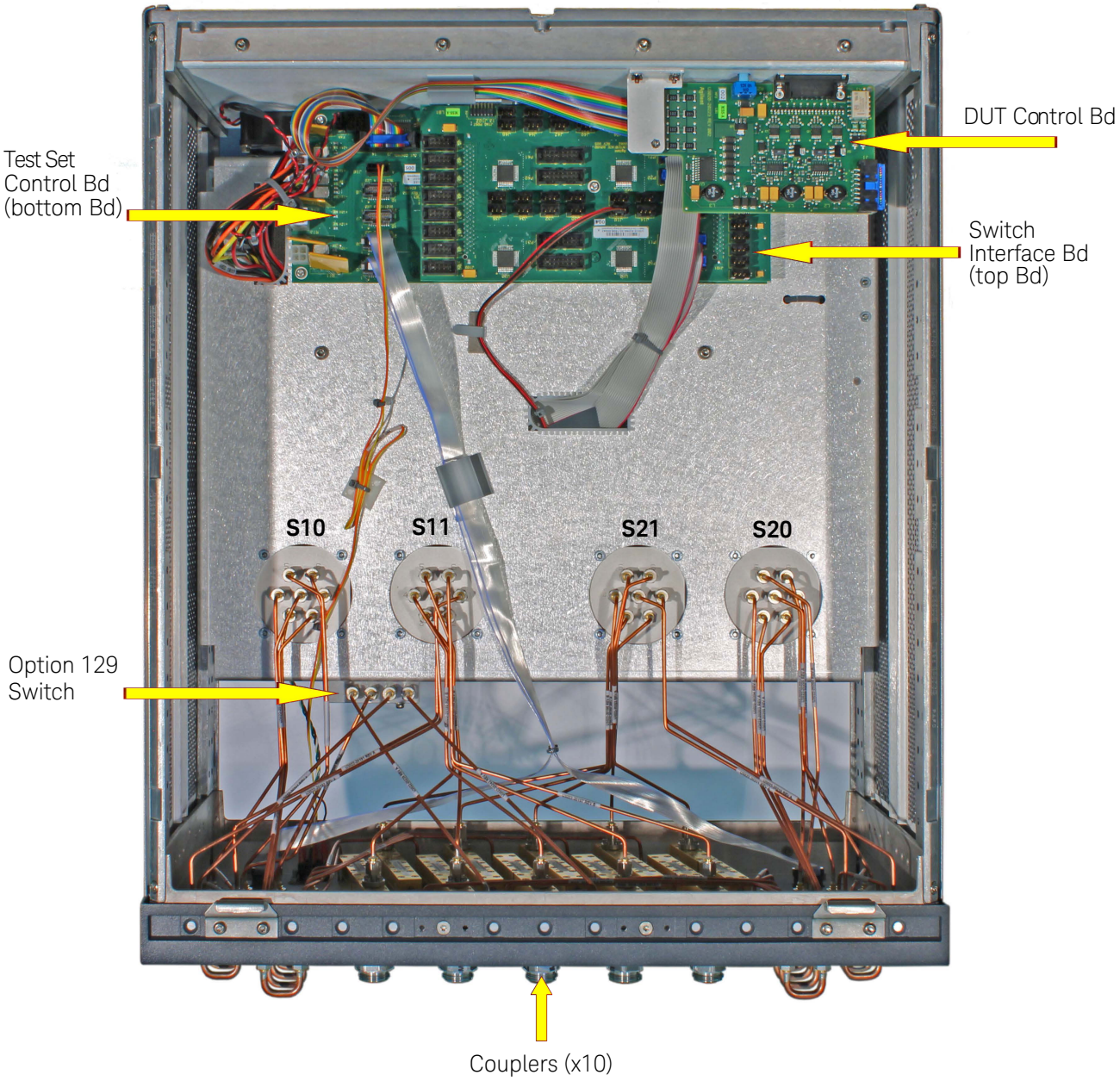
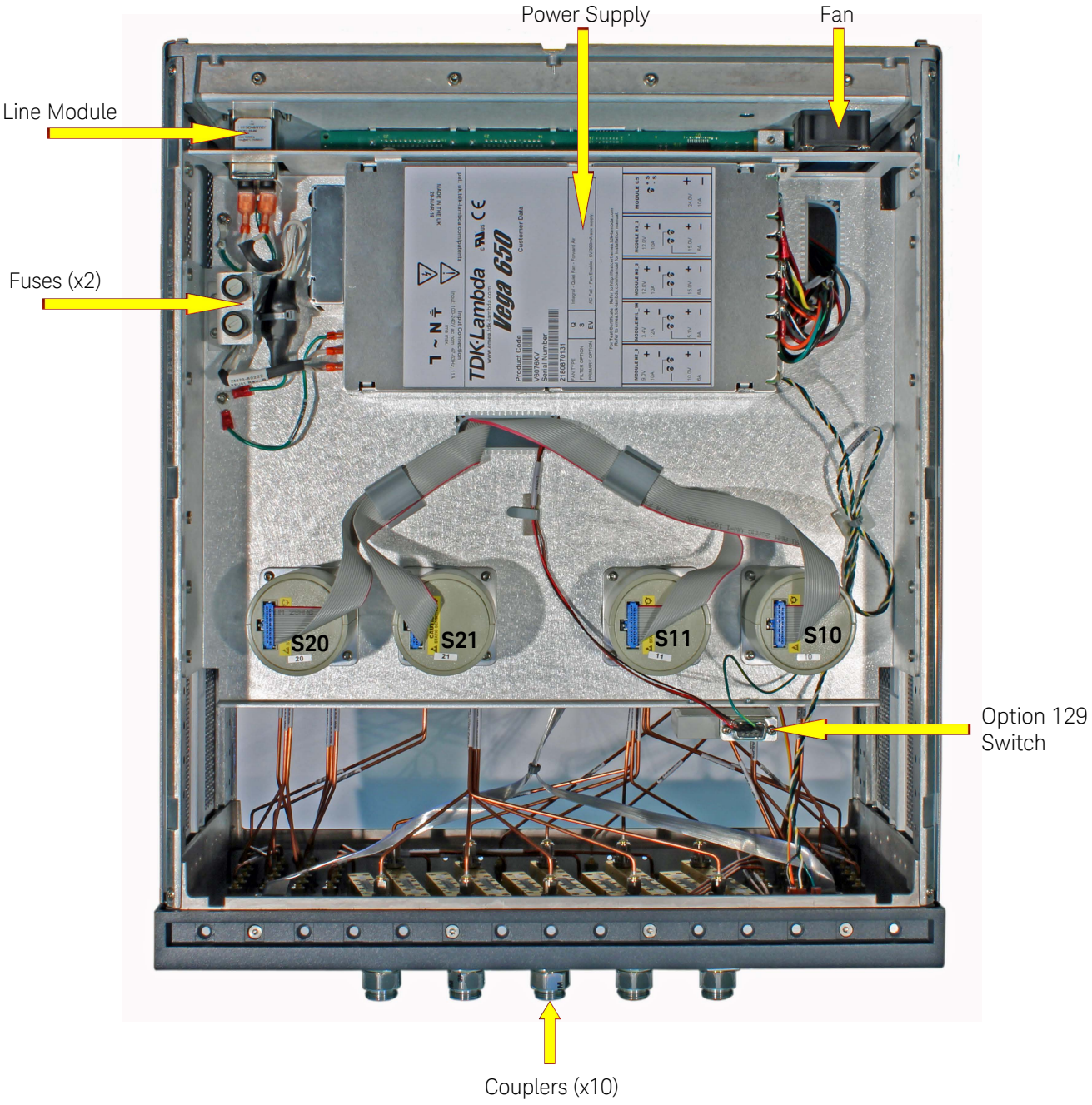


Figure 57 Bottom View (Option 129)



Theory of Operation

The following is a description of the operation of the U3022AH10. Reference the U3022AH10 block diagrams shown, beginning with Figure 58 on page 77. This section assumes the user has a general understanding of couplers, switches, and network analyzers.

RF Switch Components

All internal RF switches are all mechanical switches. The frequency range is DC to 26.5 GHz. The switches select the RF paths from the PNA-X 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. Refer to the "System Block Diagrams" beginning on page 77.

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 Diagrams

Figure 58 12 Port Standard Configuration

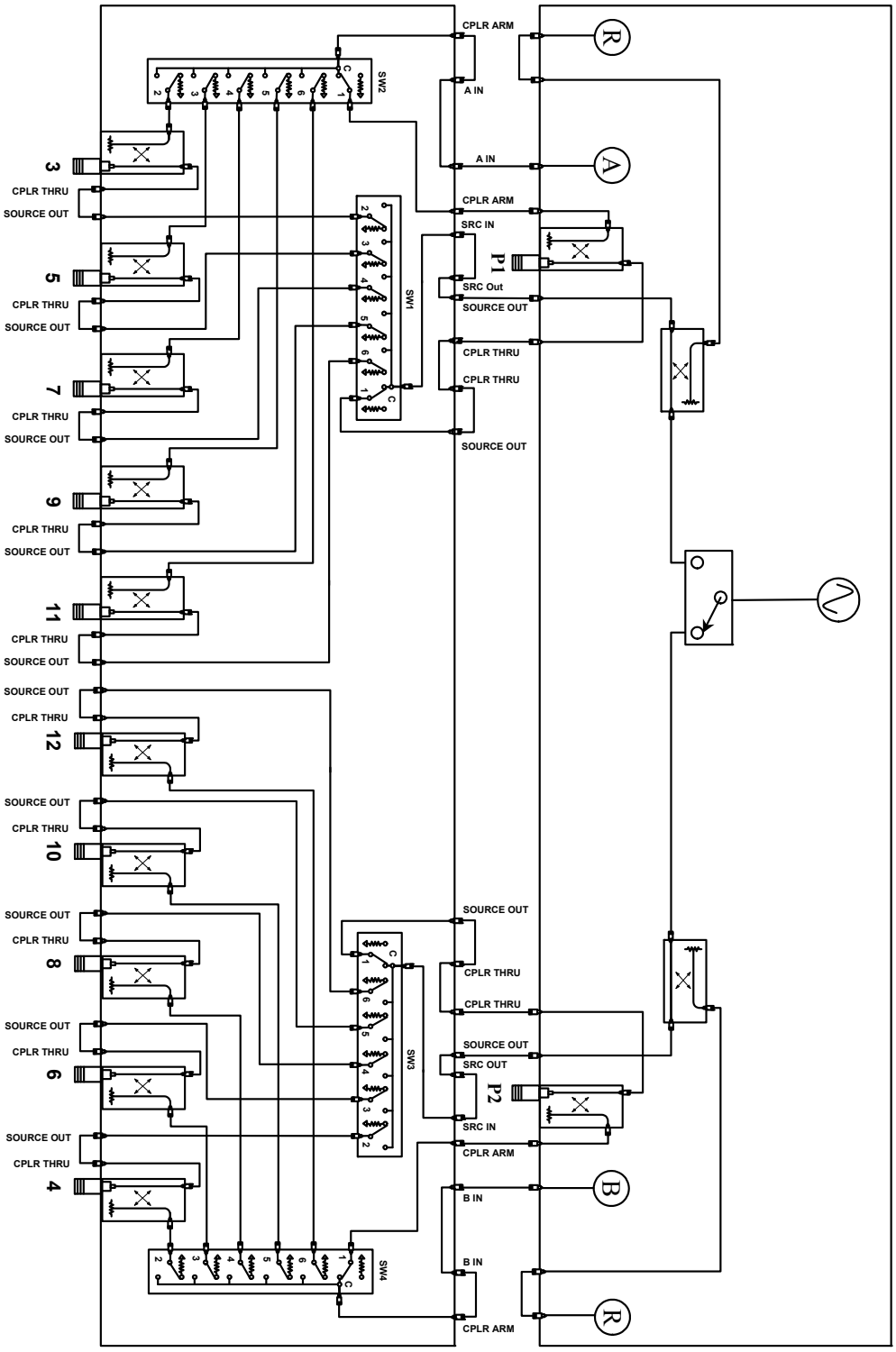


Figure 59 2-Way Power Configuration (1 Watt)

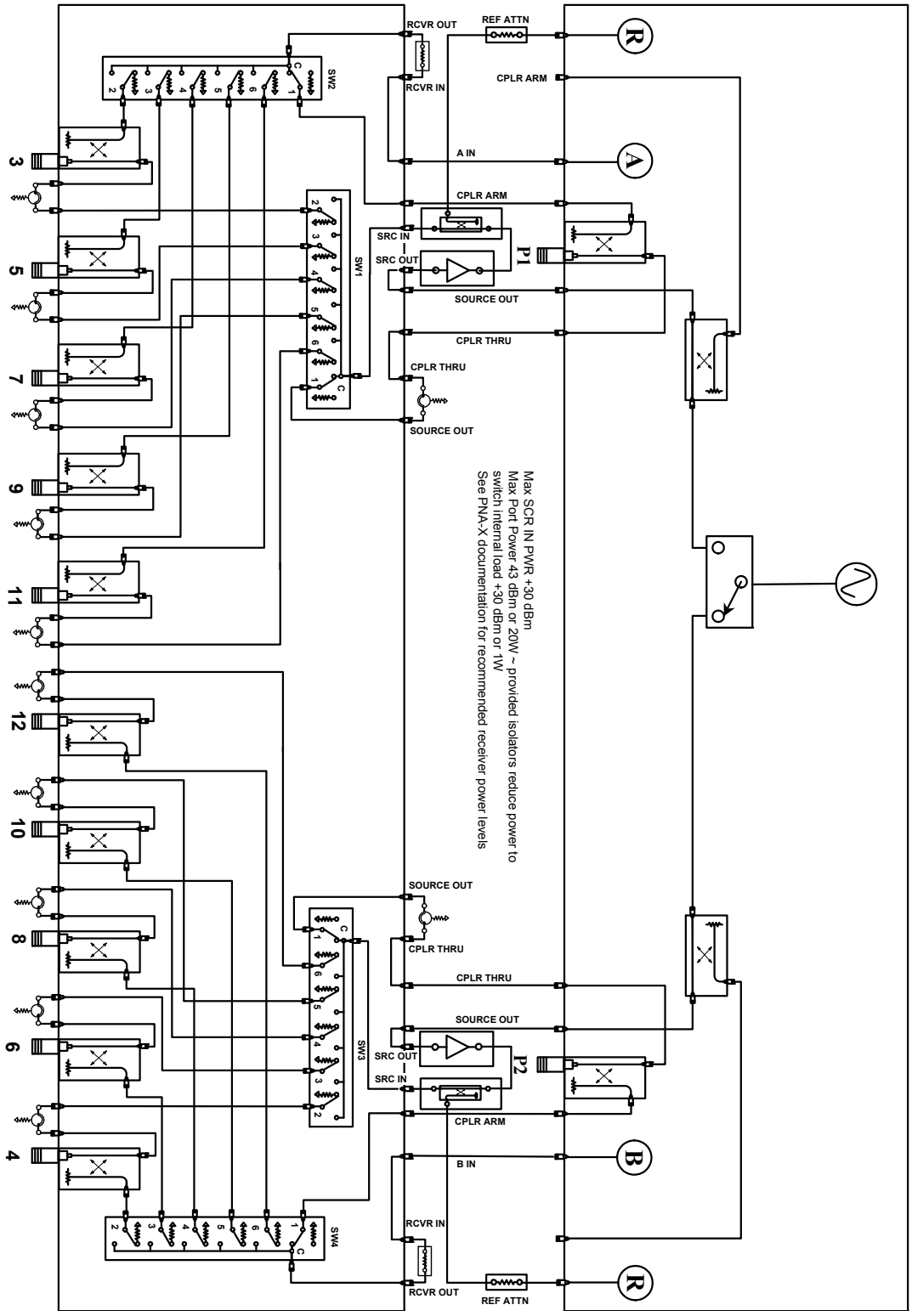


Figure 60 Odd Port High Power Configuration (1 Watt)

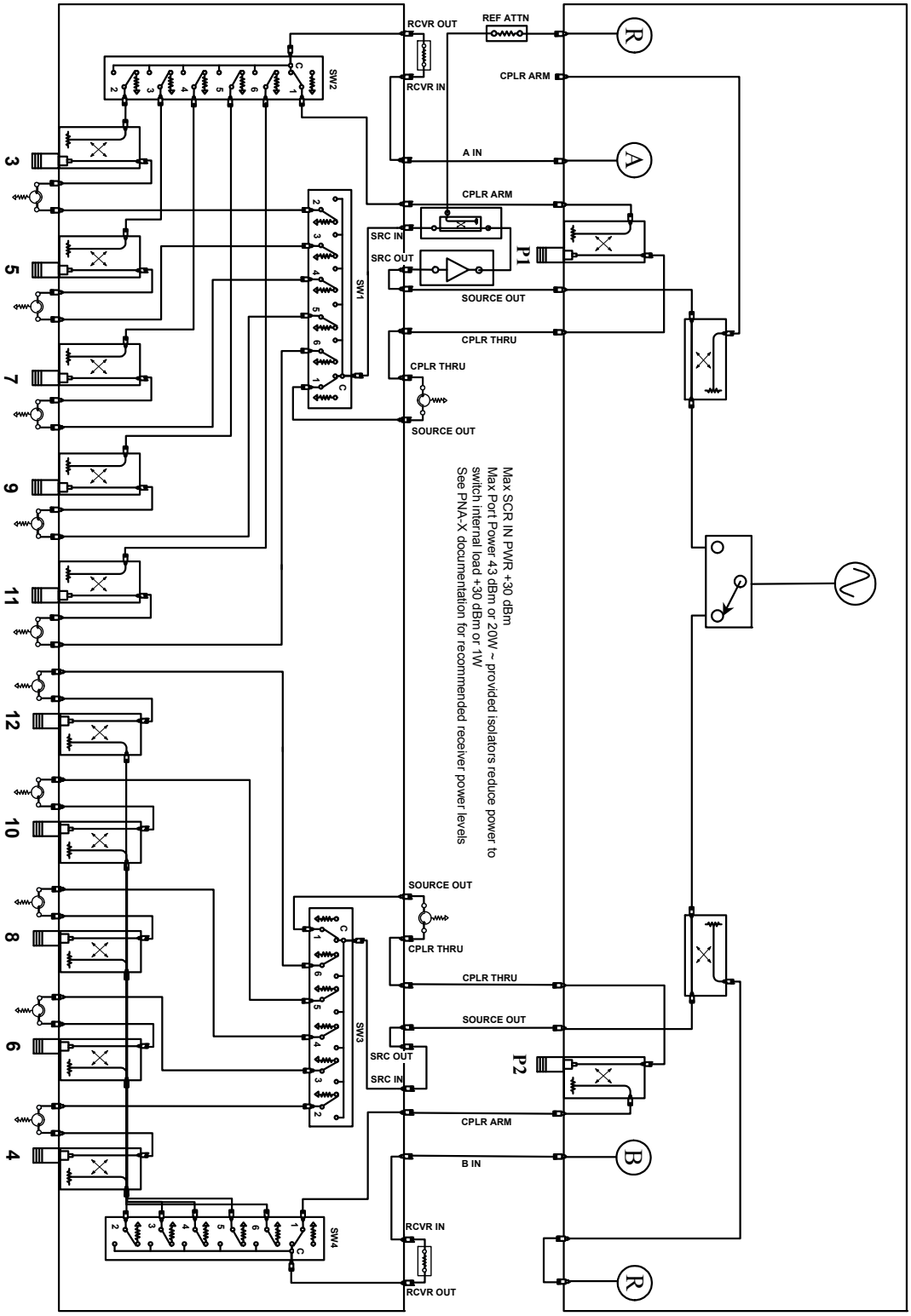
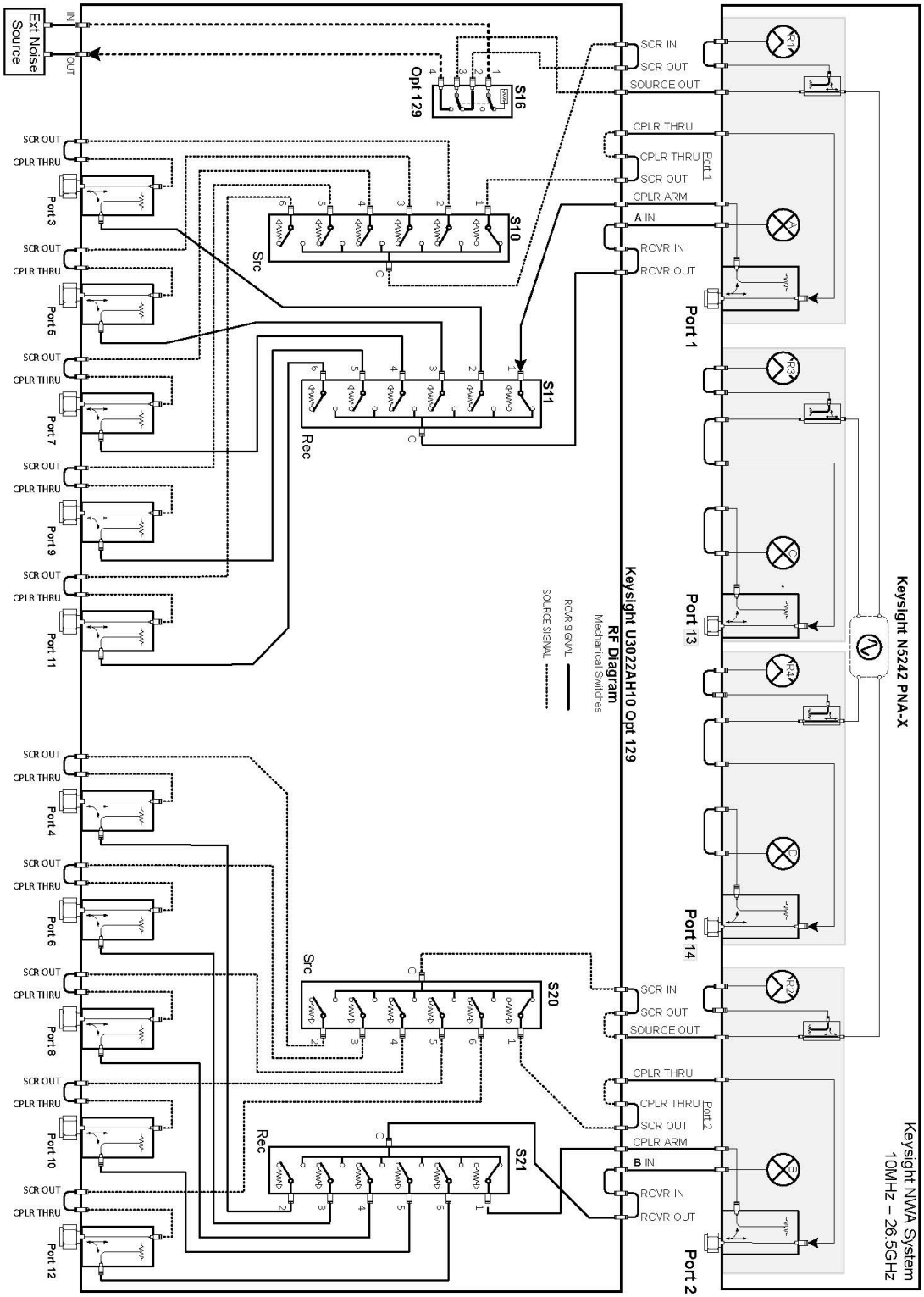


Figure 61 14-Port System, Option 129 Test Set



Troubleshooting the Test Set

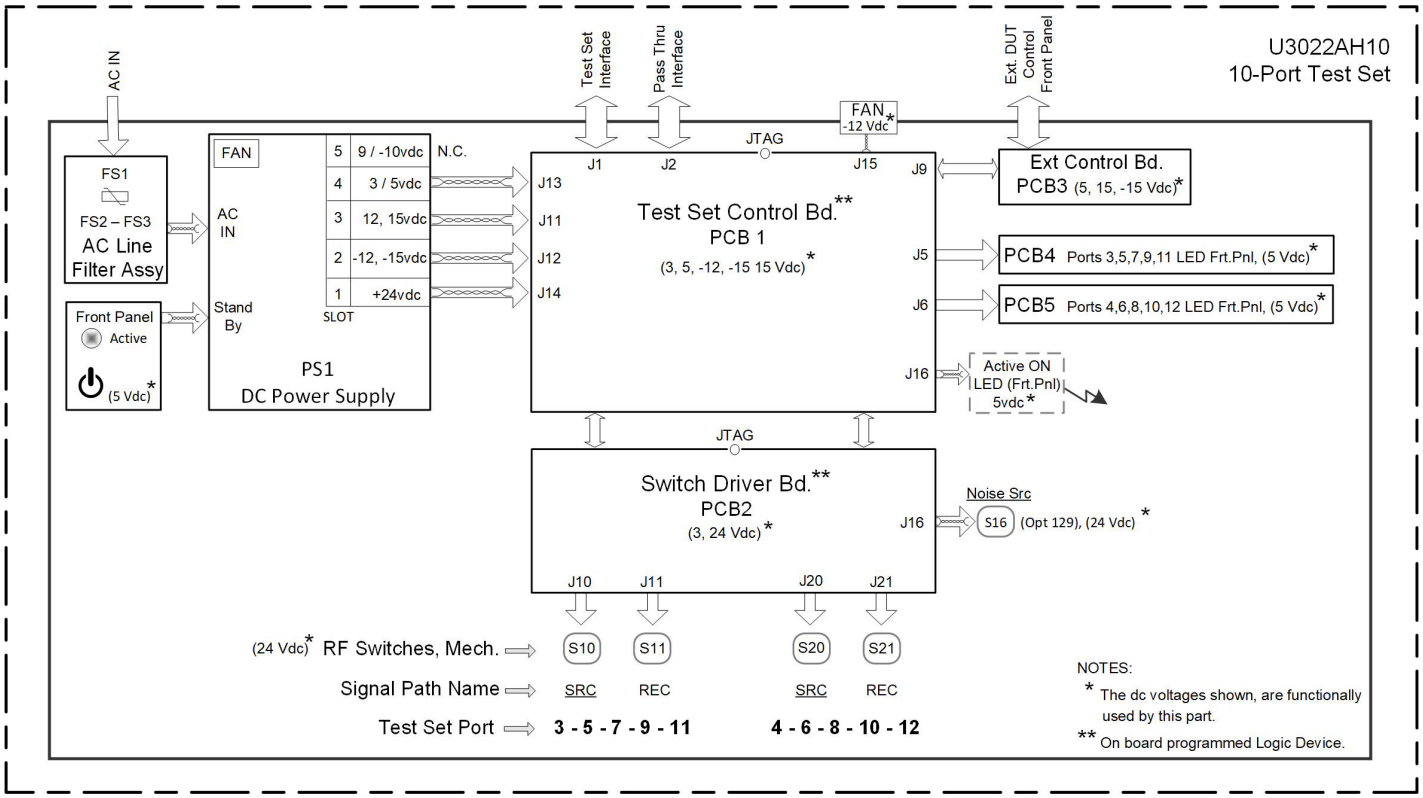
If the U3022AH10 is not operating properly, use the following procedures to isolate and repair the type of failure encountered. It is recommended that a qualified service technician perform the following procedures.

Refer to the Keysight PNA Series: Service & Support Home Page at: http://na.support.keysight.com/pna for further information.

To request service, please contact your local service center. In the US, call 800-829-4444. For a listing of service centers worldwide, please visit us at http://www.keysight.com/find/assist.

When sending the Test Set in for repair, please also send your PNA and cables. This will allow us to verify proper operation of the complete system, and speed your repair turn-around time. Refer to "Keysight Support, Services, and Assistance" on page 95.

Figure 62 Test Set Electrical Diagram



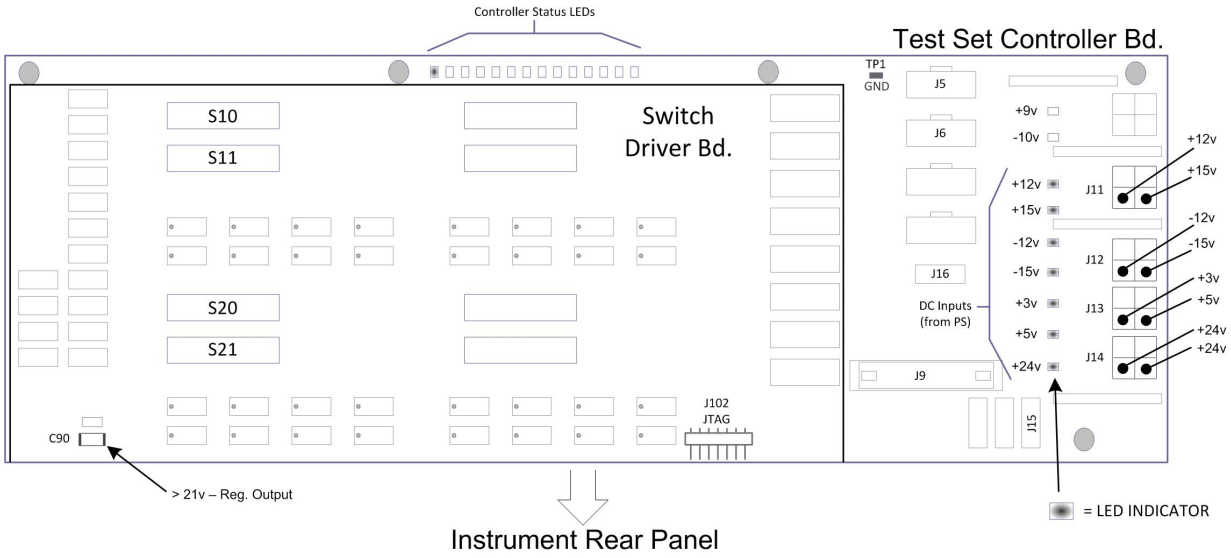
Non-RF Malfunctions

If the Test Set is not operating properly, use the following checklist to aid in isolating the source of the non-RF malfunction. Typical malfunctions may be the loss of the rear panel fan, control lines, or front panel indicator lights.

WARNING The opening of covers or removal of parts is likely to expose the user to dangerous voltages. Disconnect the instrument from all voltage sources before opening.

1. Verify the front panel power switch is operational.
   a. The rear panel FAN and front panel Active LED should operate when the Standby Switch is in the ON position.
2. AC Line voltage checks (remove AC power from the instrument).
   a. Ensure the proper AC line voltage is present at the instrument line cord.
   b. Remove the AC power cord from the instrument. Check the instrument AC line module fuse; refer to Figure 6, page 21.
   c. Check the internal AC lines fuses. Remove the instrument bottom cover. Near the rear panel are two fuse holders. Remove the the fuses and verify that they are operational. See Figure 57, page 75.
3. Internal DC Power Checks. During this check you will reapply AC power to the instrument with the top cover removed. Connect the AC power cord to the Test Set.
   a. Set the front panel switch to the Standby position. No fans or indicator lights should be operational.
   b. Set the front panel switch to the ON position. The rear panel and internal power supply fan should be operational. The front panel Active LED should be ON if the Test Set is connected to an active PNA-X.
   c. Verify that the DC power indicator LEDs are ON. Refer to Figure 63, page 83.
   Note: The LED indicators only indicate the presence of a DC voltage, not the DC voltage level. Use the indicated wire locations for voltage measurements. TP1 is your common.

Figure 63 DC Power Status LEDs



d. If there is still no AC power, suspect the Power Supply Module. The actual power supply terminal connections should also be checked with a DVM by removing the bottom cover and using the power supply label to identify the terminal voltage values.

e. If all DC voltage input LEDs are ON, but the fan is not, replace the fan.

4. Front Panel R and S Indicator LED check.

   a. If these indicators are not operating, you should perform the first steps of the RF troubleshooting checklist.

5. Control Lines of DUT Control Board are not working.

   a. Verify that the control voltage pin connections to the DUT control lines are connected properly. Refer to "DUT Control Lines" on page 56.

   b. Verify that the rear panel DC voltage control adjustment can be set to 5 Vdc. Refer to Figure 5 on page 20.

RF Switching Malfunctions

If the Test Set RF signal functionality is not operating properly, use the following checklist to aid in isolating the source of the malfunction. Typical malfunctions may be a loss of RF switch control failure and/or a non-RF failure as outlined in the previous section. The internal RF switches used in this instrument are controlled by the +21 Vdc voltage from the switch driver board.

1. The PNA and the Test Set need to be connected together with the Test Set I/O cable (N4011-21002).
2. Verify the Test Set I/O cable is installed correctly. See Figure 13 on page 27.

3. Using the Multiport Mode (Option 551), verify the PNA firmware is correct and the Test Set file is loaded into the PNA. Refer to "Network Analyzer Requirements" on page 12.
4. Using the I/O Command values, confirm that the correct address and data values are being used. Refer to the address and data value tables on page 55.
5. Follow the "Non-RF Malfunctions" checklist on page 82, if you haven't already.
6. Front Panel R and S Indicator LED Check.
   a. Check that the Test Set controller board "Controller Status LEDs" are ON. Refer to Figure 63 on page 83. If the LEDs are OFF, remove the switch driver board and see if the LEDs come on. If the LEDs are still OFF, replace the controller board.
   b. If the status LEDs are ON and the front panel Active LED is ON, suspect the Front Panel LED board or the ribbon cable and replace as needed.
7. Check the DC +21 Vdc switch drive voltages on the switch driver board by connecting a voltmeter to one of the Jxx locations as shown in Figure 63. Do not disconnect the RF switch connector in order to keep the switch in place as a load for the following voltage measurement.
   a. Measure Pin 3 to Tp1 = +21 Vdc voltages. If +21 Vdc is abnormal, suspect the switch driver board.
   b. If the +21 Vdc is okay, measure the switch drive line voltage. You should measure > -21 Vdc. Refer to Figure 63.
   c. If the voltages are not normal, suspect a faulty RF switch.

Source and Receiver Path Test

If you suspect an RF signal path problem within the Test Set, the following procedure is provided to check all RF signal paths through the Test Set.

Before beginning this procedure, you should complete the following steps:

- Install the Test Set I/O interface cable between the PNA and the Test Set on the rear panel.
- Remove the front panel RF interface cables and reinstall the PNA front panel U-shaped cables.
- You will need two 26.5 GHz 3.5 mm RF Flex cables and a 3.5 mm f/f adapter.

Equipment Setup

- Power ON both the Test Set and the PNA-X.
- Preset the PNA-X, setting the PNA-X to Standalone Mode.
- Confirm the frequency range is set to 10 MHz to 26.5 GHz.
- Connect RF Flex cables to PNA Ports 1 and 2. Connect the cables together with a 3.5 mm adapter.
- Configure the PNA-X to measure S21 and normalize the response trace.
- Set the PNA to Interface Control Mode with front panel keys:
  Trace/Chan > Channel > Hardware Setup > Interface Control -OR-
  (Instrument > Setup > Internal Hardware > Interface Control...). In the drop-down window, select the **Enable Interface Control** box.

NOTE The <addrs>.<data> entries noted in the Test Instruction Tables (beginning on page 86) will be used to configure the RF switches for this testing. After making your entry, select **<OK>** to execute the command. To return back for further entries, select **Interface Control** on the PNA display.

Cable Connections

The RF Flex cables will be connected to the designated Test Set front panel ports and an uncorrected response trace should be displayed that resembles the S21 response plot similar to those indicated in Table 19 below.

Table 19 RF Signal Path Insertion Loss (S21) Summary

RF Path Description	Signal	Insertion Loss (Typical)
Source OUT to Ports 3-12	Source	Figure 64
RCVR A/B IN to Ports 3-12	Receiver	Figure 65
Source OUT to CPLR THRU	Source	Figure 66
A/B IN to CPLR ARM	Receiver	Figure 66

NOTE The <addrs>.<data> values shown in the following test instructions are for the new Option 129 Test Set. Refer to Table 11 on page 55 for values used for the standard model.

Source Signal Path Insertion LossTest

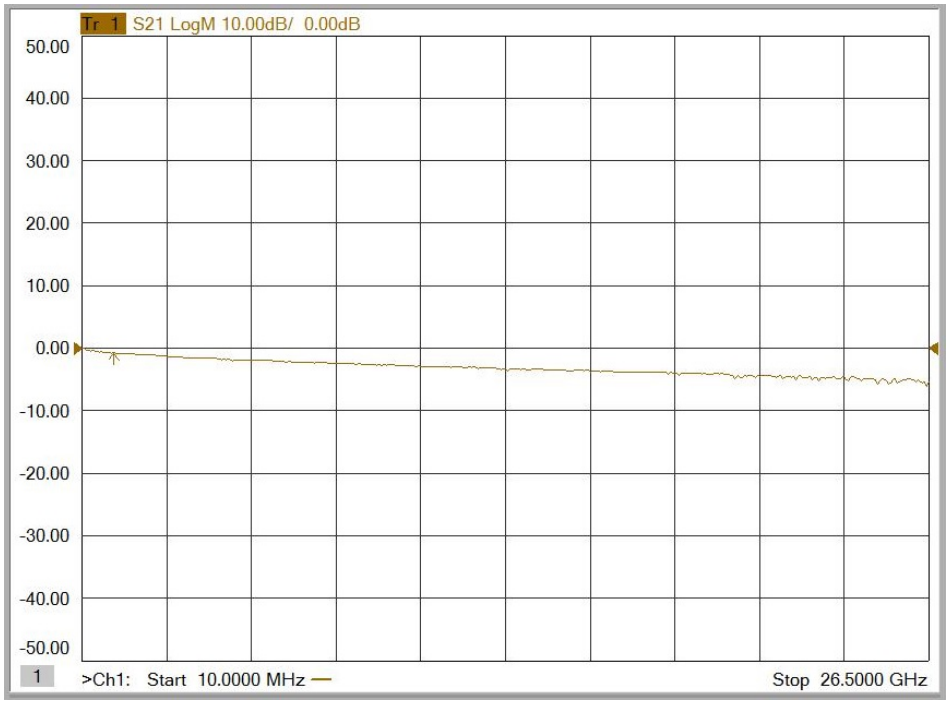
Connect the RF Flex cables to the Front Panel Test port and Source IN access port indicated in Table 20 below. Check that the results are similar to Figure 64 below.

Table 20 Source Signal Path Test Instructions

Path #	RF Path Description	Control Mode Entry <address>.<data>	Path Components	Insertion Loss (Typical)
	Odd Ports			
1	Source OUT to Port 3[1]	0.1	P3 CPLR, S10	Figure 64
2	Source OUT to Port 5	0.2	P5 CPLR, S10	
3	Source OUT to Port 7	0.3	P7 CPLR, S10	
4	Source OUT to Port 9	0.4	P9 CPLR, S10	
5	Source OUT to Port 11	0.5	P11 CPLR, S10	
	Even Ports			
6	Source OUT to Port 4	16.1	P4 CPLR, S20	Figure 64
7	Source OUT to Port 6	16.2	P6 CPLR, S20	
8	Source OUT to Port 8	16.3	P8 CPLR, S20	
9	Source OUT to Port 10	16.4	P10 CPLR, S20	
10	Source OUT to Port 12	16.5	P12 CPLR, S20	

1. Use the Source IN port associated with this group of test ports.

Figure 64 Source OUT to Ports 3-12 Path Response



Receiver Signal Path Insertion LossTest

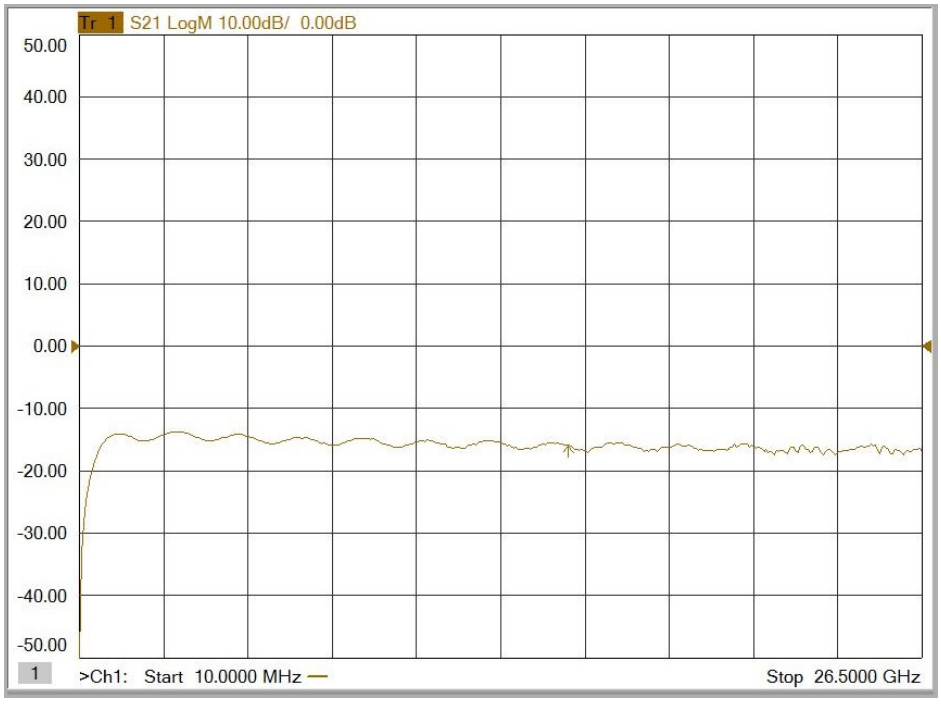
Connect the RF Flex cables to the Test Port and RCVR A/B IN ports as indicated in Table 21 below. Check that the results are similar to Figure 65 below.

Table 21 Receiver Signal Path Test Instructions

Path #	RF Path Description	Control Mode Entry <address>.<data>	Path Components	Insertion Loss (Typical)
	Odd Ports			
1	A IN to to Port 3[1]	0.16	P3 CPLR, S11	Figure 65
2	A IN to Port 5	0.32	P5 CPLR, S11	
3	A IN to Port 7	0.48	P7 CPLR, S11	
4	A IN to Port 9	0.64	P9 CPLR, S11	
5	A IN to Port 11	0.80	P11 CPLR, S11	
	Even Ports			
6	B IN to Port 4	16.16	P4 CPLR, S21	Figure 65
7	B IN to Port 6	16.32	P6 CPLR, S21	
8	B IN to Port 8	16.48	P8 CPLR, S21	
9	B IN to Port 10	16.64	P10 CPLR, S21	
10	B IN to Port 12	16.80	P12 CPLR, S21	

[1] Use the Source IN port associated with this group of test ports.

Figure 65 RCVR A/B IN to Ports 3-12 Path Response



Receiver Signal Path Insertion LossTest

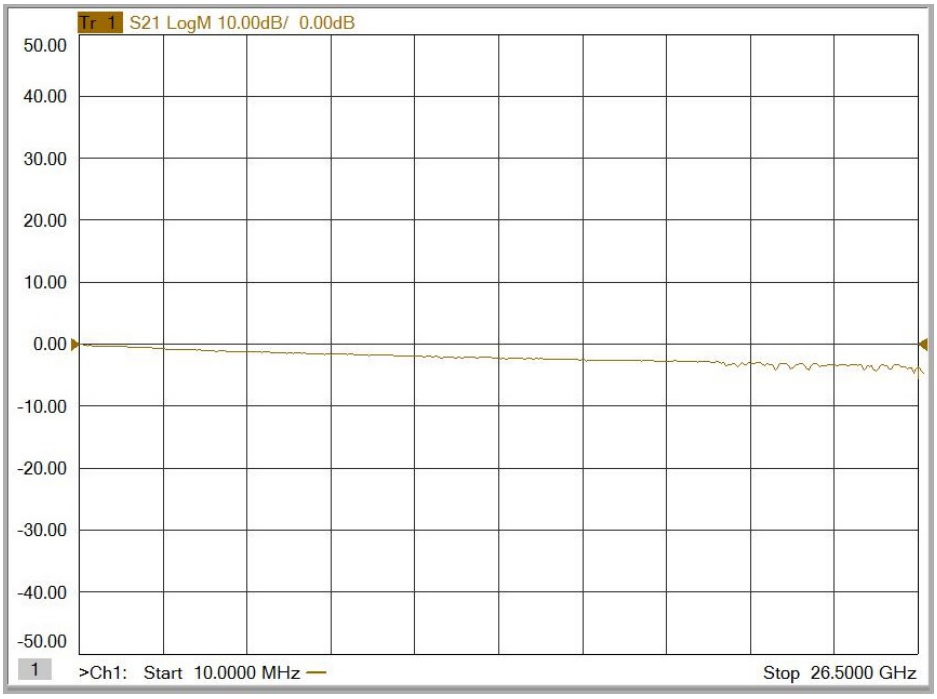
Connect the RF Flex cables to the Source OUT and CPLR THRU ports as indicated in Table 22 below. Check that the results are similar to Figure 66 below.

Table 22 Source Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode Entry <address>.<data>	Path Components	Insertion Loss (Typical)
1	Odd Ports	Source OUT to CPLR THRU[1]	0.0	S10	Figure 66
2	Even Ports	Source OUT CPLR THRU	16.0	S20	

1. Use the Source IN port associated with this group of test ports.

Figure 66 Source and Receiver Bypass Path Response



Connect the RF Flex cables to the receiver A/B IN and CPLR ARM ports indicated in Table 23 below and check that the results are similar to Figure 66 above.

Table 23 Receiver Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode Entry <address>.<data>	Path Components	Insertion Loss (Typical)
1	Odd Ports	A IN to CPLR ARM[1]	0.0	S11	Figure 66
2	Even Ports	B IN to CPLR ARM	16.0	S21	

1. Use the Source IN port associated with this group of test ports.

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 Keysight Technologies web site at http://regulations.about.keysight.com/DoC/

Statement of Compliance

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

Before Applying Power

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

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

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

CAUTION 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.

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

Servicing

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 Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended. Discard used batteries according to manufacturer's instructions.

WARNING These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

WARNING The opening of covers or removal of parts is likely to expose the user to dangerous voltages. Disconnect the instrument from all voltage sources before opening.

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

WARNING The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch (disconnecting device).

WARNING To prevent electrical shock, disconnect the Keysight 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.

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.

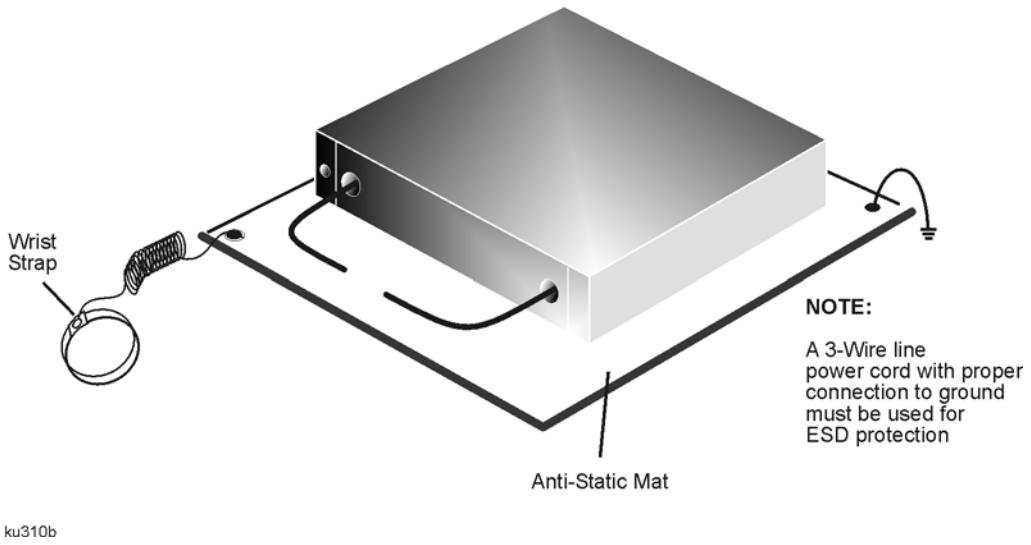
Electrostatic Discharge Protection

Protection against electrostatic discharge (ESD) is essential while removing assemblies from or connecting cables to the instrument. 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 in front of your test equipment.
- **always** wear a grounded wrist strap with grounding cord, connected to a grounded conductive table mat, having a 1 MΩ 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 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 67 ESD Protection Setup



Instrument Markings

Listed below are definitions for the markings that may be found on the product.

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

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

This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive).

This symbol indicates that the power line switch is ON.

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

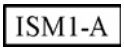
This symbol indicates that the power line switch is in the OFF position.

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.

ccr.keysight@keysight.com The Keysight email address is required by EU directives applicable to our product.

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



This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).

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 egress and operational environment.

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

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

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

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

Battery: Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Keysight Technologies for disposal. Refer to "Contacting Keysight" on page 95 for assistance.

EMC: Complies with the essential requirements of the European EMC Directive as well as current editions of the following standards (dates editions are cited in the Declaration of Conformity):

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11
- ICES/NMB-00 1
  This ISM device complies with Canadian ICES-001.
  Cet appareil ISM est conforme a la norme NMB-001 du Canada.

South Korean Class A EMC Declaration

If there is a "KC" mark on the instrument, then the following statement applies:

This equipment has been conformity assessed for use in business environments. In a residential environment, this equipment may cause radio interference.

※ This EMC statement applies to the equipment only for use in a business environment.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

Safety: Complies with the essential requirements of the European Low Voltage Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- USA: UL std no. 61010-1

Acoustic Statement: (European Machinery Directive):

- Accoustical noise emission
  LpA<70 dB
  Operator position
  Normal operation mode Per ISO 7779

Keysight Support, Services, and Assistance

Service and Support Options

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

Contacting Keysight

Assistance with test and measurements needs and information or finding a local Keysight office are available online at:

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

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

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

Shipping Your Product to Keysight for Service or Repair

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

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

- To improve turn-around time, return your test set along with your network analyzer and cables to Keysight so that we may verify the operation of the complete system.
- Include a complete description of the service requested or of the failure and a description of any failed test and any error message.
- Remove and retain the front handles and all rack mount hardware. The analyzer should be sent to Keysight in the same configuration as it was originally shipped.
- Ship the analyzer using the original or comparable antistatic packaging materials.
- Contact Keysight for instructions on where to ship your analyzer.

Edition 6: December 2020
Supersedes: August 2020

U3022-90002

KEYSIGHT TECHNOLOGIES

www.keysight.com