Keysight Technologies U3024AH10 Multiport Test Set

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

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KEYSIGHT TECHNOLOGIES

User's and Service Guide

Notices

Trademark Acknowledgments

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CAUTION

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WARNING

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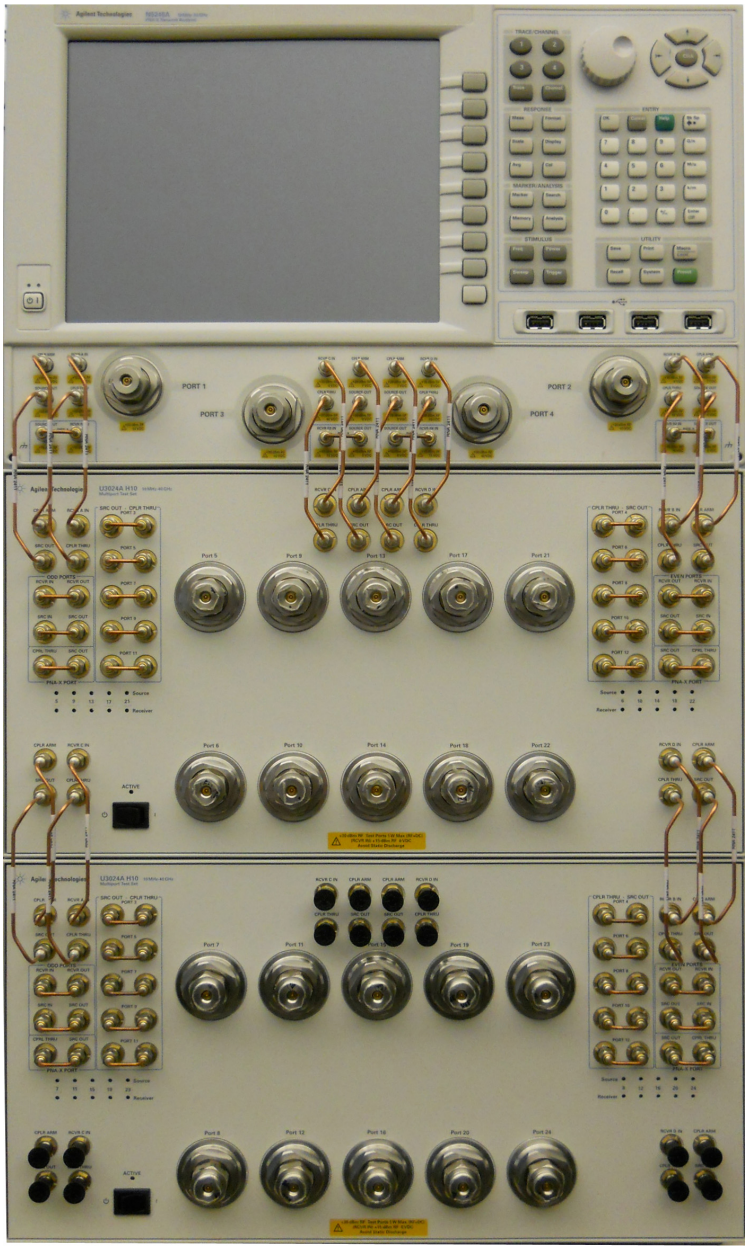
U3024AH10

Introduction

This document describes how to use the U3024AH10 Multiport Test Set Extension.

Figure 1 N5244/45A 4-Port PNA-X with 14-Port Configuration

Figure 2 N5244/45A 4-Port PNA-X with 24-Port Configuration



Description

The Keysight U3024AH10 is a Multiport Test Set Extension designed to be configured for high power measurements in either a 14 or 24-Port network analyzer measurement system. Two U3024AH10 Test Sets are required for the 24-Port network analyzer system, as shown in Figure 2, page 2. The Keysight U3024AH10 has the following key features:

- 10 Test Ports (2.4 mm male connectors)
- Low-loss mechanical RF switching
- High-powered device measurement capability
- N-Port calibration and full cross bar measurement capability
- Frequency range of operation: 10 MHz - 40 GHz (Standard Opt 700)
- Keysight PNA-X compatibility with rear panel Test Set I/O interface for operational control. The PNA Option 551 is required. An external personal computer is not required.

NOTE **The Keysight N5224A/B, N5225A/B, N5244A/B, and N5245A/B PNA/PNA-X Network Analyzers will be referred to throughout this document as the PNA-X. The U3024AH10 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.

Table 1 U3024AH10 Accessories Supplied

Description	Part Number	Quantity
Lock-Links[1]	1600-1423	4
Short, Coax 2.4 mm female	85056-60021	1
RF Cable, Semi-rigid, Front Panel Jumper[1]	N5245-20155	16
Guard, Jumper Cable - Side[1]	N5242-00029	2
Guard, Jumper Cable - Center[1]	N5247-00019	2
User's and Service Guide, U3024AH10	U3024-90001	1

1. These items are attached to the front of the Test Set at the factory.

Verifying the Shipment

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

Inspect the shipping container. If the container or packing material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is physical damage, refer to “Contacting Keysight” on page 99. Keep the damaged shipping materials (if any) for inspection by the carrier and an Keysight Technologies representative.

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.

The test set files indicated in Table 2 must be installed into the analyzer’s file directory location:

"A" Models: C:\Program Files (x86)\Agilent\Network Analyzer\TestSets
"B" Models: C:\Program Files (x86)\Keysight\Network Analyzer\TestSets

Table 2 PNA-X Configuration Requirements

4-Port Network Analyzer	Options	Test Set File	System Figure
N5224/25A/B N5244/45A/B	400	u3024ah10_pnax_p4.tsx	1
		u3024ah10_x2_pnax_p4.tsx	2*
* The image shows two Test Sets configured in a 24-Port measurement system.			

Ensure the network analyzer has the latest version of firmware installed. The following website link will provide the necessary information: http://na.support.keysight.com/pna/firmware/firmware.html.

Definitions

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

Available Options

Test Set Options

- 700 -Standard, 10 MHz to 40 GHz frequency range, mechanical switches.

Front Handle and Rack Kits

- U3024AH10-1CM Front Rack Mount Flange Without Handles (5063-9216)
- U3024AH10-1CN Front Handles (5063-9229)
- U3024AH10-1CP Front Rack Mount Flange With Handles (5063-9223)

Network Analyzer Interface Kit Options

Table 3 below lists the Interface Kit Options required for a 14 or 24-Port PNA-X system. An Interface Kit includes both the hardware Lock-Link and the RF interface cables to interface the two instruments. Individual Lock-Link and Cable Kit numbers are shown for reference.

Table 3 Cable Kit Options

	Interface Kit Option	Hardware Lock-Link Kit	Cable Kit, Connector Type
14-Port System			
N5224/25A/B PNA-X, Opt 400 N5244/45A/B PNA-X, Opt 400	U3021PX2 Opt H45	U3021-60002[1]	U3024-60001, 2.4 (m)/(m)[2]
24-Port System			
N5224/25A/B PNA-X, Opt 400 N5244/45A/B PNA-X, Opt 400	U3021PX2 Opt H45 and U3040AC01 Opt 001	U3021-60002[3]	U3024-60001, 2.4 (m)/(m)[4]
		U3040-60001, 2.4 (m)/(m)[4]	

1. Refer to "14-Port System Setup" on page 15.
2. Refer to "14-Port System Interface Cable Connections" on page 18.
3. Refer to "24-Port System Setup" on page 20.
4. Refer to "24-Port System Interface Cable Connections" on page 24.

An additional expanded 24-Port System configuration is also available. The 24-Port System can be expanded by adding two U3040AS84 Test Sets. To accommodate a >24-Port expanded system, order User Interface Options U3021PX2-H45, U3040AC01-001, and U3040AC01-002. Refer to the U3040-90002 Service Note for more details regarding this system.

Specifications

The U3024AH10 performance is based on external components such as the calibration kit and network analyzer. There are no internal adjustments in the Test Set, therefore an annual calibration is not required. A functional certificate is supplied for the U3024AH10 only.

Specifications for the U3024AH10 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 customer's PNA-X that is used with the Test Set and components used for high power configurations.

CAUTION **The life expectancy of the following switches are 5 million cycles. When making measurements using more than one port, single sweeps are recommended to minimize switch cycles.**

- **87106-60069 (x4)**

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 below 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
N5224/25A/B, N5244/45A/B	450
U3024AH10	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
N5224/25A/B	49.0 kg (108 lb.)	26.61 cm (10.5 in)	42.56 cm (16.8 in)	58.23 cm (22.9 in)
N5244/45A/B	41.8 kg (92 lb.)			
U3024AH10	11.4 kg (25 lb)	22.15 cm (8.7 in)	42.5 cm (16.7 in)	50 cm (20 in)

Frequency Range and Maximum Power Levels

The U3024AH10 frequency range is 10 MHz to 40 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 below.

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 U3024AH10 Multiport Test Set RF Power Levels:		
PORT 3-12	+30 dBm 40 Vdc	+43 dBm 40 Vdc
SRC 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 U3024AH10 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 Figure 46 on page 61 and Figure 44 on page 60.
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)

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

Reflection Tracking Performance

Specifications for the reflection tracking are typical and are intended as non-warrantied information.

Reflection tracking takes into account Source Loss, Receiver Loss, Margin, and PNA-X Mixer Cal.

NOTE Typical specifications are based on 1 to 2 units performance. Refer to Table 7 below, and "14-Port Operational Verification Limit," Table 18 on page 64.

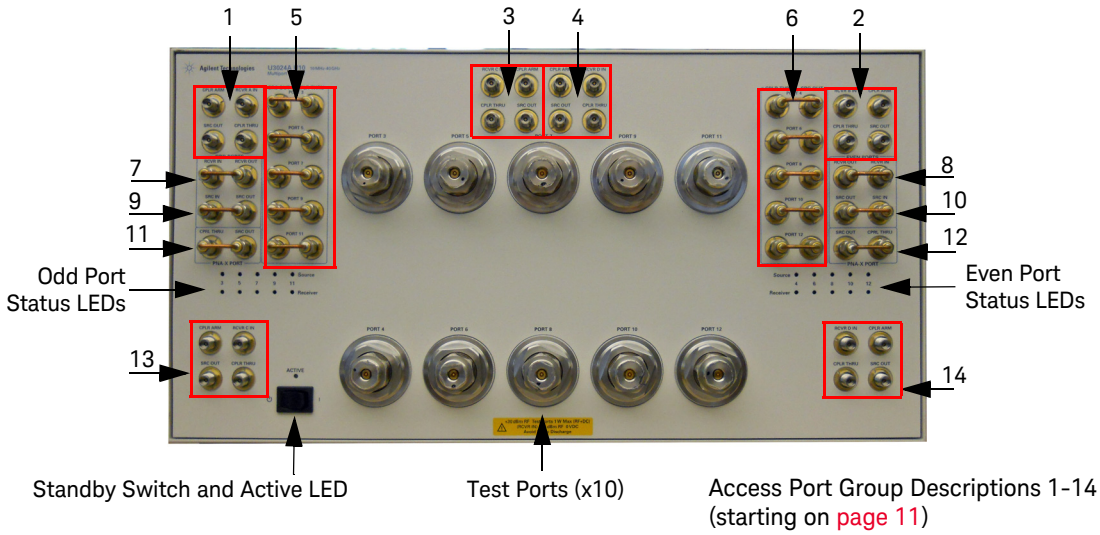
Table 7 14-Port Reflection Tracking System[1]

Frequency	Ports 1 to 2	Ports 3 to 12
10 MHz to 2 GHz	–1	–1
2 GHz to 5 GHz	–2	–2
5 GHz to 10 GHz	–3	–2.5
10 GHz to 15 GHz	–4	–3
15 GHz to 20 GHz	–5	–3.5
20 GHz to 25 GHz	–5.5	–4
25 GHz to 30 GHz	–6	–4.5
30 GHz to 35 GHz	–6.5	5
35 GHz to 40 GHz	–7	–5.5
40 GHz to 45 GHz	–7.5	–6
45 GHz to 50 GHz	–8	–6.5

1. Ports 13 and 14 are PNA-X Port 3 and 4, which do not pass through the Test Set. No degradation to the PNA-X Ports 3 and 4 (13 and 14) are noted.

Front and Rear Panel Features

Figure 3 Front Panel Features



Standby Switch

This switch is used to place the internal DC power supply into Standby mode only. It is not an AC line switch. The main power cord can be used to disconnect AC line power from the Test Set.

Active LED

When the Test Set is connected and addressed by a PNA-X, the LED is ON (illuminated). When the LED is OFF (not illuminated), the Test Set is in Standby, or not being addressed by the PNA-X. **Note:** When two Test Sets are used, as in the 24-Port System, the first Test Set connected to the PNA-X will never have an ON Active LED. Instead, the last Test Set will be the Test Set showing the Active LED status for all.

Test Ports - 2.4 mm Bulkhead (male)

These ten ports are labeled Ports 3 to 12, and are the measurement ports for your DUT. The bulkhead connector has a ruggedized hex nut that is 20 mm across the flats and is compatible with Keysight torque wrenches.

Test Port Status LEDs

Each test port has an "S" and "R" status LED assigned to it. On the left side of the front panel are the odd numbered port status LEDs, and on the right side are the even numbered port status LEDs. The "S" indicates Source mode and "R" indicates Receiver mode for that test port. An illuminated LED indicates that the port is active in either the Source (output) or Receiver (input) path mode. In S-Parameter measurement mode S33, for example, both the "S" and "R" status LEDs for Test Port 3 will be illuminated, since Port 3 is both outputting a source signal and receiving a reflected measurement signal.

- If all of the odd numbered port LEDs are Off, PNA-X Port 1 is active and the Odd Test Ports are terminated.
- If all of the even numbered port LEDs are Off, PNA-X Port 2 is active and the Even Test Ports are terminated.

Access Port Group Descriptions

All access ports are 2.4 mm female bulkhead connector types. Ports designated #5 through #12 have front panel jumpers (N5245-20155) installed.

1. This group of ports is always connected to PNA-X Port 1 access ports.

2. This group of ports is always connected to PNA-X Port 2 access ports.

3. These ports are system expansion ports associated to PNA-X Port 3. They are connected to PNA-X Port 3 access ports when a second Test Set is being used in the 24-Port system configuration or a >24-Port system. For the 14-Port system, they are not used.

4. These ports are system expansion ports associated to PNA-X Port 4. They are connected to PNA-X Port 4 access ports when a second Test Set is being used in the 24-Port system configuration or a >24-Port system. For the 14-Port system, they are not used.

5. This group of ten ports, SRC OUT - CPLR THRU, are associated with the odd numbered test ports. The jumper shown can be removed to install the amplifiers and isolators needed for high-powered measurement configurations.

6. This group of ten ports, SRC OUT - CPLR THRU, are associated with the even numbered test ports. The jumper shown can be removed to install the amplifiers and isolators needed for high-powered measurement configurations.

7. These two ports, RCVR IN - RCVR OUT, are associated with all odd numbered test ports. The jumper shown can be removed to install an attenuator into the PNA-X Port 1 RCVR A Input path as needed for high-powered measurement configurations.

8. These two ports, RCVR IN - RCVR OUT, are associated with all even numbered test ports. The jumper shown can be removed to install an attenuator into the PNA-X Port 2 RCVR B Input path as needed for high-powered measurement configurations.

9. These two ports, SRC IN - SRC OUT, are associated with all odd numbered test ports. The jumper shown can be removed to install an amplifier and/or coupler into the PNA-X Port 1 source path as needed for high-powered measurement configurations.

10. These two ports, SRC IN - SRC OUT, are associated with all even numbered test ports. The jumper shown can be removed to install an amplifier and/or coupler into the PNA-X Port 2 source path as needed for high-powered measurement configurations.

11. These two ports, CPLR THRU - SRC OUT, are associated with the PNA-X Port 1 source path. The jumper shown can be removed to install an amplifier and/or isolator into the PNA-X Port 1 source path as needed for high-powered measurement configurations.

12. These two ports, CPLR THRU - SRC OUT, are associated with the PNA-X Port 2 source path. The jumper shown can be removed to install an amplifier and/or isolator into the PNA-X Port 2 source path as needed for high-powered measurement configurations.

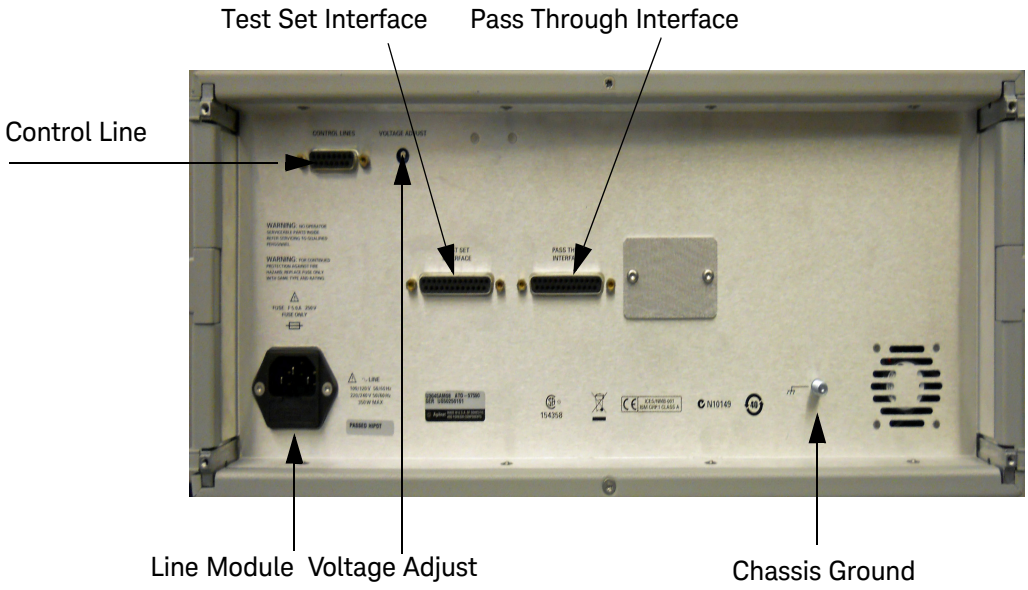
Access Port Group Descriptions

All access ports are 2.4 mm female bulkhead connector types. Ports designated #5 through #12 have front panel jumpers (N5245-20155) installed.

13. These ports are system expansion ports which use PNA-X Port 3. They are only connected to a second Test Set for the 24-Port system configuration or >24-Port system. For the 14-Port system, they are not used.

14. These ports are system expansion ports which use PNA-X Port 4. They are only connected to a second Test Set for the 24-Port system configuration or >24-Port system. For the 14-Port system, they are not used.

Figure 4 Rear Panel (Multiport Test Set)



Control Lines and Voltage Adjust

For further information pertaining to control lines and voltage adjustments see. Refer to “Control Lines” on page 49.

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

The Pass Through Interface is used to connection to another test set.

Chassis Ground

A threaded terminal post for connecting the Test Set to a conductive object, cabinet or structure to ensure a common potential and reduce leakage current in a system. Requires an English 1/4-20 thread nut (2950-0004) and lock washer (2190-0067).

Line Module

The line module contains the power cord receptacle. The line fuse, as well as a spare, reside within the line module. Figure 5 on page 14 illustrates where the fuses are located and how to access them.

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. 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. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

CAUTION Always use the three-prong AC power cord supplied with this product. Failure to ensure adequate grounding by not using this cord may cause damage to the product.

Power Cords

A line power cord is supplied in one of several configurations, depending on the destination of the original shipment. Keysight can supply additional certified power cords to meet region electrical supply and receptacle configurations. Please contact Keysight at www.keysight.com for assistance with power cord selection.

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).**

Available Fuses

- Fuse (F 5 A/250V, 2110-0709) UL listed and CSA certified.

WARNING **For continued protection against fire hazard, replace fuses, and or circuit breakers only with same type and ratings. The use of other fuses, circuit breakers or materials is prohibited.**

Figure 5 Line Fuse

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

14-Port System Setup

The Keysight U3024AH10 High Power Test Set will be configured as a 14-Port network analyzer system and for high power measurement applications. If your system is to be rack mounted, the following procedure does not need to be performed.

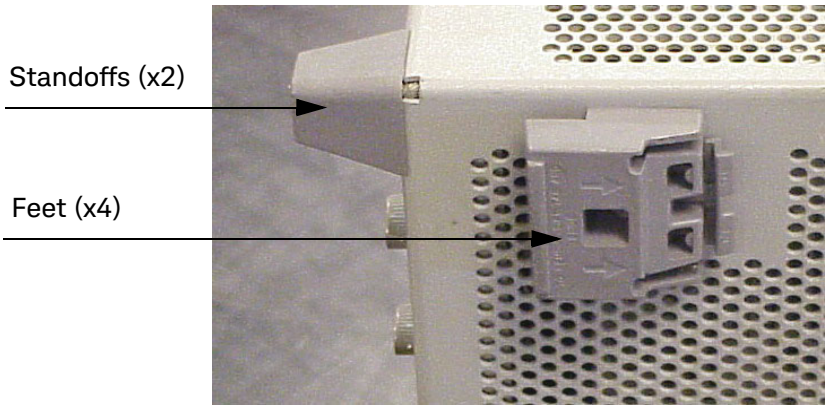
You will need the following hardware provided in the Lock-Link Kit (U3021-60002):

- Screws, T20 M4 x 0.7, 25mm length (0515-1619)
- Screws, T15 M3.5 x 0.6, 12mm length (0515-2317)
- Locking Feet, Pair, for Analyzer (5023-0132)
- Locking Feet, Right, for Test Set (N5242-20138)
- Locking Feet, Left, for Test Set (N5242-20139)

Attaching the Test Set to the Network Analyzer

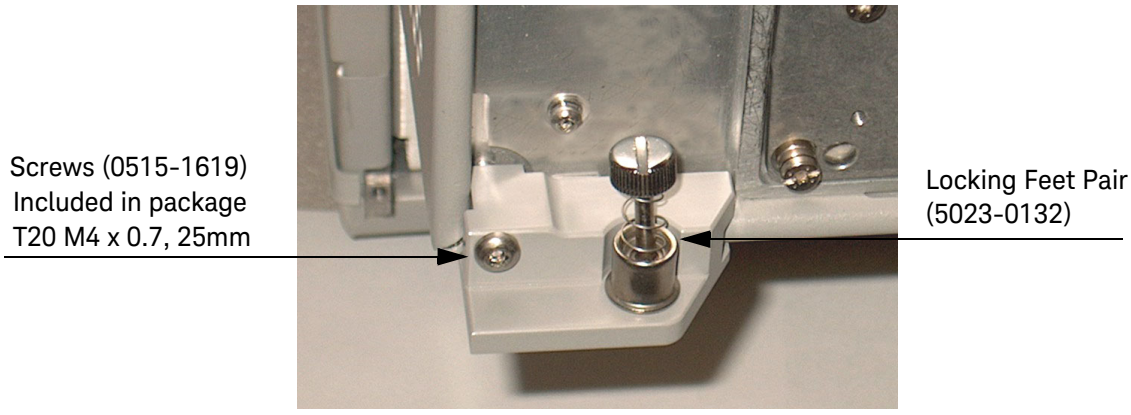
1. Remove the feet from the bottom of the network analyzer.
2. Remove the two lower standoffs and screws (0515-1619) from the rear panel on the network analyzer, using a T20 Torx driver.

Figure 6 Rear Bottom Feet



3. Install the two rear locking feet pair (5023-0132) using the included screws (0515-1619), where the standoffs were removed.

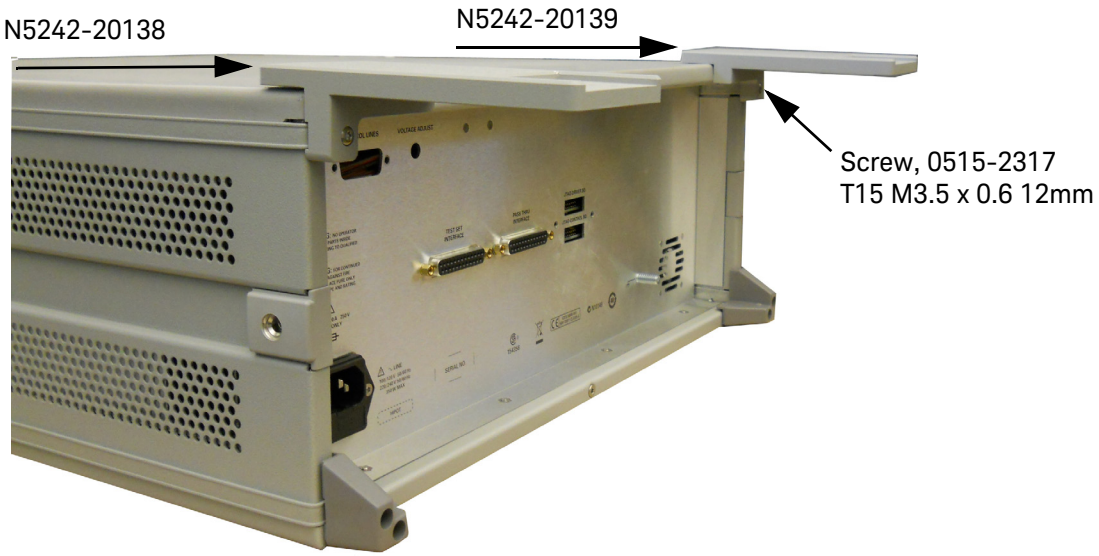
Figure 7 Install Locking Feet on the Network Analyzer



4. Remove the two upper standoffs from the Test Set, using the T20 Torx driver.

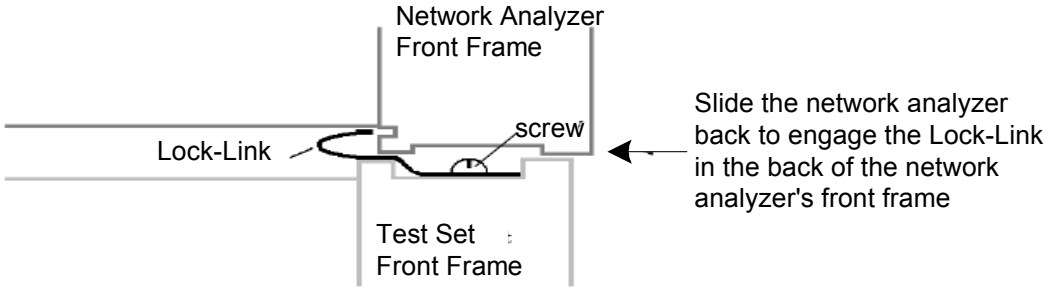
5. Install the two rear locking feet onto the U3024AH10. Looking at the front panel, the N5242-20138 is the right foot and the N5242-20139 is the left foot. Use the two screws that are included with this option.

Figure 8 14-Port System Locking Feet



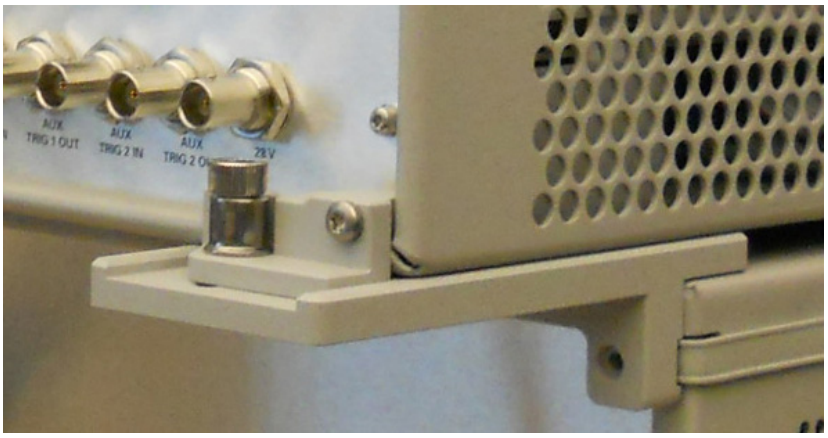
6. Place the network analyzer on top of the Test Set and ensure that the front frame of the network analyzer is positioned slightly forward of the Lock-Links that are attached to the Test Set. Slide the network analyzer back so the locks engage the front frame of the analyzer.

Figure 9 Locking the Analyzer to the Test Set



7. Secure the network analyzer’s rear lower locking feet to the Test Set upper locking feet, using the spring–loaded screws on the locking feet, as shown in Figure 10 below. 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 instruments slightly to align.

Figure 10 Locking Feet Screws



14-Port System Interface Cable Connections

This section provides the procedure for installing the interface cables and port labeling for 14-Port systems are supplied with Cable Kit U3024-60001.

Figure 11 and Figure 12 on page 19 illustrate the cable connection of the Test Set to the Network Analyzer.

CAUTION **Overtorque will cause damage to the Test Set and may cause connectors to spin or become loose.**

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

1. Remove the four front panel jumpers on the PNA-X (Ports 1 & 2) from the SOURCE and RCVR ports. The reference jumpers must remain installed.
2. Connect the eight RF interface cables from the PNA-X to the Test Set in the order listed in Table 8 below. As you are connecting each cable, torque to 8 in-lb. Refer to Figure 11 for cable positioning.
3. Connect the sixteen front panel jumpers (N5245-20155) to the Test Set, as shown in Figure 11, for normal multiport operation.
4. Add the front panel port labels to the PNA-X Ports 3 and 4 from the label page (U3024-80001) included with your kit. See Figure 11.
   - Port 13 label over PNA- X Port 3
   - Port 14 label over PNA- X Port 4
5. Connect the PNA-X Test Set I/O cable (N4011-21002) to the Test Set Interface connector on the rear panel. See Figure 12.

Table 8 Interface Cable Connections (14-Port)

Numeric Order	RF Cables	From (PNA-X)	To (Test Set)	Qty
1	U3024-20049	Port 1 & 2 CPLR THRU	CPLR THRU	2
2	U3024-20049	Port 1 & 2 SOURCE OUT	SRC OUT	2
3	U3024-20050	Port 1 & 2, CPLR ARM	CPLR ARM	2
4	U3024-20050	Port 1 & 2, RCVR A & B IN	RCVR A IN & B IN	2

Figure 11 14-Port System Front Panel Cable Connection

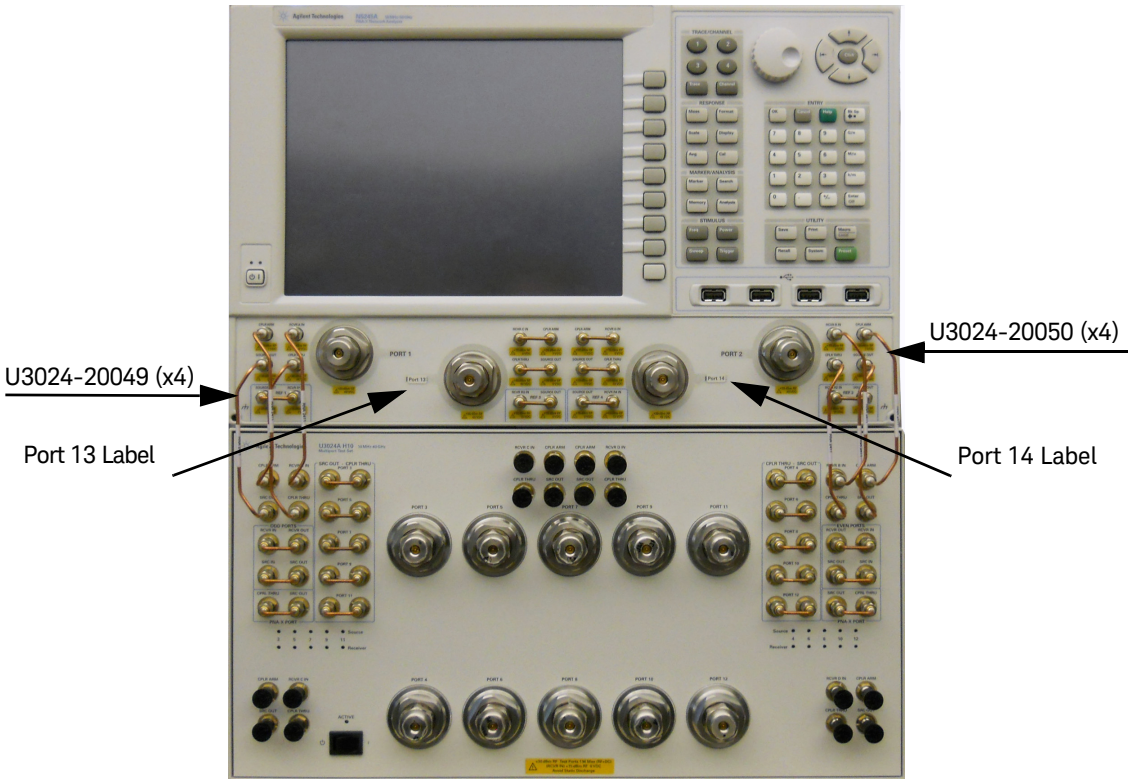
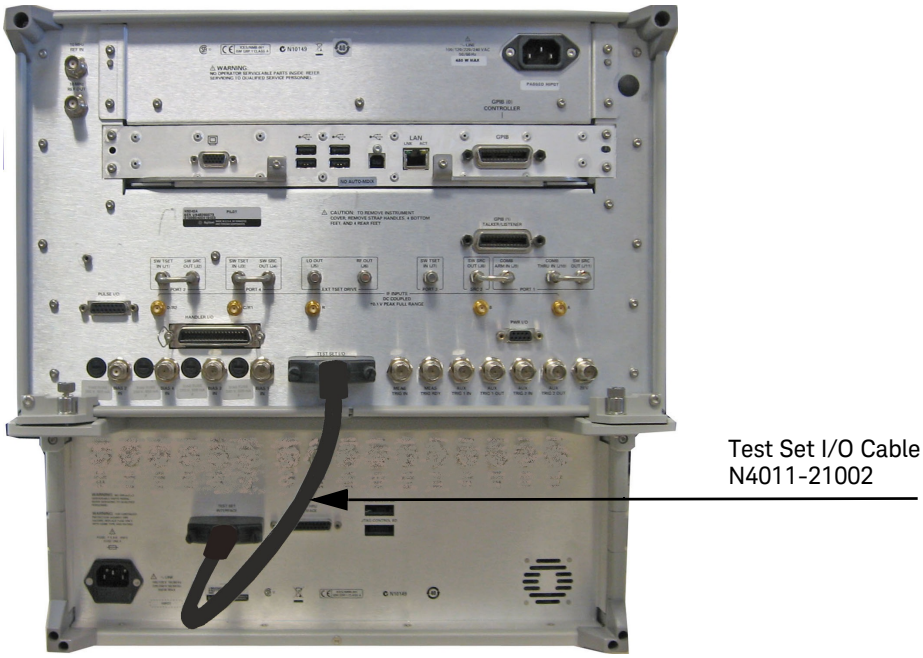


Figure 12 14-Port System Rear Panel Test Set I/O Cable Connection



24-Port System Setup

The Keysight U3024AH10 High Power Test Set will be configured as a 24-Port network analyzer system and for high power measurement applications. If your system is to be rack mounted, the following procedure does not need to be performed.

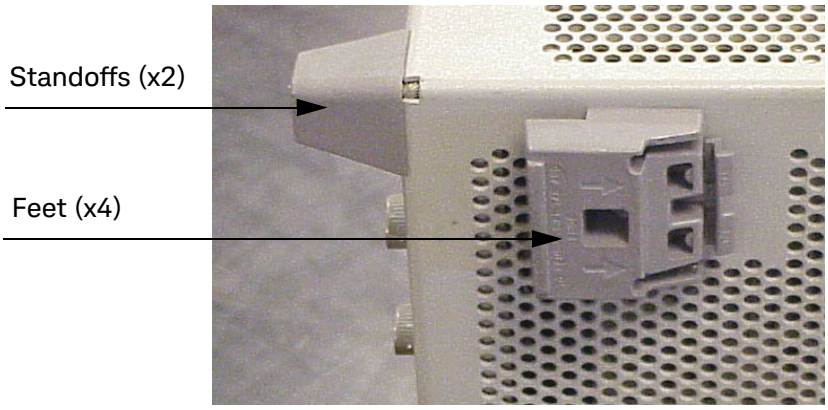
You will need the following hardware provided in the Lock-Link Kit (U3021-60002):

- Screws, T20 M4 x 0.7, 25mm length (0515-1619)
- Screws, T15 M3.5 x 0.6, 12mm length (0515-2317)
- Locking Feet, Pair, for Analyzer (5023-0132)
- U3040-60001 Kit, Test Locking Feet (5063-9253)
- Locking Feet, Right, for Test Set (N5242-20138)
- Locking Feet, Left, for Test Set (N5242-20139)

Preparing the Network Analyzer

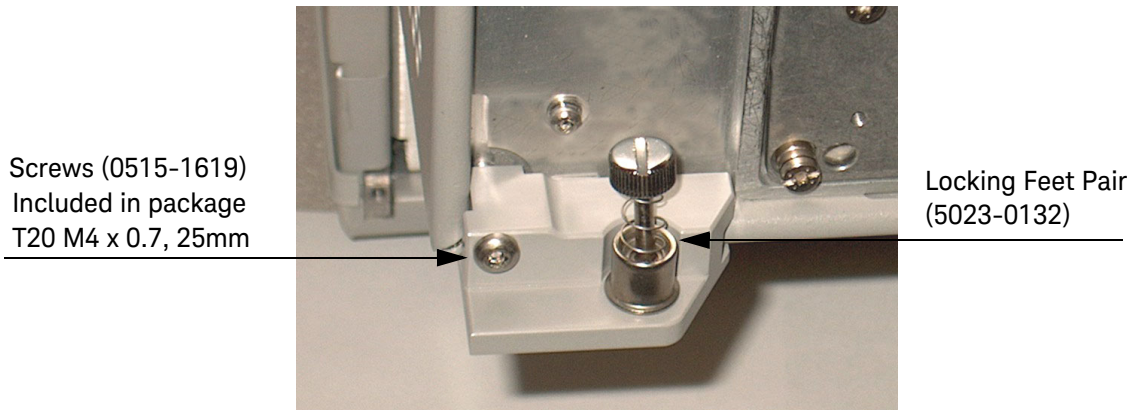
1. Remove the feet from the bottom of the network analyzer.
2. Remove the two lower standoffs and screws (0515-1619) from the rear panel on the network analyzer, using a T20 Torx driver.

Figure 6 Rear Bottom Feet



3. Install the two rear locking feet pair (5023-0132) using the included screws (0515-1619), where the standoffs were removed.

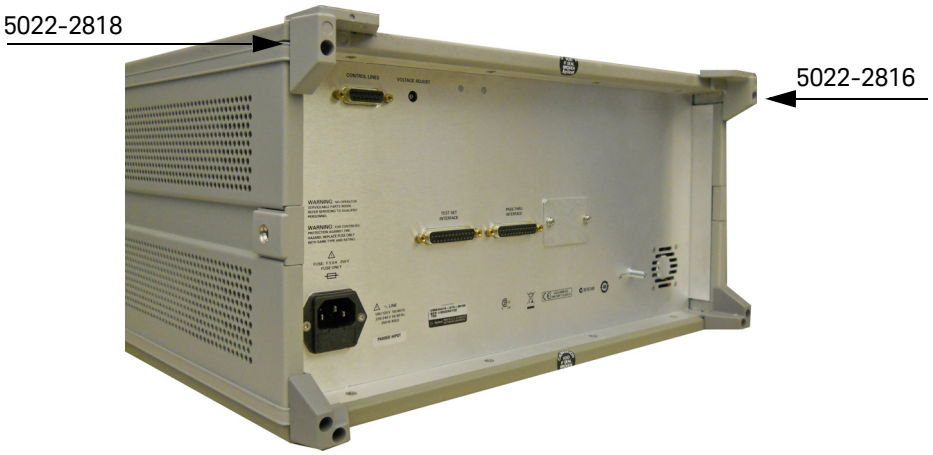
Figure 7 Install Locking Feet on the Network Analyzer



Preparing the Two Test Sets

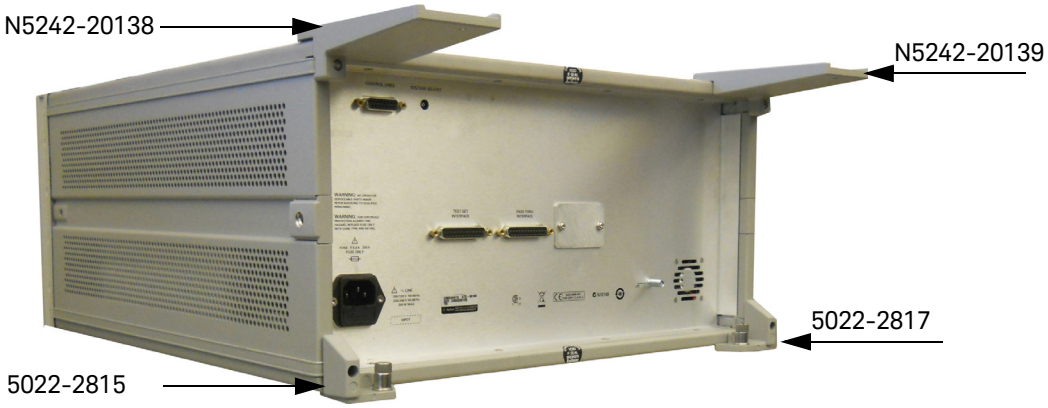
1. Remove the two top standoffs from the bottom Test Set.
2. Install the two rear locking feet to the top of the Test Set from kit U3040-60001 (5063-9253), as shown in Figure 13 below. Secure with the screws (0515-1244) included with this kit.

Figure 13 Installing Lock Feet on the Bottom Test Set



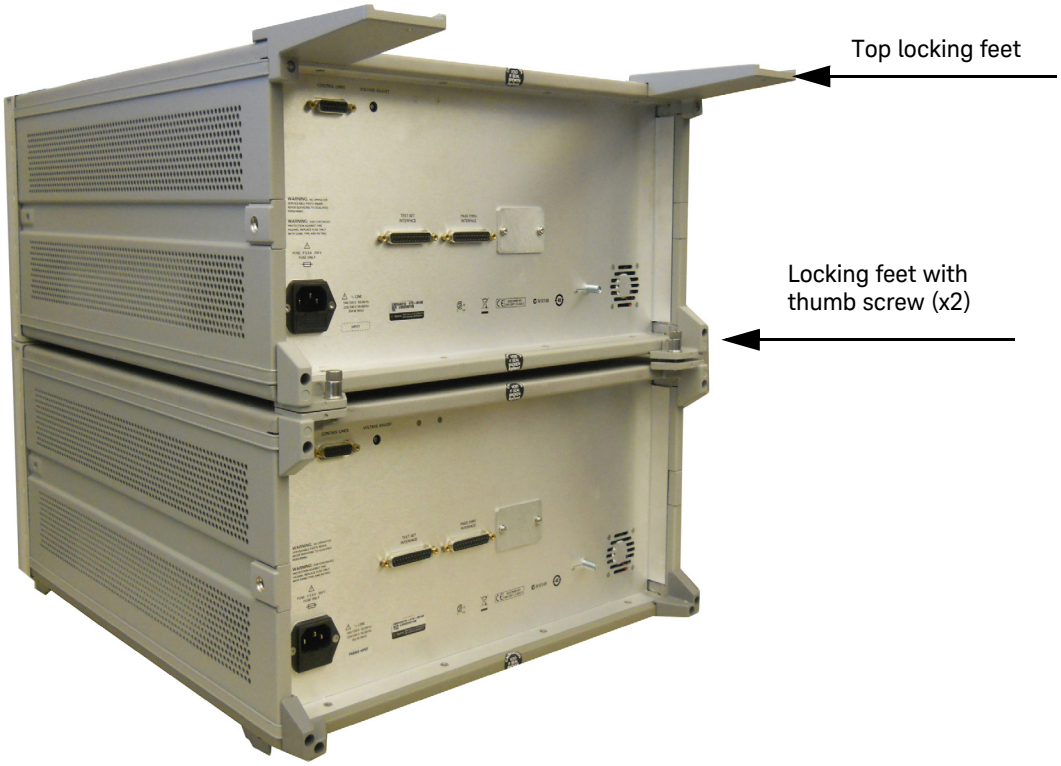
3. Remove all four bottom feet from the Top Test Set.
4. Install the two large rear locking feet (from U3021-60021 kit) onto the top of the Test Set. N5242-20138 is the right foot and the N5242-20139 is the left foot, as shown in Figure 14 below. Two screws (0515-2317) are included with this kit to secure these feet.
5. Install two remaining locking feet (with thumb screws) from the kit (5063-9253) to the bottom of the top Test Set, using the screws (0515-1244) included in the kit. See Figure 14 below.

Figure 14 Installing Locking Feet on Top Test Set



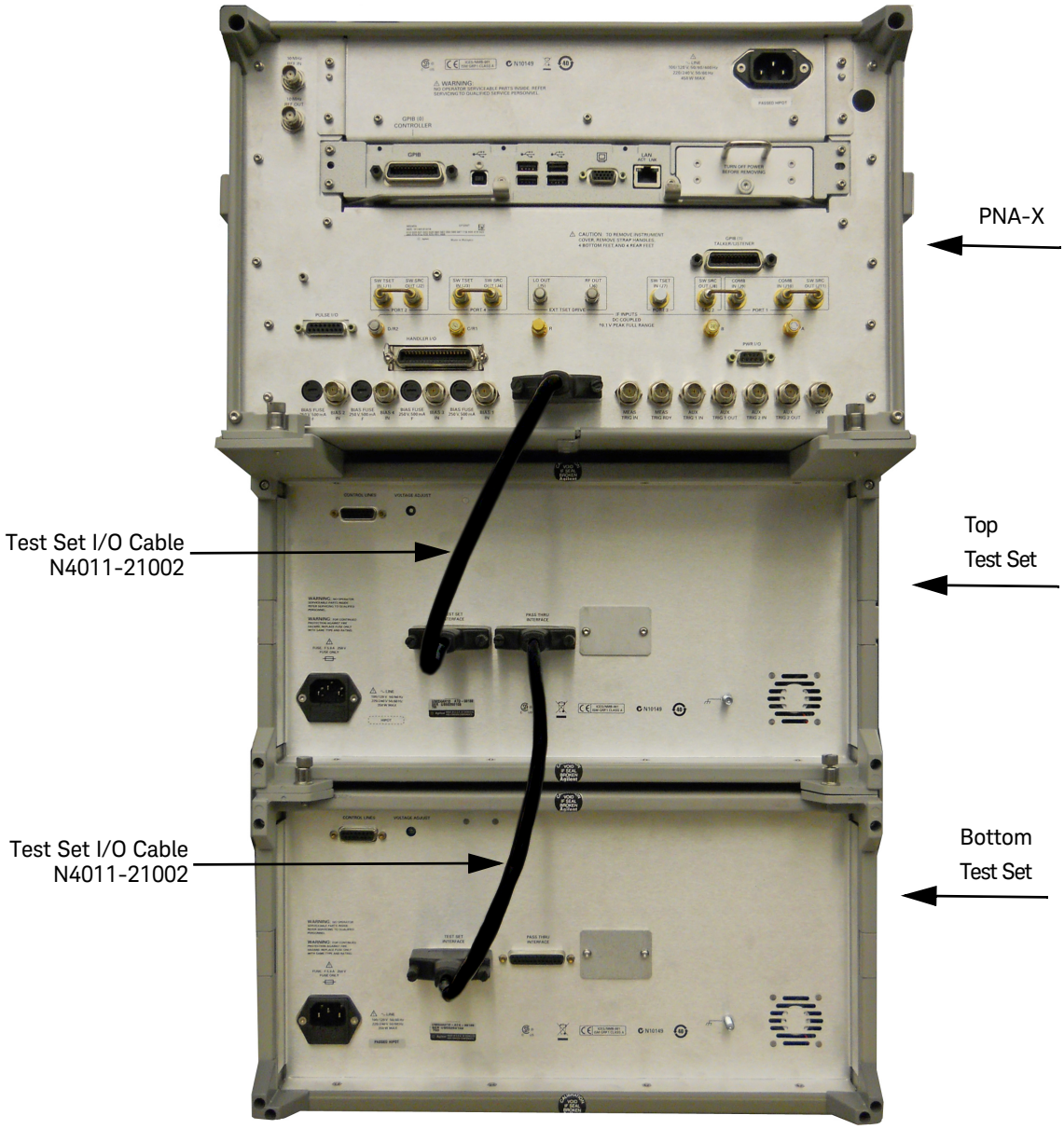
6. Place the top Test Set on top of the bottom Test Set. Ensure that the front frame is positioned slightly forward of the locks that are attached to the bottom Test Set. Slide Test Set back so that they are locked into position. Refer to Figure 9 on page 16 and Figure 15 below.

Figure 15 Locking Feet for the 24-Port System



7. Place the PNA-X on top of the two Test Sets. Ensure that the front frame is positioned slightly forward of the Lock-Links that are attached to the top Test Set. Slide the analyzer back so that they are locked into position. 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. Refer to Figure 16 on page 23.
8. Connect the two Test Set I/O Cables (N4011-21002), included in the U3024/40-60001 kits, to the locations shown in Figure 16 on page 23.

Figure 16 24-Port Rear Panel I/O Cable Connections



24-Port System Interface Cable Connections

This section provides the procedure for installing the interface cables and port labeling for a 24-Port system.

Figure 17 on page 26 and Table 10 illustrate the cable configuration of the PNA-X Network Analyzer and two Test Sets. The cables have been supplied with the Kit (U3024-60001 & U3040-60001).

CAUTION **Over torque will cause damage to the Test Set and may cause connectors to spin or become loose.**

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

1. Remove the eight front panel jumpers on the PNA-X (Ports 1, 2, 3 and 4) from the SOURCE and RCVR ports. The reference jumpers must remain installed.
2. Connect 16 RF interface cables from the PNA-X to the top Test Set, and 8 RF interface cables from the top Test Set to the bottom Test Set in the order listed in Table 10 on page 25. As you are connecting each cable, torque to 8 in-lb. Refer to Figure 17 for cable positioning.
3. Connect the 16 high power access front panel jumpers (N5245-20155), as shown in Figure 3 on page 10 for normal multiport operation.
4. Place the front panel labels over the Test Set's ports and LED indicators silk screening, using the label page (U3024-80001) included with your kit. Use the corresponding port number labels for the LEDs.

Table 9 Test Port Labeling

Test Sets	Port/**Label**				
Top	3/**5**	5/**9**	7/**13**	9/**17**	11/**21**
	4/**6**	6/**10**	8/**14**	10/**18**	12/**22**
Bottom	3/**7**	5/**11**	7/**15**	9/**19**	11/**23**
	4/**8**	6/**12**	8/**16**	10/**20**	12/**24**

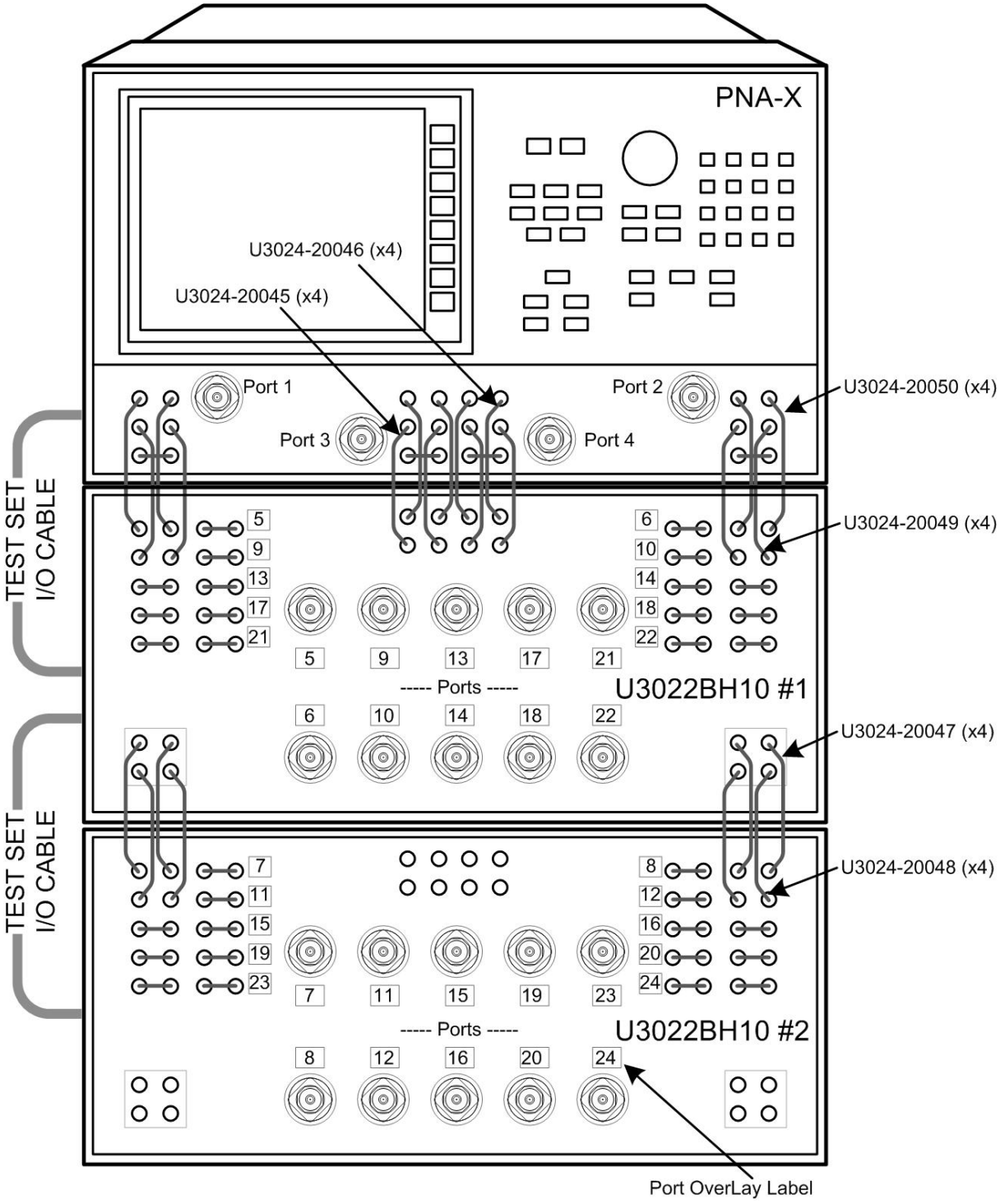
5. Connect the PNA-X Test Set I/O cables (N4011-21002) to the Test Set Interface connectors on the rear panel. The top Test Set is connected to the PNA-X and the bottom Test Set is connected to the top Test Set I/O PASS THRU connector. See Figure 16 on page 23.

Table 10 Interface Cable Connections (24-Port)

Installation Order	RF Cable Part Number	From PNA-X	To Top Test Set	Qty
1	U3024-20045[1]	Port 3 & 4 CPLR THRU	CPLR THRU	2
2	U3024-20045[1]	Port 3 & 4 SOURCE OUT	SRC OUT	2
3	U3024-20046[1]	Port 3 & 4 CPLR ARM	CPLR ARM	2
4	U3024-20046[1]	Port 3 & 4 RCVR C & D IN	RCVR C & D IN	2
5	U3024-20049[2]	Port 1 & 2 CPLR THRU	CPLR THRU	2
6	U3024-20049[2]	Port 1 & 2 SOURCE OUT	SRC OUT	2
7	U3024-20050[2]	Port 1 & 2, CPLR ARM	CPLR ARM	2
8	U3024-20050[2]	Port 1 & 2, RCVR A & B IN	RCVR A IN & B IN	2
Installation Order	**RF Cable Part Number**	**From Top Test Set**	**To Bottom Test Set**	**Qty**
1	U3024-20048[1]	Test Set Port 3 & 4 CPLR ARM	CPLR ARM	2
2	U3024-20048[1]	Test Set Port 3 & 4 RCVR C & D IN	RCVR C & D IN	2
3	U3024-20047[1]	Test Set Port 3 & 4 CPLR THRU	CPLR THRU	2
4	U3024-20047[1]	Test Set Port 3 & 4 SRC OUT	SRC OUT	2

1. Part of Cable Kit U3040-60001
2. Part of Cable Kit U3024-60001

Figure 17 24-Port RF Interface Cable Configuration



System Operational Check

The following procedure will confirm that the RF interface cables between the Test Set and the PNA-X in the 14-Port system is working correctly. Ensure the PNA-X has the U3024AH10 Test Set file installed. Refer to "PNA-X Multiport Mode" on page 31.

Before beginning this procedure, you'll need to complete the following steps:

- Stack the PNA-X on top of the Test Set
- Install the Test Set I/O interface cable on the rear panel
- Install all of the RF interface cables on the front panel
- Install the included female 2.4 mm short (85056-60021) to PNA-X Port 1

Equipment Setup

- Turn ON the power to both the Test Set and the PNA-X
- Preset the PNA-X and set the PNA-X to "Multi-Port Mode"
- Set the PNA-X to measure S11
- Attach the 2.4 mm short to the PNA-X Port 1

Verify Results

Compare the S11 reflection response trace on the PNA-X with the one shown in Figure 19 and check to make sure that no abnormal trace spikes are present. 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 cable installation.

Relocate the 2.4 mm short to each remaining test port, and an uncorrected reflection response trace should be displayed that resembles the plots listed in the Table below.

Table 11 Reflection Response Results

Reflection Port	Response Trace	Cable Path Diagram
Ports 1 and 2	Figure 18	Figure 19
Ports 3 - 12	Figure 20	Figure 21

Figure 18 Typical Reflection Response Ports 1 and 2

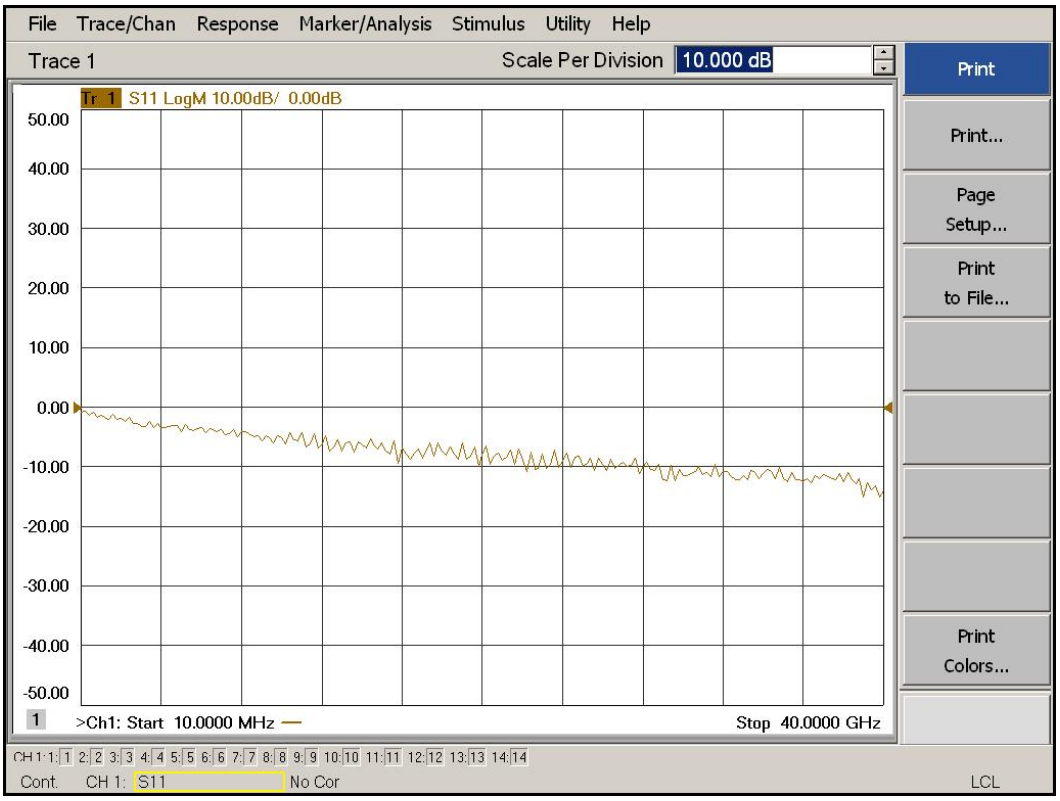


Figure 19 Reflection Response Signal Path Diagram Ports 1 and 2

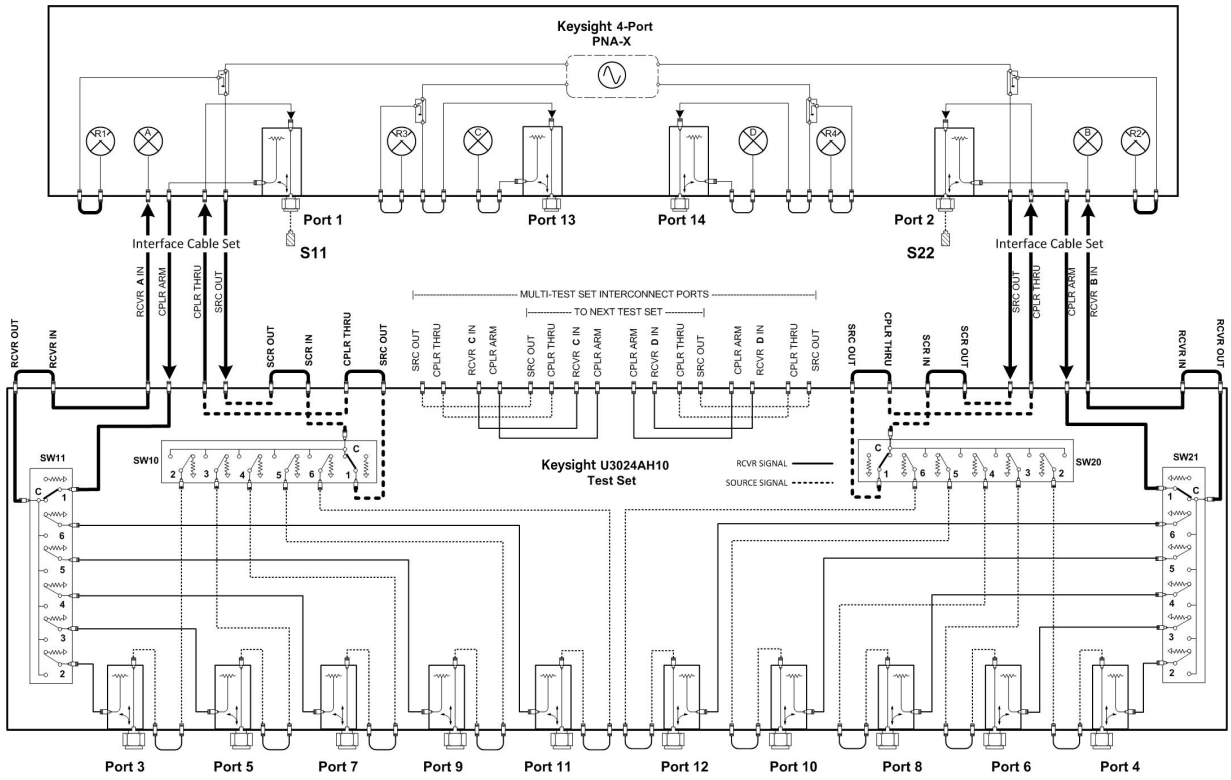


Figure 20 Typical Reflection Response Ports 3 to 12

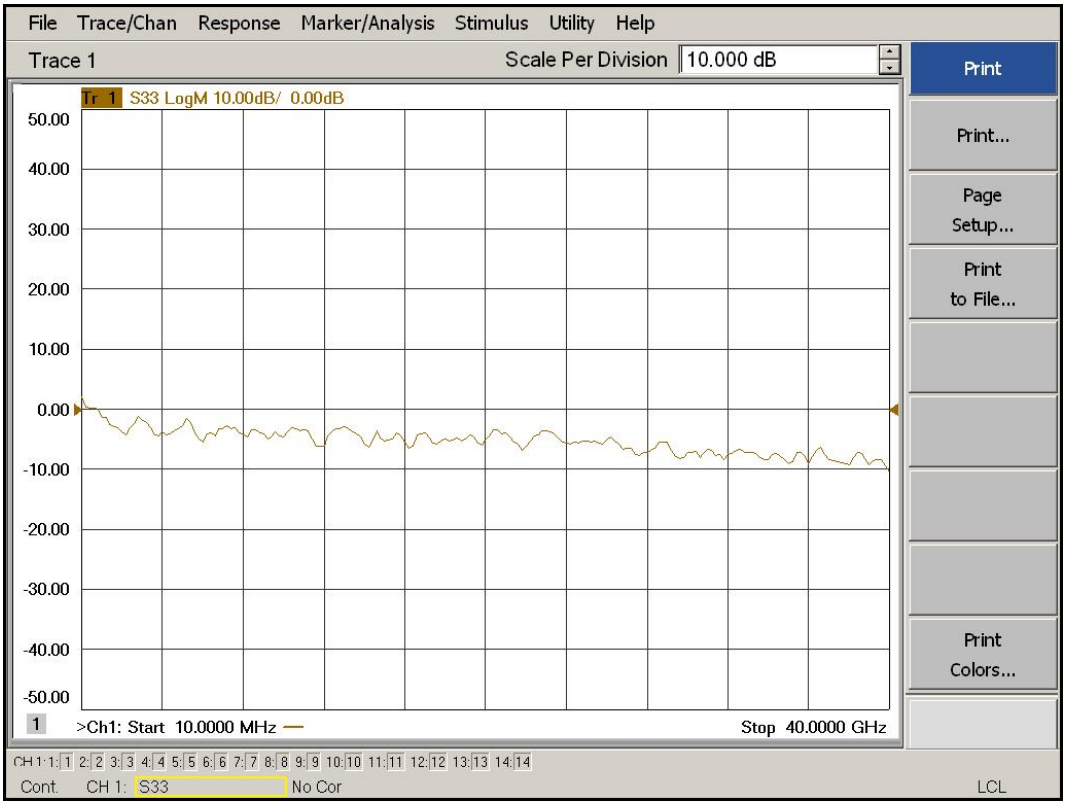
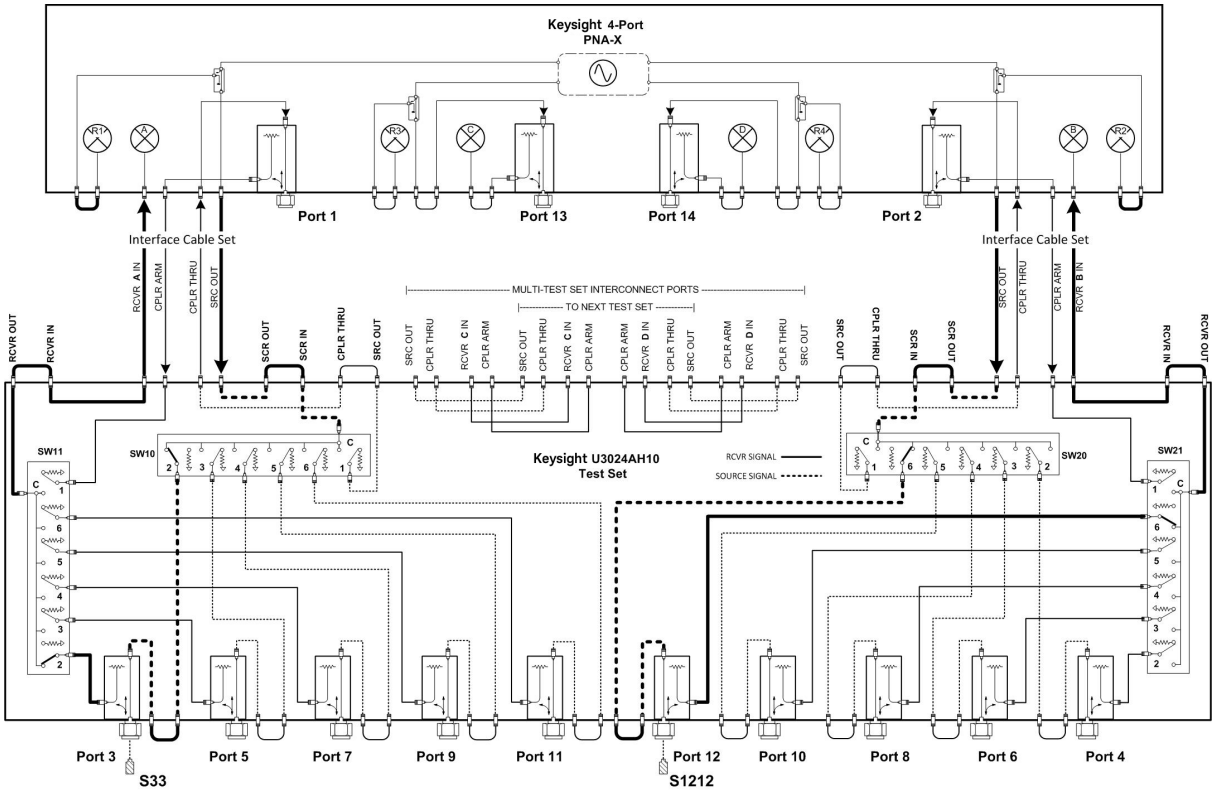


Figure 21 Reflection Response Signal Path Diagram Ports 3 and 12



Controlling the System with the Network Analyzer

This section will describe how to operate the Test Set with the PNA-X.

A PNA-X must be used to control the Test Set using the Test Set I/O interface on the rear panel. There are three methods to control the Test Set. Multiport mode is recommended due to ease of use and multiport calibration capability (N-Port).

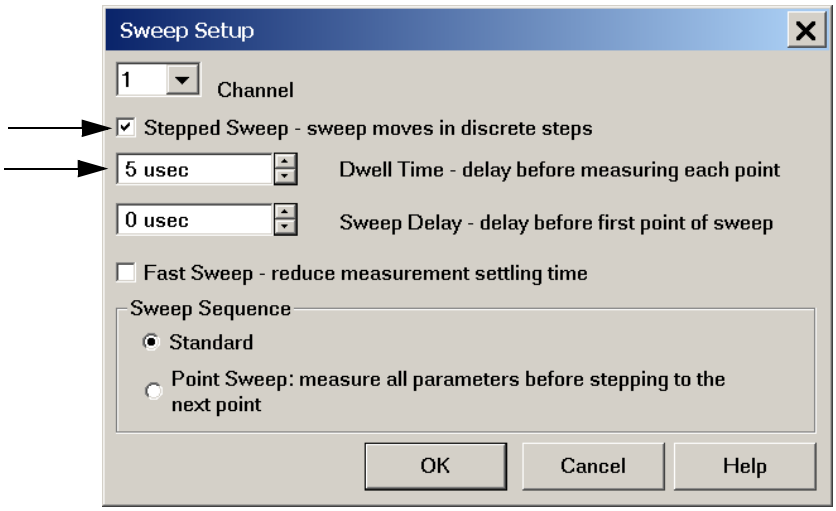
- "PNA-X Multiport Mode" on page 31.
- "Interface Control Mode" on page 38.
- "GPIB Control Mode" on page 42.

Sweep Setup for Multiport and Standalone PNA Modes

Due to the extra electrical length of the test set and test port cables, 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. Stepped Sweep is available on all PNA models.

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

Figure 22 PNA Sweep Setup



PNA-X Multiport Mode

The PNA-X requires Option 551 for Multiport mode. The PNA-X must have the Test Set file installed to enable the PNA-X to control the Test Set. The PNA-X Multiport mode allows you to select measurement ports, complete an N-Port calibration, operate control lines, and rename test ports. Refer to the Help menu for more information.

NOTE If you change from Multiport mode to Standard PNA mode, send command 0.0 and 16.0. This will default the source and receiver paths in the Test Set and allow the PNA-X ports to operate. Refer to "Setting the Test Port Paths with Address and Data Inputs" on page 45.

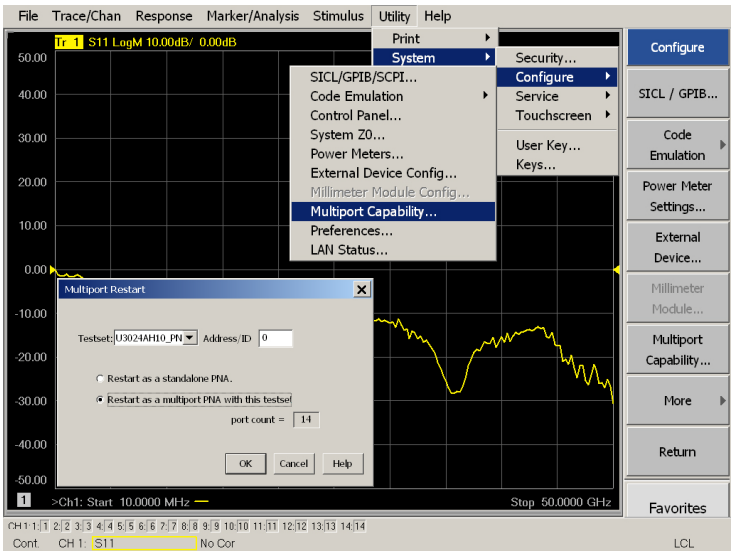
NOTE The <address> <data> commands will only function while the PNA is in Standalone Mode. Select **Restart as a standalone PNA** > **OK**. Refer to Figure 23 below.

Multiport Mode Operation

1. The Option 551 must be installed for multiport capability. To access the multiport application select Utility > System > Configure > Multiport Capability.
2. Select U3024AH10_PNAX_p4 (14-Port System), or U3024AH10_x2_PNAX_p4 (24-Port System) from the drop-down menu. Select Restart as a multiport PNA with this testset > OK. The PNA-X will restart the network application with the Test Set interface features.

If the Test Set is not available in the drop-down list it will be necessary for you to copy the required Test Set file to the PNA-X hard drive. The current version of the Test Set files are available on the web at http://na.support.keysight.com/multiport. Copy the appropriate file to c:\program files\Agilent\Network Analyzer\testsets directory.

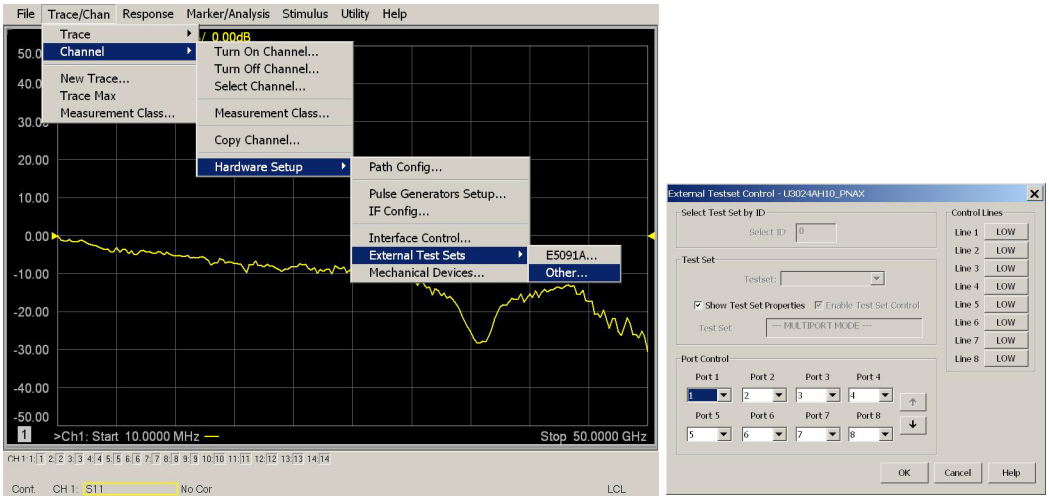
Figure 23 Test Set Selection



External Test Set Control Operation

To verify that the network application has the Test Set interface features, select **Trace/Chan** > **Channel** > **Hardware Setup** > **External Test Set** > **Other.** The Test Set will be displayed as **External Test Set Control-U3024AH10_PNA-X**.

Figure 24 External Test Set Control



NOTE When in 24-Port mode External Test Set Control DUT control lines are disabled.

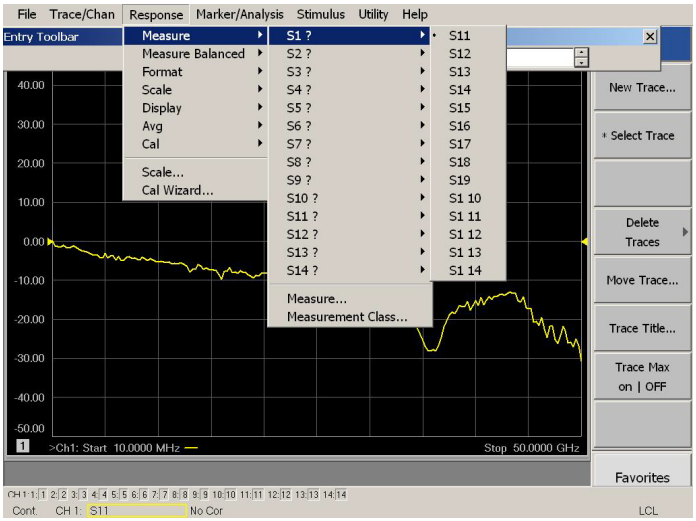
This menu will allow the physical ports to be identified as any port number for your convenience. For example; Port 5 can be re-named Port 2.

The **External Test Set Control-U3024AH10** also allows control of the DUT control lines, refer to "Control Lines" on page 49. To change the state from LOW to HIGH, select the graphical user interface (GUI) for the specific control (LINE 1 thru 8), click **OK**. Each line can be controlled separately.

Selecting S-Parameter Measurement

S-Parameter selection can be accomplished using **Response** > **Measure**. Use the drop-down menu to select 196 for a 14-Port or 576 S-Parameters for a 24-Port system. The first number in the Sxx selection is the Receiver Port and the second number will be the Source Port. Any port can be selected to be the Receiver, Source or both, as in S11. The front panel R LED indicates the port is the Receiver and the S LED indicates the port is the Source.

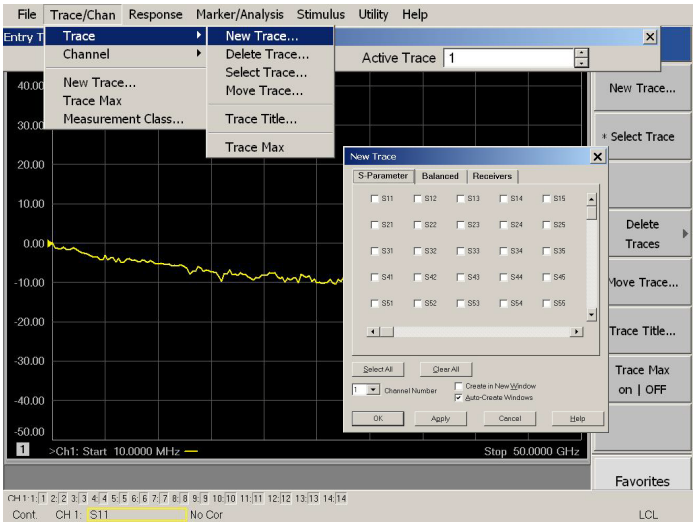
Figure 25 S-Parameter Measurement



Selecting New S-Parameter Measurement

S-Parameter Tab: Multiple S-Parameters can be made by selecting **Trace/Chan** > **Trace** > **New Trace**. Use the drop-down menu and select of any of the S-Parameters.

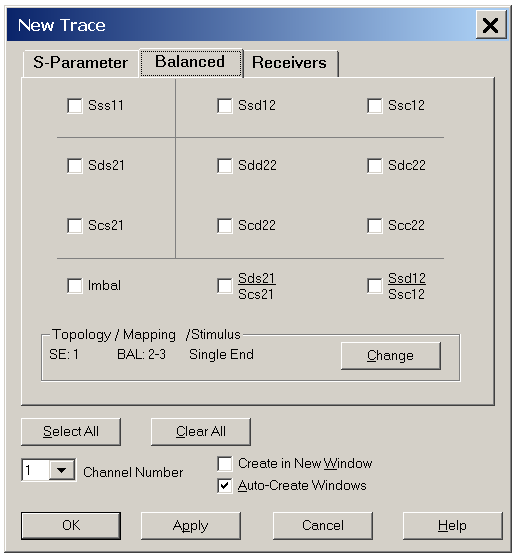
Figure 26 New S-Parameter Measurement



Balanced Tab: Balanced Measurements can be configured by selecting the Balance tab in the New Trace menu.

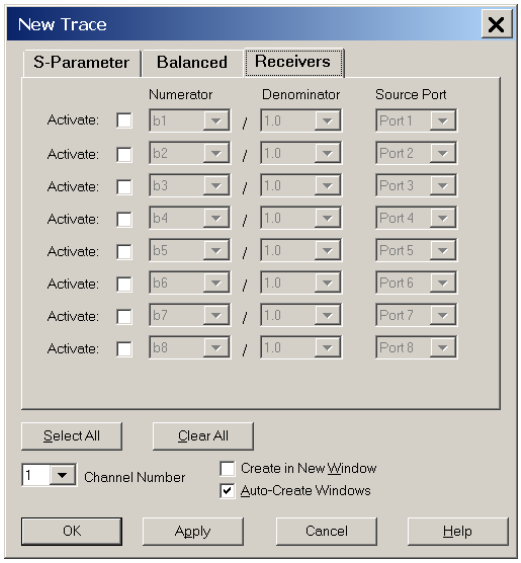
For more information on balanced (differential) component measurement, refer to the Application Note 1373-1 and 1373-2 (5988-5634EN and 5988-5635EN) at http://www.keysight.com. In the search menu type "**Multiport and Balanced**."

Figure 27 Selecting Balanced Measurements



Receivers 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 28 Receiver Measurements



N-Port Calibration with N5224/25A/B and N5244/45A/B

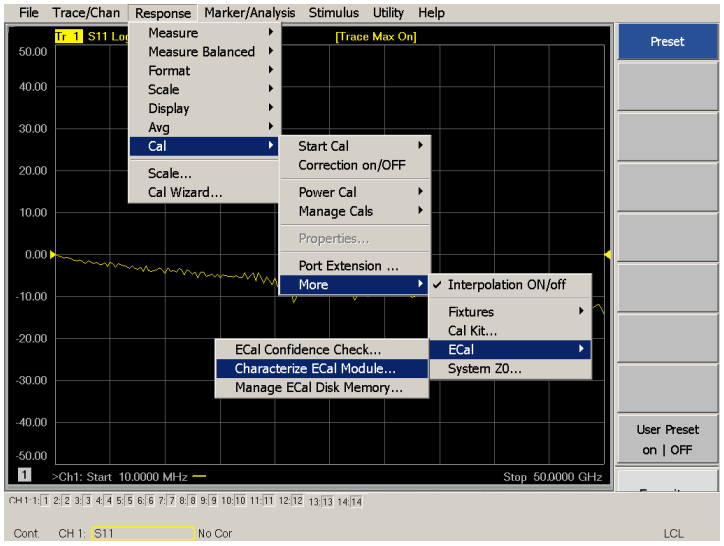
It is recommended that you perform an ECal characterization to minimize the connections required for multiple port calibration. The N4693AB Option M0F is recommended with cable (85133F) if you are calibrating at the PNA-X and Test Set ports.

Characterize the ECal module with adapters that will not be used in the measurement of the DUT. To characterize the ECal module, select **Response** > **Cal** > **More** > **ECal** > **Characterize ECal Module**.

Calibrate at the end of the test port RF cables and any adapters that are used to connect the DUT. This removes the effect on the measurement of the DUT. Failure to do this will create ripple and other measurement errors.

NOTE If measurement errors occur, ensure the newest version of firmware is installed on the PNA-X. Measurement errors can be a result of firmware algorithms. Consult with Keysight Service or the firmware web page for the latest PNA-X Option 551 firmware revisions and history at: http://na.support.keysight.com/pna/firmware/firmware.html.

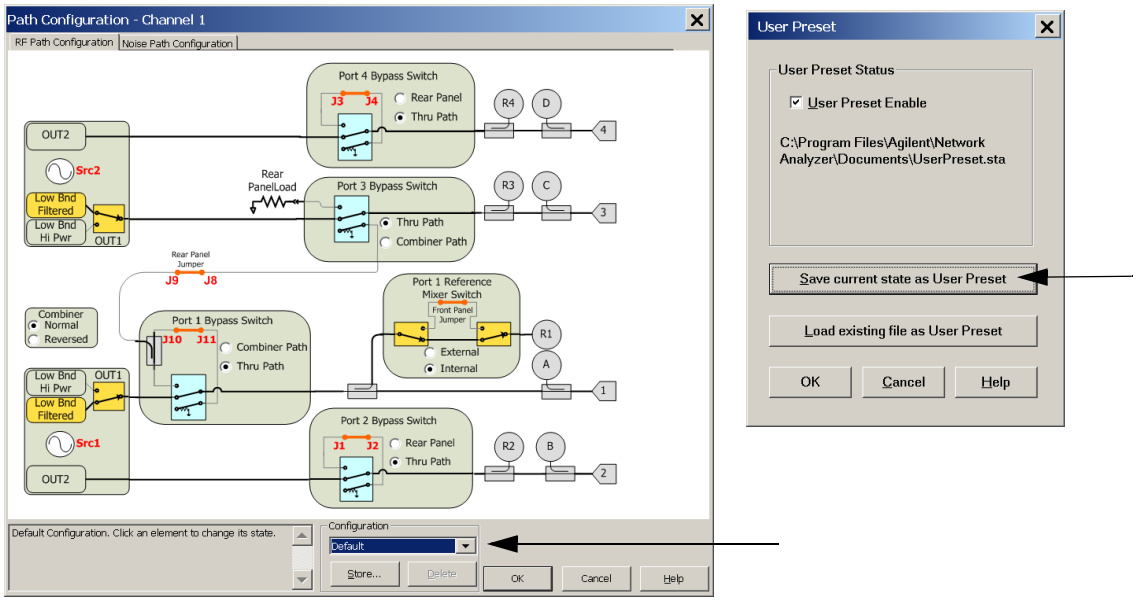
Figure 29 ECal Characterization



NOTE

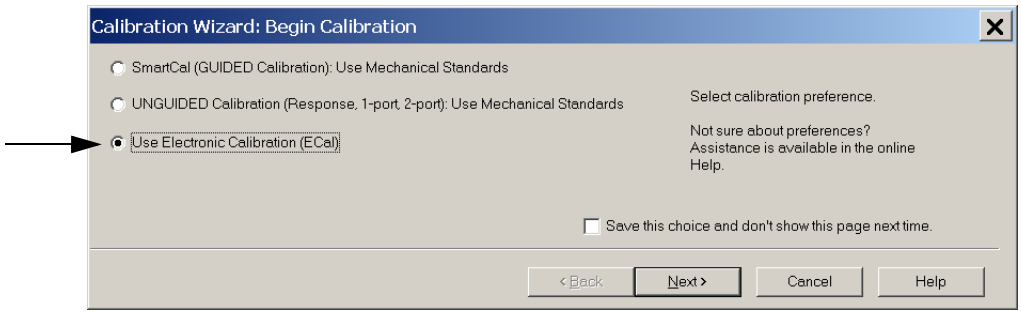
If the PNA-X has Option 029 or H29 (noise figure capability) verify that the path configuration is set to Default. If the PNA-X is not in Default configuration, all odd ports will not operate correctly. Select **Trace/Chan** > **Channel** > **Hardware Setup** > **Path Config**... and in the drop-down 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), the PNA-X will return to Option 029 path configuration.

Figure 30 RF Path Configuration



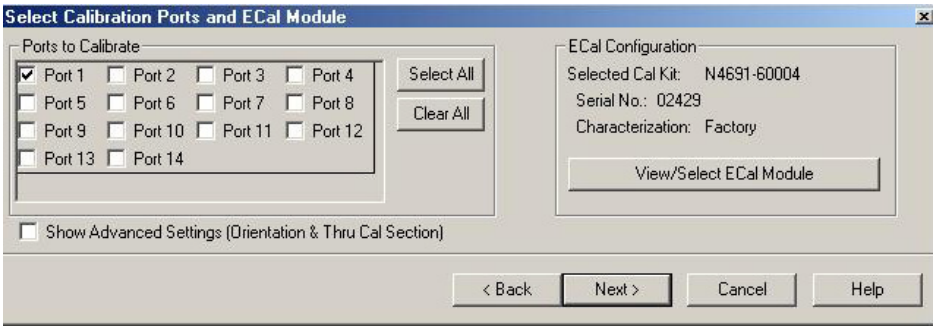
1. On the PNA-X select Response > Cal Wizard.
   a. If using a mechanical cal kit, select SmartCal (Guided Calibration) > Next.
   b. If using an ECal module, connect the ECal to an available PNA-X USB port and select Use Electronic Calibration (ECal) > Next.

Figure 31 Begin Calibration



2. Continue following the Cal Wizard prompts. In the Select Calibration Ports and ECal Module dialog box click the **Select All**, check box, or select the ports you are calibrating and click **Next**. If an ECal characterization has been done, select **View/Select ECal Module** and select the previously saved user file from step 1.

Figure 32 14-Port Calibration



3. Connect the ECal or the mechanical cal kit to the ports you are calibrating following the Cal Wizard prompts and click **Measure** after each connection. The electrical delay value may be shown in the dialog box after the last measurement, click **OK**.
4. At the Calibration Completed prompt, select **Save As User Calset**, type the name and **Save**. See Figure 49 on page 67.
5. After calibrating Test Set ports, use a quality load and short to verify the calibration on each port or end of the test cable. Measure reflection and confirm the return loss is as expected. If the result is not as expected, repeat the calibration without the Test Set and ensure that the PNA-X is in standard (non-multiport) mode.

NOTE

If measurement errors occur, ensure the newest version of firmware is installed on the PNA. Measurement errors can be a result of firmware algorithms. Consult with Keysight Service or firmware web page for the latest PNA Option 551 firmware revisions and history at: http://na.support.keysight.com/pna/firmware/firmware.html.

Interface Control Mode

The Interface Control feature allows you to send data and remote commands to control external equipment using the GPIB, Material Handler I/O, Test Set I/O, and Auxiliary I/O without the need of an external computer. Refer to PNA-X Help menu, “Rear Panel Tour” and “Interface Control.”

This section includes:

- How to Access Interface Control Settings
- Interface Control dialog box

NOTE **The interface control mode will not function properly when using Multiport mode. The Multiport mode will reset the switch path commands of the interface control. It is recommended that the PNA-X be restarted in Standalone mode. Refer to** Figure 23 “Test Set Selection” on page 31**.**

- 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.

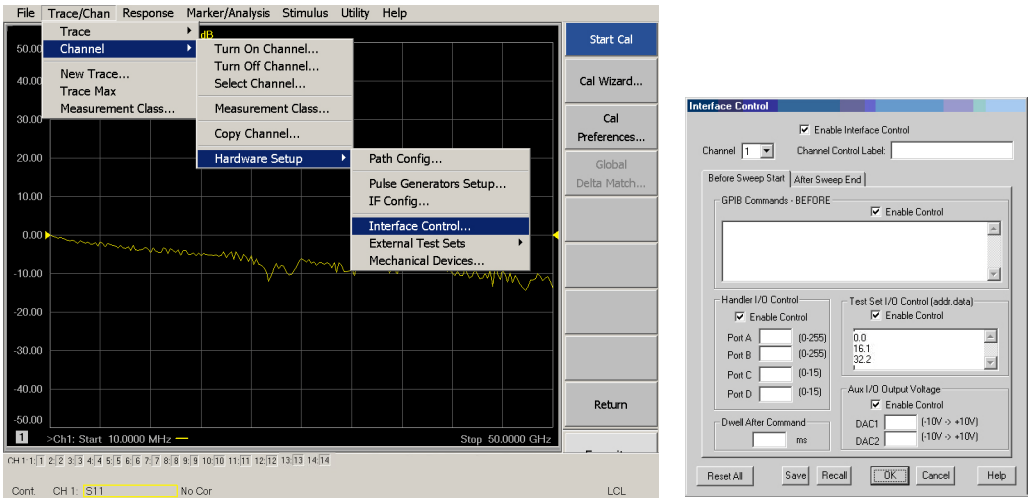
1. GPIB Interface
2. Material Handler Interface
3. Test Set Interface
4. Dwell Time

How to Access Interface Control Mode

1. To access the Interface Control mode, select **Trace/Chan** > **Channel** > **Hardware Setup** > **Interface Control** and in the drop-down menu select **Enable Interface Control**.

NOTE The PNA-X Series Network Analyzer includes the Interface Control application and rear panel connection. Information regarding this application can be found in the PNA-X Help menu, Interface Control. The application is shown below.

Figure 33 Enable Interface Control

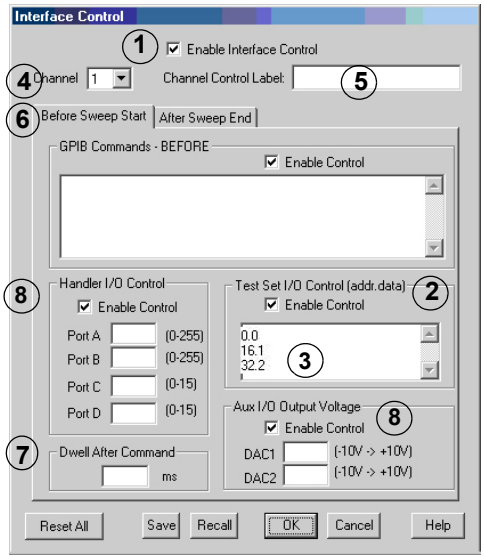


Using Interface Control Mode

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 PNA-X 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 34 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 PNA-X. 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 45.

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 PNA-X.

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 PNA-X screen during the channel sweep.

Before Sweep Start – After Sweep End Tabs: ⑥

Commands (GPIB, I/O's 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-X 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-X. Refer to the PNA-X 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-X 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.

GPIB Control Mode

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

- Overview
- How to Access GPIB Command Processor
- GPIB Command Processor Console

Overview of the GPIB Control

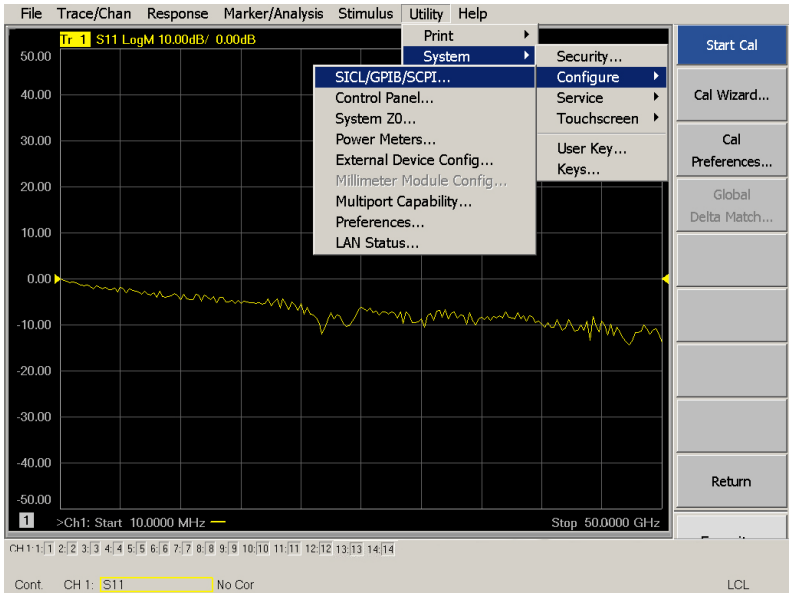
The GPIB Command Processor allows you to send address and data to control an external Test Set, without needing to create a remote program. The user is required to manually input address and data using the GPIB Command Processor Console in the PNA-X Help menu.

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

How to Access GPIB Command Processor

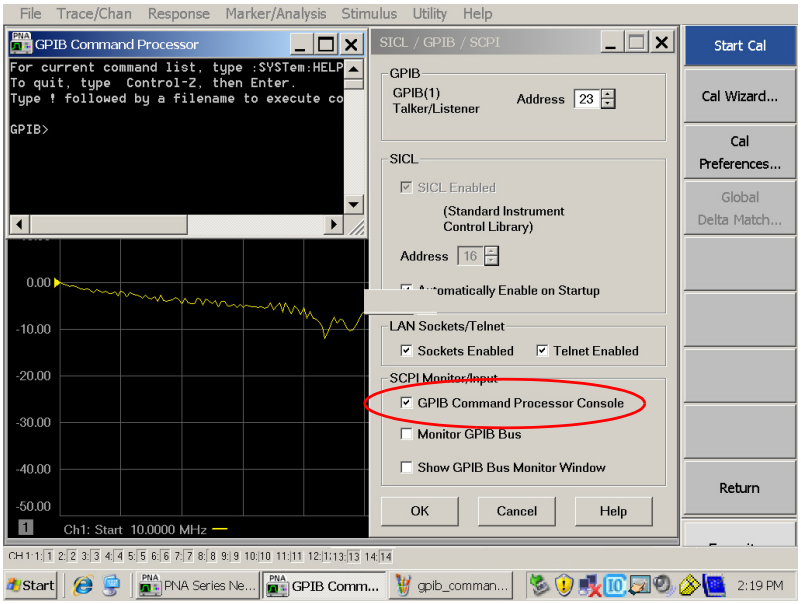
1. To access the GPIB Command Processor select **Utility** > **System** > **Configure** > **SICL/GPIB/SCPI**.

Figure 35 Utility Configure



2. Select **GPIB Command Processor Console** > **OK**.

Figure 36 GPIB Command Processor



GPIB Command Processor Console

Write Commands Once the GPIB Command Processor Console is open, commands can remotely control the external Test Set I/O connector by sending the following:

address: a integer number

data: a integer number

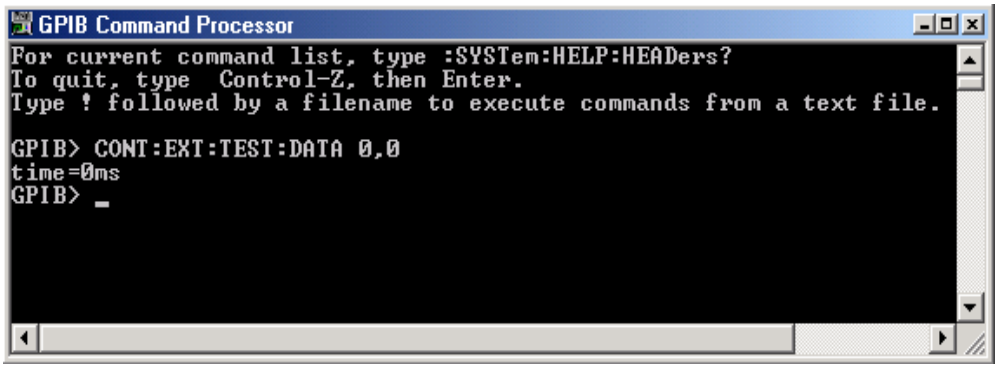
Address and data are separated by a comma. Commands should be separated by a new line, or carriage return.

For example:

CONT:EXT:TEST:DATA <address>,<data>
CONT:EXT:TEST:DATA 0,0

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

Figure 37 GPIB Command Console



Refer to "Address and Data Values" on page 45.

Address and Data Values

NOTE The <address> <data> commands will only function while the PNA is in Standalone Mode. Select **Restart as a standalone PNA** > **OK**. Refer to Figure 23 on page 31.

Setting the Test Port Paths with Address and Data Inputs

Refer to Table 12 on page 46 and Figure 38 on page 47 for information to set the internal switch paths of the Test Set.

NOTE The syntax <address>.<data> values are used for the manual PNA-X front panel entry for the Test Set I/O control mode, and the syntax <address>,<data> is used for computer GPIB data command mode entries.

The <address> value selects a group of available front panel Test Set ports. The <data> value narrows the front panel Test Set port to one specific port. Refer to Table 12.

The following instructions will apply to the front panel PNA-X entry. Refer to "Interface Control Mode" on page 38 and "GPIB Control Mode" on page 42.

How to Determine the <address> and <data> Values

Refer to Table 12.

<address>

1. In the Source or Receiver Path columns find the desired port number. Note the value shown in the Address column= **<address>** value.

NOTE If the Source and Receiver you select have the same <address>, only one "<address>.<data>" command will be used. If they have different <address> values two "<address1>.<data>" "<address2>.<data>" commands will be used in two separate line entries (Example 2).

<data>

1. In the Source path column find the desired source port number. Note the value shown in the Data row above the port number.
2. In the Receiver path column find the desired receiver port number. Note the value shown in the Data row above the port number.
3. Add the two noted values and the SUM = **<data>** value.
4. To manually enter the **<address>.<data>** values for Test Set control, set the PNA to the Interface Control Mode. Select **Trace/Chan** > **Channel** > **Hardware Setup** > **Interface Control** in the drop-down menu and select **Enable Interface Control**.

   For further information, refer to "Interface Control Mode" on page 38.

Example 1: Refer to Figure 38 on page 47.

- Source = Port 3 (<address>.<data> = 0.1)
- Receiver = Port 9 (<address>.<data> = 0.64)
- Front Panel PNA Control Mode line entry: 0.65

Refer to Figure 38, "Example 1, Test Set Signal Path" for in-depth RF path information.

Example 2:

- Source = Port 5 (<address>.<data> = 0.2)
- Receiver = Port 6 (<address>.<data> = 16.32)
- Front Panel PNA Control Mode line1 entry: 0.2
- Front Panel PNA Control Mode line2 entry: 16.32

Table 12 14-Port Address and Data Values[1]

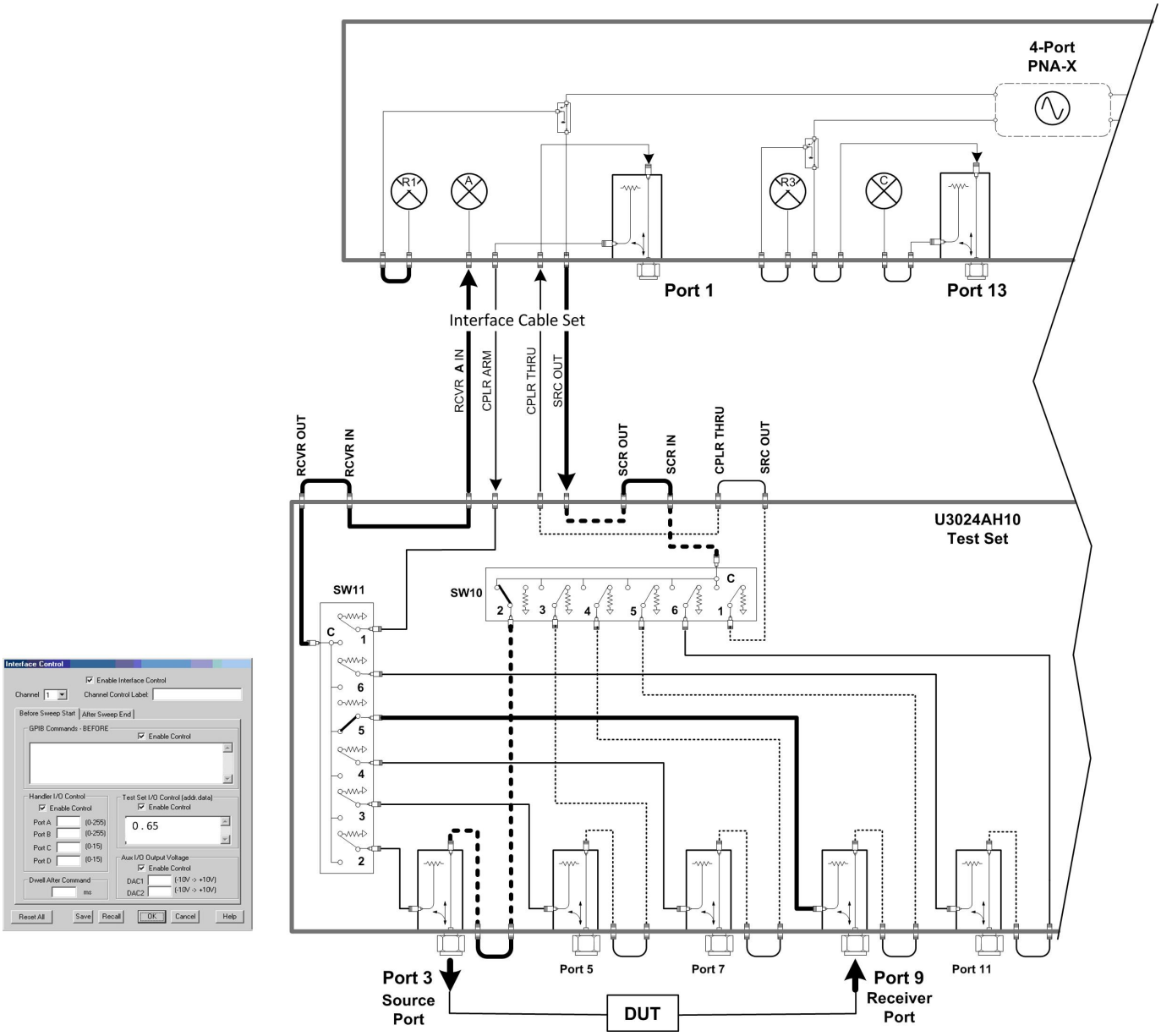
		Source Port Path							Receiver Port Path					
Address	Data →	0	1	2	3	4	5		0	16	32	48	64	80
0	Ports	1	3	5	7	9	11		1	3	5	7	9	11
16	Ports	2	4	6	8	10	12		2	4	6	8	10	12

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

Table 13 24-Port Address and Data Values

Top Test Set:														
		Source Port Path							Receiver Path					
Address	Data →	0	1	2	3	4	5		0	16	32	48	64	80
0	Ports	1	5	9	13	17	21		1	5	9	13	17	21
16	Ports	2	6	10	14	18	22		2	6	10	14	18	22
Bottom Test Set:														
Address	Data →	0	1	2	3	4	5		0	16	32	48	64	80
1	Ports	3	7	11	15	19	23		3	7	11	15	19	23
17	Ports	4	8	12	16	20	24		4	8	12	16	20	24

Figure 38 Example 1, Test Set Signal Path



Setting the Control Lines with Address and Data Values

This section describes how to control the rear panel DUT control lines using address and data values. Refer to "Control Lines" on page 49 for more detailed information.

NOTE The <address> <data> commands will only function while the PNA is in Standalone Mode. Select **Restart as a standalone PNA** > **OK**. Refer to Figure 23 on page 31.

All DUT control lines are initially configured in a High logic state after the line power has been turned on, and until set by the <address>.<data> input. The control lines will remain in the last state set when changing from Multiport mode to Standalone mode. Sending a command 112.0 will ensure that all of the control lines are high.

As described in "Setting the Test Port Paths with Address and Data Inputs," the <address>.<data> value are determined in a similar manner, with the exception that Table 14 (below) will be used. The <address> value is always = 112

Example: To change the default DUT control line, so that lines 1 & 8 are changed to the alternate position, enter front panel PNA-X control mode line entry = 112.129 > **OK**. All other lines remain in the default High state.

Table 14 Test Set DUT Control Address and Data Logic Table

<address>	<data>	Description	Line/ Pin
112	0	ALL DUT Control Lines set to logic high or connected to Pin 13	1-8
112	255	ALL DUT Control Lines set to logic low or connected to Pin 14	1-8
112	1	DUT Control Line 1 set to logic low or connected to Pin 14	1
112	2	DUT Control Line 2 set to logic low or connected to Pin 14	2
112	4	DUT Control Line 3 set to logic low or connected to Pin 14	3
112	8	DUT Control Line 4 set to logic low or connected to Pin 14	4
112	16	DUT Control Line 5 set to logic low or connected to Pin 14	5
112	32	DUT Control Line 6 set to logic low or connected to Pin 14	6
112	64	DUT Control Line 7 set to logic low or connected to Pin 14	7
112	128	DUT Control Line 8 set to logic low or connected to Pin 14	8

Another method that can be used to change the logic state of these control lines is explained in "External Test Set Control Operation" on page 32.

NOTE Only the top Test Set control lines operate in a 24-Port system.

Control Lines

The 15 pin female D-Sub connector on the rear panel provides 8 latched data lines that can be used to control your device under test (DUT. The lines can be controlled with the multiport external test set control, or Test Set I/O commands. Refer to "External Test Set Control Operation" on page 32 and "Setting the Control Lines with Address and Data Values" on page 48. See Table 15 below for DUT control line specification.

The output voltage of the lines can be from the internal adjustable voltage source (+2 to +5 Vdc), or an external DC power supply depending on how the connection to the control line is configured. When using an external power supply a positive or negative voltage can be used. Refer to Figure 39 and Table 16 on page 50 for control line pin location and description. Refer to "Internal Voltage Supply Configuration" on page 51 and "External Voltage Supply Configuration" on page 52 for configurations.

Table 15 DUT Control Specifications

Item	Specifications
Connector Type	D–Sub, 15–pin female
Max Output Line Current	100 mA (each line)
Control Line DC resistance	< 10 Ω (each line)
Voltage Range:	
Positive Input	0 to +5 V
Negative Input	–5 to 0 V
Internal Variable Voltage	+2 to +5 V

Figure 39 DUT Control Line Pin Assignment (rear panel view)

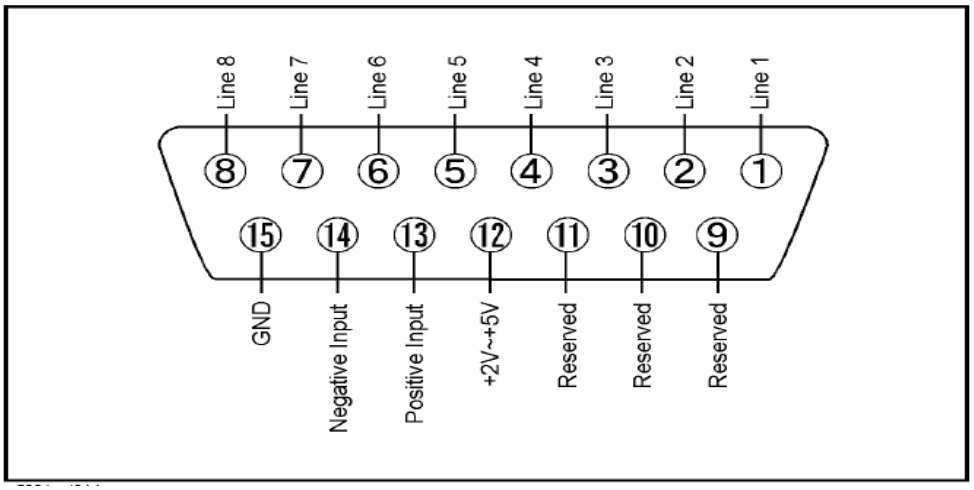


Table 16 DUT Control Line Interface Connector Pin Assignment

Pin	Signal Name	Description
1	Line 1	Control Line Output of the latched voltage from pin 13 or pin 14.
2	Line 2	Control Line Output of the latched voltage from pin 13 or pin 14.
3	Line 3	Control Line Output of the latched voltage from pin 13 or pin 14.
4	Line 4	Control Line Output of the latched voltage from pin 13 or pin 14.
5	Line 5	Control Line Output of the latched voltage from pin 13 or pin 14.
6	Line 6	Control Line Output of the latched voltage from pin 13 or pin 14.
7	Line 7	Control Line Output of the latched voltage from pin 13 or pin 14.
8	Line 8	Control Line Output of the latched voltage from pin 13 or pin 14.
9, 10, & 11		Not used.
12	+2 V to +5 V	Internal voltage output, adjusted with the trimmer on the rear panel.
13	Positive Input	Connection for internal (pin 12) or external positive voltage supply.
14	Negative Input	Connection for ground (pin 15) or external negative voltage supply.
15	Gnd	Ground Terminal.

Internal Voltage Supply Configuration

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

1. Turn on the Test Set.

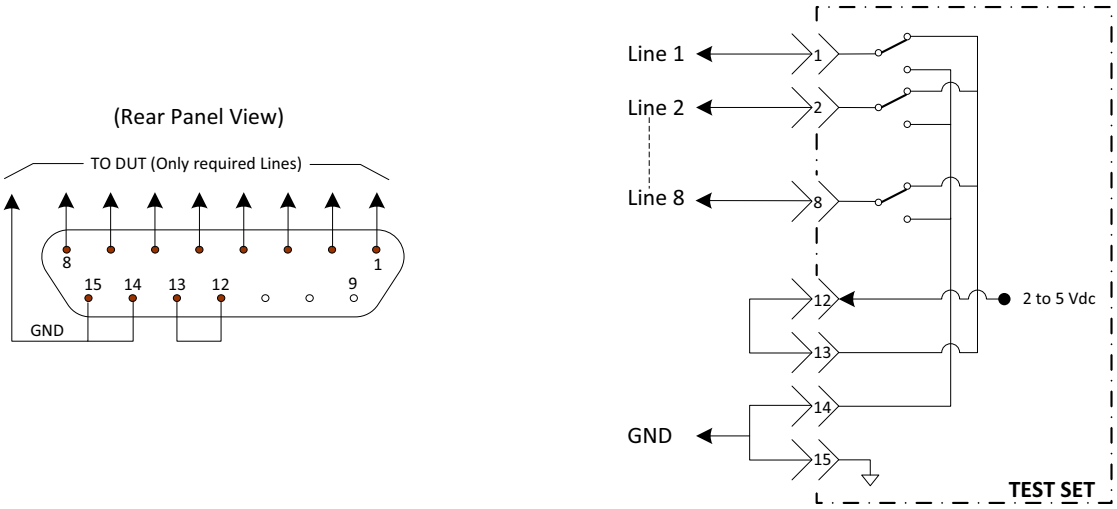
2. Measure the voltage between pin 12 and 15 using a multimeter.

3. Rotate the voltage adjustment trimmer on the rear panel until the multimeter indicates the selected voltage.

Figure 40 below illustrates an example of the connection between the DUT and the Test Set using the internal DC power supply. Connect pin 12 to pin 13 and pin 14 to pin 15 to provide the ground path. Connect the control lines to the external DUT.

CAUTION **You may only connect pin 12–13, and pin 14–15; damage may result if any other paths are short-circuited.**

Figure 40 Internal DC Power Configuration (rear panel view)



External Voltage Supply Configuration

Figure 41 below illustrates an example of the connection with an external DC power supply. Connect the positive and negative voltage supply from the external power supply to the positive input (pin 13) and the negative input (pin 14). Connect the power supply DC ground to pin 15.

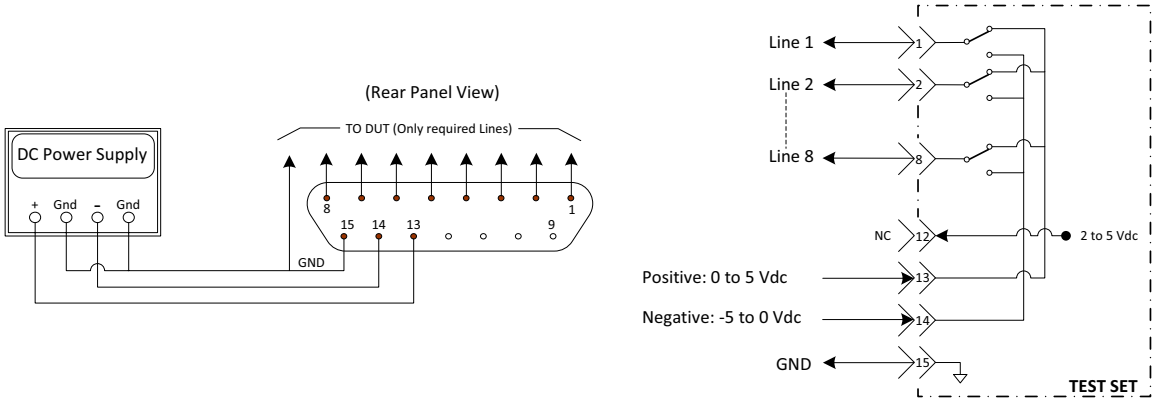
Turning On the Test Set using an External Power Supply

1. Turn On the Test Set.
2. Connect the DUT.
3. Turn On the external power supply.

Turning Off the Test Set using an External Power Supply

1. Turn Off the Power Supply.
2. Turn Off the Test Set.
3. Disconnect the DUT.

Figure 41 Test Set to the DUT and External DC Power Supply



High Power Measurements with the U3024AH10

The Test Set and the 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 PNA-X 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 switches and the PNA-X source.
- The booster amplifiers are used to provide added gain.

CAUTION When using high power configurations an attenuator must be placed in the receiver path, and the couplers and isolators must be installed in the source path, or damage to the PNA-X or the U3024AH10 Test Set will occur. Refer to "Frequency Range and Maximum Power Levels" on page 8.

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

NOTE Refer to the configuration diagrams for external component connections and/or operating constraints when utilizing the high power capability. External components are not supplied with the high power Test Set. See Figure 43 and Figure 44 on page 60, Figure 57 through Figure 60 beginning on page 77.

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 8.

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 45, “Odd Ports (1 Watt),” on page 61 and Figure 59 on page 79.
   - Figure 46, “Port 1 (20 Watt),” on page 61.
   - Figure 47, “Port 3 (20 Watt),” on page 62.
   - Figure 58, “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 55.
5. Set the power level out of the DUT. Refer to “Setting the Power Level at the Output of the DUT” on page 57.
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 63.

Measuring Booster Amplifier Gain

1. Connect the Test Set to the PNA-X. See "14-Port System Setup" on page 15 and Figure 42 on page 56.
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 45 and Figure 46 on page 61, as well as the block diagrams beginning on page 76.
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 below, Figure 46 on page 61, and Figure 47 on page 62.
6. Turn on the PNA-X and the U3024AH10 Test Set.
7. Select Multiport mode. Refer to "Controlling the System with the Network Analyzer" on page 30.
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. For 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. Using a power meter, measure the Coupler Output power.

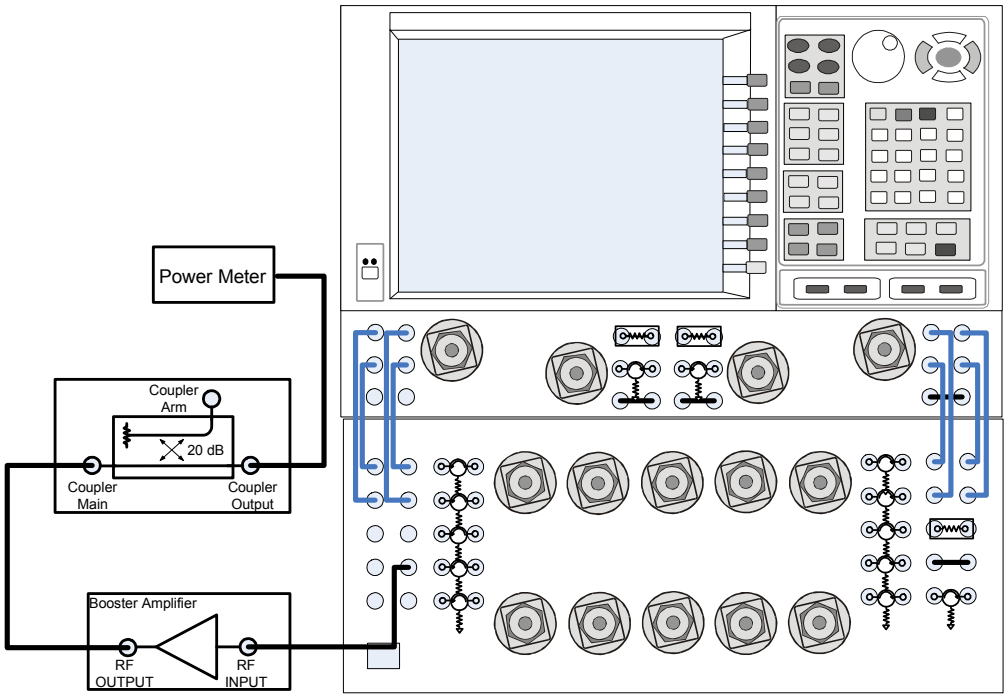
CAUTION **Additional attenuation may be required between the coupler and the power meter to protect the power meter from damage.**

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 45 on page 61
Even Port SRC OUT[2]	1 Watt	All Even Ports	See Figure 45 on page 61
Port 1 SRC OUT	20 Watts	Port 1	See Figure 46 on page 61
Port 2 SRC OUT[3]	20 Watts	Port 2	See Figure 46 on page 61
Port 3 to 12 SRC OUT	20 Watts	Port 3 to 12	See Figure 47 on page 62

1. A 2-way high power source configuration can be configured for transmission and reverse transmission measurements. Refer to Figure 58 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 45 on page 61.
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 46 on page 61.

Figure 42 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 SRC IN. The reverse attenuation or isolation factor of the isolator should be 20 dB or greater.
3. Turn On the Amplifier.
4. Select S11 and measure the power at Port 1 on the PNA-X, using the power meter. If you are using another port as the source port, set Sxx to the port desired. Example, S33 would be Port 3. Ensure the power is less than +43 dBm for the 20 watt configuration, or less than 30 dBm for the 1 watt configuration.
5. Reduce the PNA-X power to a minimum.

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

6. Connect the port selected to be the source output to the input of the DUT.
7. Measure the power level out of the DUT. Increase the PNA-X power level to determine the DUT's desired input or compression level. This value will be used to determine the receiver input attenuator values. Save this state to recall the power level for the Input power level to the DUT. The power level should not be above the level that was determined in step 13 on page 56.

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 43 and Figure 44 on page 60.

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 43 1 Watt High Power Configuration

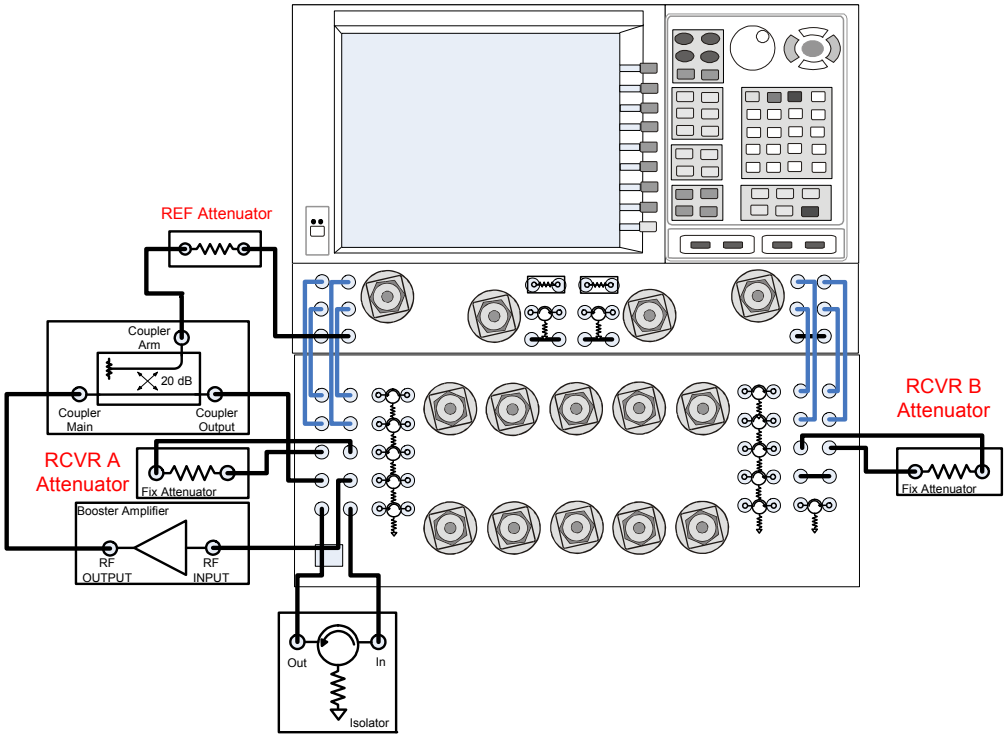


Figure 44 20 Watt High Power Configuration

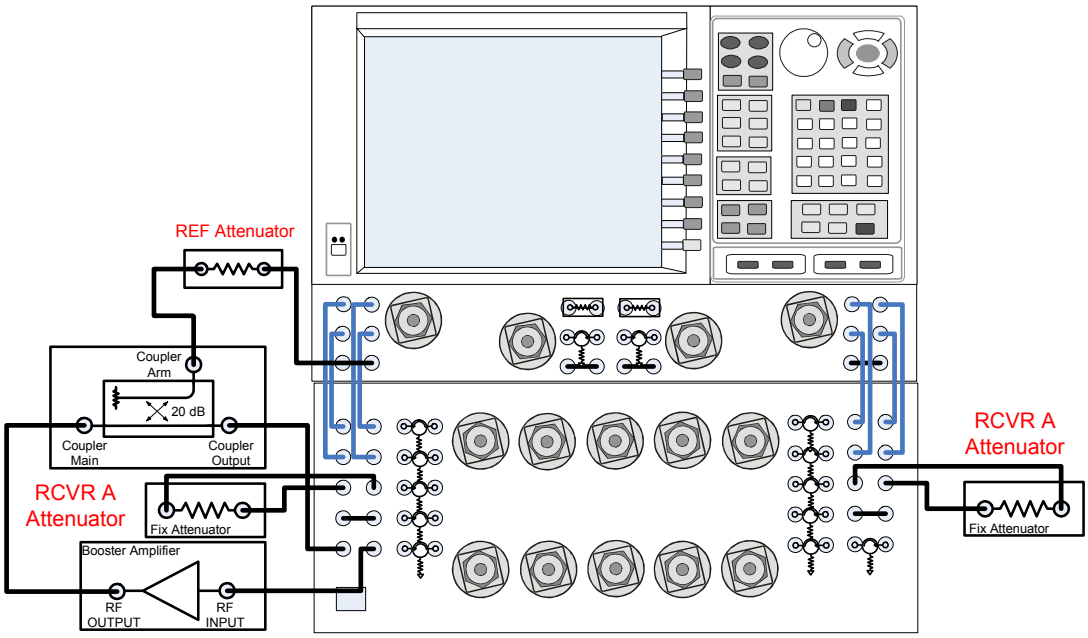


Figure 45 Odd Ports (1 Watt)

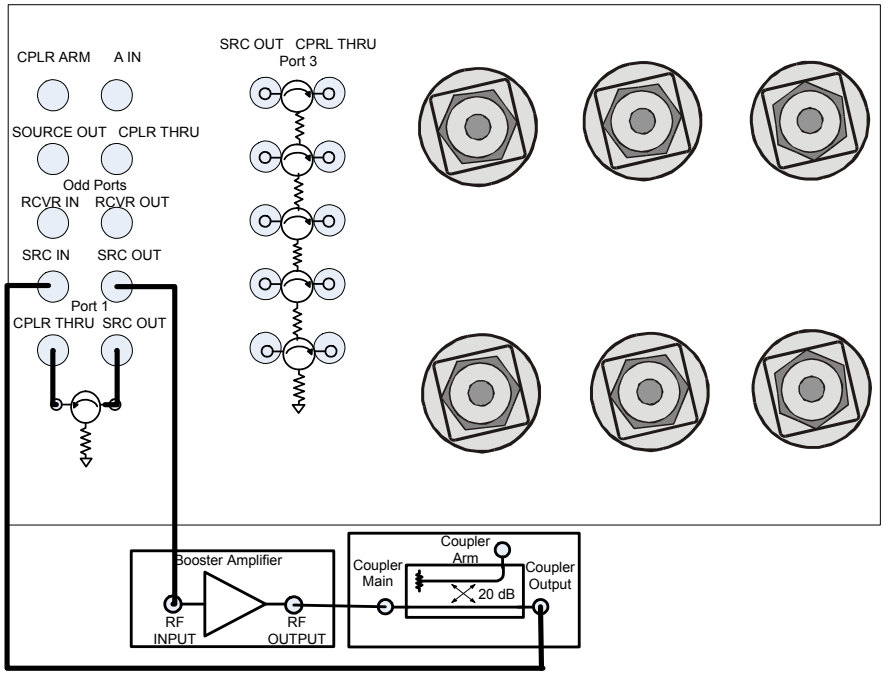


Figure 46 Port 1 (20 Watt)

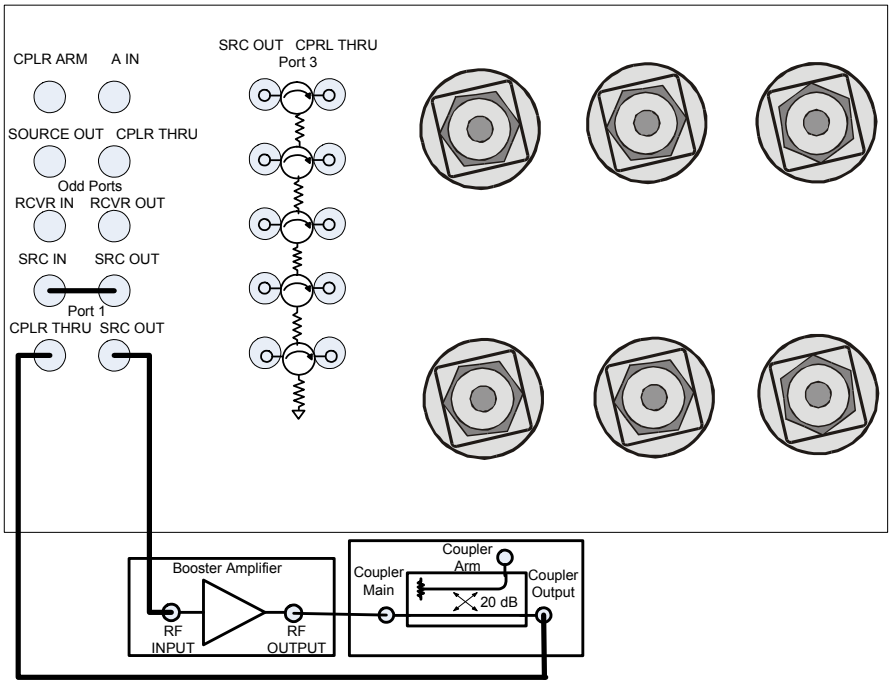
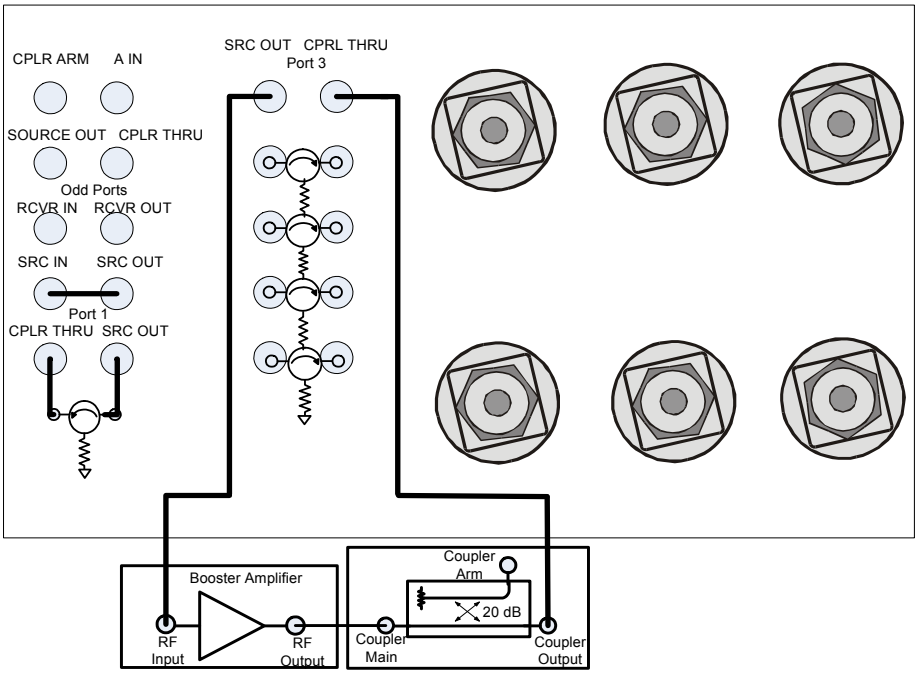


Figure 47 Port 3 (20 Watt)



CAUTION High power isolators should be inserted between the SRC 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 U3024AH10 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.

Operational Check (ECal)

This section provides the test calibration procedure to confirm the U3024AH10 operational performance. The operation verification limits provided ensure that your system is operating properly. The operational check is performed with the system configured as in "14-Port System Setup" on page 15 or "24-Port System Setup" on page 20. The operational check configuration does not apply to the high power devices. Ensure that the standard jumpers are installed.

Verification Limits

Specifications for the U3024AH10 Multiport Test Set are typical. System performance for the PNA-X and Test Set are only characteristic and intended as non-warrantied information. A functional certificate is provided for the U3024AH10 only.

It is recommended that you return your instrument to Keysight Technologies for servicing or repair if the Test Set and PNA-X performance exceed the operational verification limits. "Contacting Keysight" on page 99.

Table 18 14-Port Operation Verification Limit[1]

Frequency	Reflection Tracking Ports 1 - 2	Reflection Tracking Ports 3 or 12
10 MHz to 5 GHz	–6 dB	–4 dB
5 GHz to 10 GHz	–10 dB	–8 dB
10 GHz to 15 GHz	–11 dB	–9 dB
15 GHz to 20 GHz	–12 dB	–10 dB
20 GHz to 25 GHz	–13 dB	–11 dB
25 GHz to 30 GHz	–15 dB	–13 dB
30 GHz to 35 GHz	–16 dB	–14 dB
35 GHz to 40 GHz	–17 dB	–15 dB

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

Table 19 24-Port System Operation Verification Limit[1]

Frequency	Reflection Tracking Ports 1 - 4	Reflection Tracking Ports 5 or 24
10 MHz to 5 GHz	–6 dB	–8 dB
5 GHz to 10 GHz	–10 dB	–8 dB
10 GHz to 15 GHz	–11 dB	–12 dB
15 GHz to 20 GHz	–12 dB	–13 dB
20 GHz to 25 GHz	–13 dB	–14 dB
25 GHz to 30 GHz	–15 dB	–15 dB
30 GHz to 35 GHz	–16 dB	–17 dB
35 GHz to 40 GHz	–17 dB	–18 dB

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

NOTE If you suspect that your 14 or 24-Port configuration is not operating properly, ensure that all front RF jumper interface cables are correctly attached.

Equipment Required

The Keysight U3024AH10 requires that the user be familiar with the equipment listed.

Table 20 Equipment List

Description	Qty
N4693A 2.4 mm ECal Module 10 MHz - 50 GHz (Option 00F or M0F) *or* 85057B Verification Kit.	1
N5224/25A/B, N5244/45A/B Option 551	1
Set of Interface Cables (PNA-X and Test Set)	1

Operational Check Procedure

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

NOTE **If you suspect that your system configuration is not operating properly, ensure that all front RF jumper interface cables are correctly attached.**

Preparing the Network Analyzer (14 or 24-Port System)

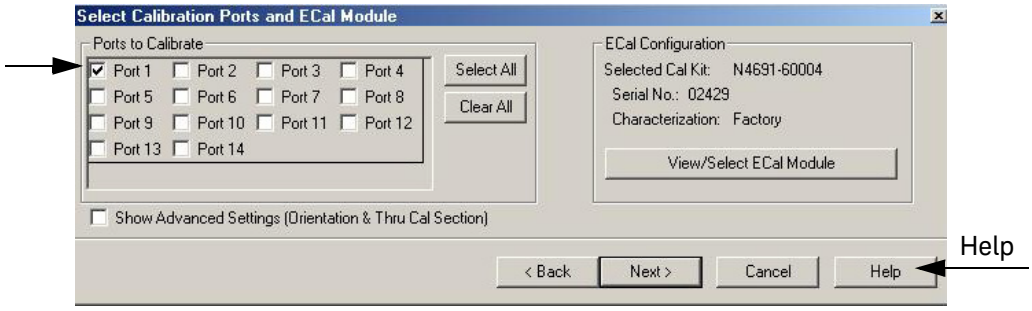
NOTE **When configurated as a 14-Port system, Ports 13 and 14 are not connected to the Test Set, therefore not verified.**

1. Connect the Test Set to the PNA-X 4-Port for a 14 or 24 Port system.
2. Turn On the Test Set.
3. On the PNA-X, press **Response** > **CAL** > **ManageCals** > **CalSet**. Delete or Rename any Cal Sets titled "999.1" thru "999.12" (14-Port) or 999.24 for a 24-Port system, although it is unlikely that you will find Cal Sets with these names.
4. Verify that the PNA-X is in 14 or 24-Port mode. See the bottom of the measurement window.
   a. If only four S-Parameters are listed, press **Utility** > **System** > **Configure** > **Multiport Capability**. On the Multiport Restart dialog, select **Restart asmultiport PNA withthistest set**. Select the file for your system (14 or 24-Port). Refer to "PNA-X Multiport Mode" on page 31.
5. Press **Preset.**
6. Verify that the **[Stop Frequency]** is set to **[40 GHz].**
7. Verify that the **[StartFrequency]** is set to **[10 MHz]**.
8. Verify that the **[Power]** is to set to **[–5 dBm]**.
9. Select **Response** > **Avg** > **IFBandwidth** > **100 Hz**.
10. Select **Stimulus** > **Sweep** > **Number of Points** > **401**.
11. Connect the ECal module to the PNA-X USB port on the front or rear panel. This procedure assumes you are using a ECal. If you are not, see "N5244/45A 1-Port Calibration and Verification Procedure" step 2.
12. Allow the ECal module, Test Set and PNA-X to warm up for a minimum of 30 minutes.

1-Port Calibration and Verification Procedure

1. Connect the ECal or the mechanical cal kit to Port 1 or the port you are testing on the PNA-X. Torque to 8 in-lb. For more information, refer to the Help menu (see Figure 48 below).
2. Perform a 1-Port Calibration on Port 1. On the PNA-X, select **Response** > **Cal**>**StartCal**> **CalibrationWizard**.
   a. If using a mechanical cal kit, select **SmartCal (GuidedCalibration)** > **Next**.
   b. If using an ECal module, connect the ECal to a PNA-X USB port. Select **UseElectronic Calibration(ECal)** > **Next**.
3. Continue following the Cal Wizard prompts. In the Select Calibration Ports and ECal Module dialog box click **ClearAll,** then select **Port1** > **Next** > **Measure**.

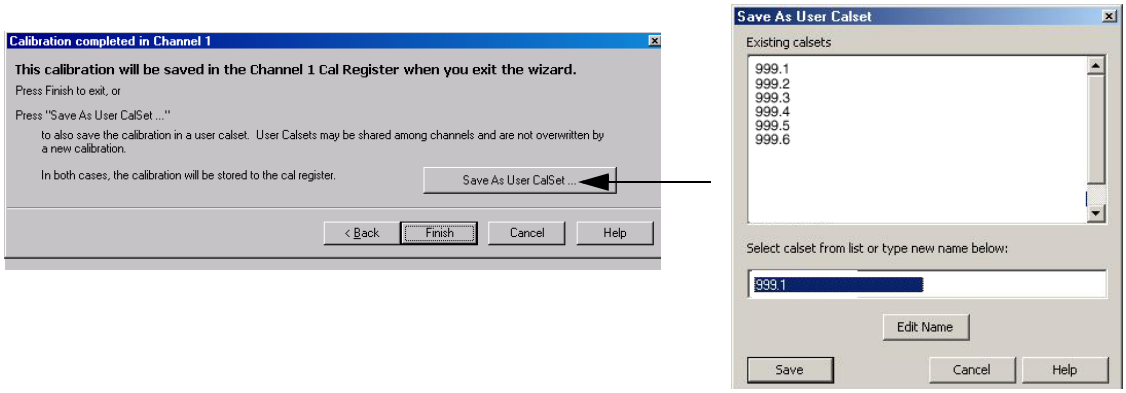
Figure 48 1-Port Calibration



4. Continue to follow the prompts until the Calibration Completed dialog box appears.
5. At the Calibration Completed prompt, select **Save As User Calset**, type the name **999.1**. Overwrite the Cal Set if it already exists and **Save**.

NOTE If you do not have a key board, select **Save As User Calset** > **Edit Name** and save as **999.x**. X is the port number you are calibrating. See Figure 49 below. Use the numeric keypad on the PNA-X front panel to enter "999.1."

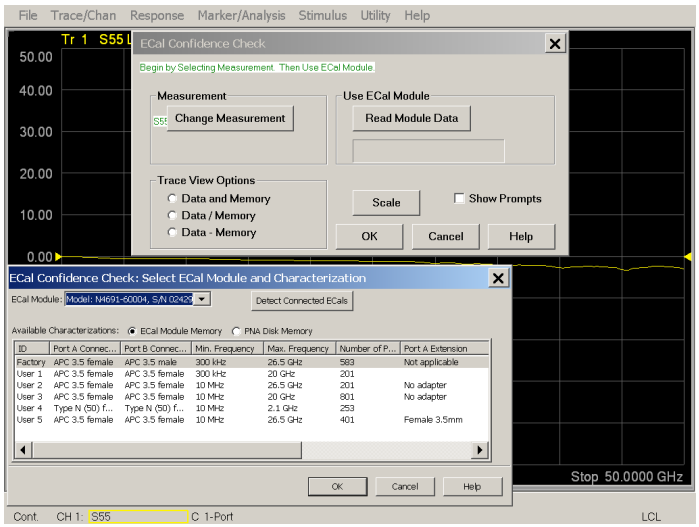
Figure 49 Calibration Complete



6. Repeat step 1 thru step 5 for the remaining ports. When finished, there should be twelve Cal Sets saved with titles “999.1” thru “999.12” for a 14-Port system, or 24 Cal Sets with titles “999.1” thru “999.24” for a 24-Port system.

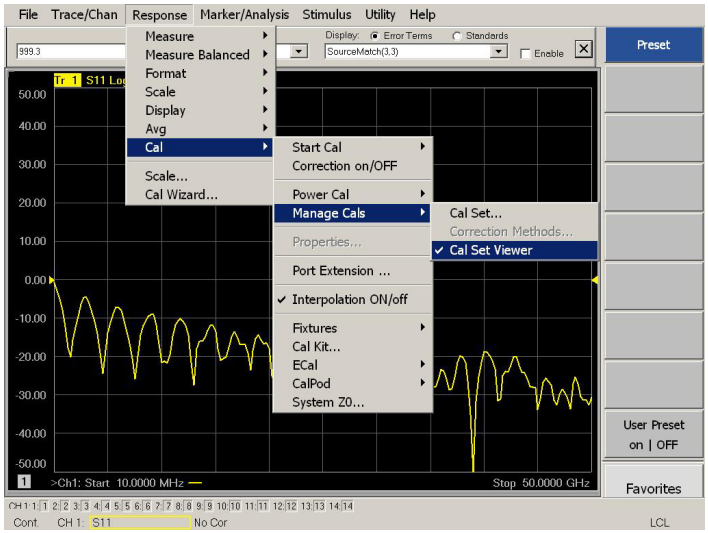
   If you are using an ECal module you can verify the individual port calibration by selecting **Response** > **Cal** > **More** > **ECal** > **ECal Confidence Check**. Click **Change Measurement** and select the test port S-Parameter > **Apply** > **OK** and click **Read Module Data**. For further information, refer to the Help menu.

Figure 50 Calibration, Cal Set Viewer



7. Press **Trace/Chan** > **Trace** > **Delete Trace**. There should be no traces on the PNA-X display.
8. To launch the Cal Set Viewer toolbar. Select **Response** > **Cal** > **Manage Cals** > **CAL Set Viewer**.

Figure 51 Calibration, Cal Set Viewer



9. From the Cal Set drop-down menu, select **999.1** and select **Enable**. Select the **Reflection Tracking(x,x)**, where x,x is the port being tested, term in the center drop-down menu and ensure that the **Enable** and **Error Terms** check boxes are selected.
10. Compare the Reflection Tracking (1,1) trace to the appropriate limits shown in Table 18 on page 64. You may also create a table on the PNA-X and enter the limit line stimulus and response values. Select **Marker/Analysis** > **Analysis** > **Limit Test** > **Limit Test ON** and **Limit Line ON** > **Global pass/fail display ON**, then click **Show Table**. The trace should be above the limit. PASS will be displayed on the screen if the limit lines are used.
11. Repeat step 9 and step 10 for the Cal Sets that you have saved.

Figure 52 PNA-X Setting the Test Limits

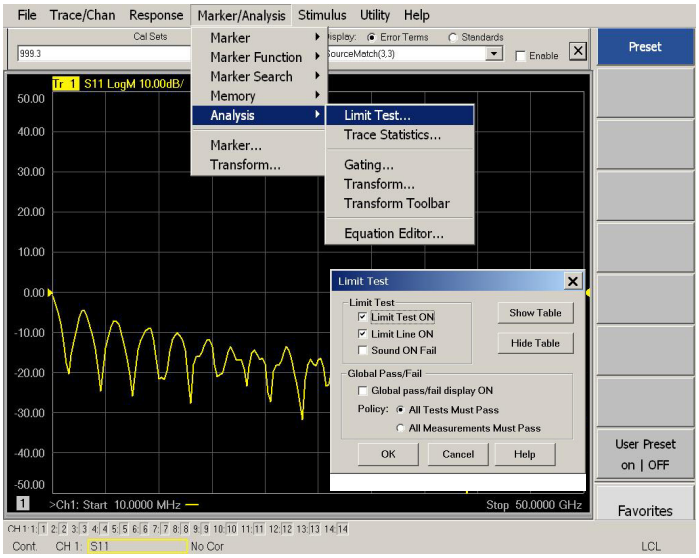
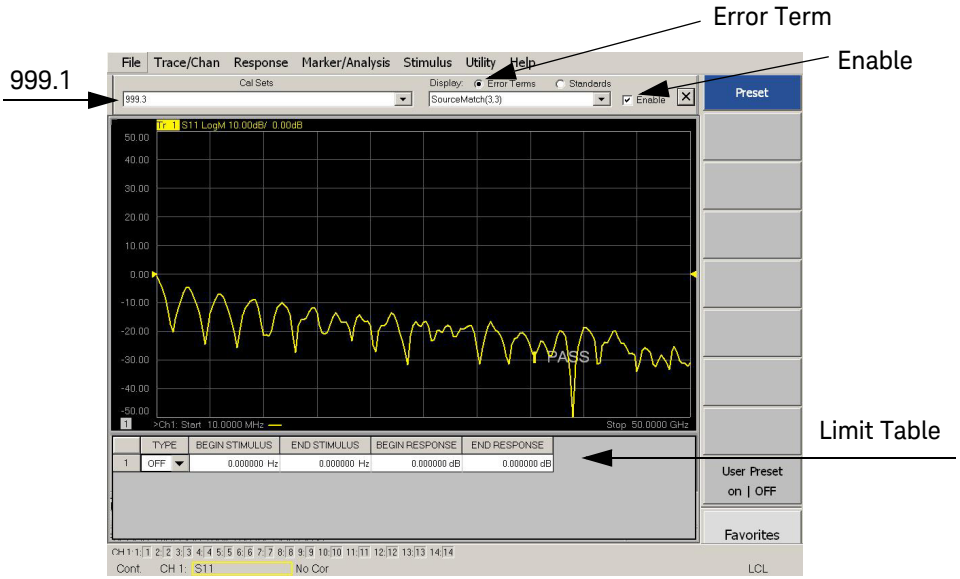


Figure 53 Reflection Tracking Trace



12. Compare the Reflection Tracking (1,1) trace to the appropriate limits in Table 18 on page 64. This can be done using Limit Lines (press **Marker/Analysis** > **Analysis** > **Limit Test**). The trace should be above the limit. PASS will be displayed if the limit lines are used.
13. Repeat step 9 and step 12 for Cal Sets “999.1” thru “999.14” (14-Port).

Figure 54 PNA-X and Test Set Reflection Tracking Trace (Port 1 - 2)

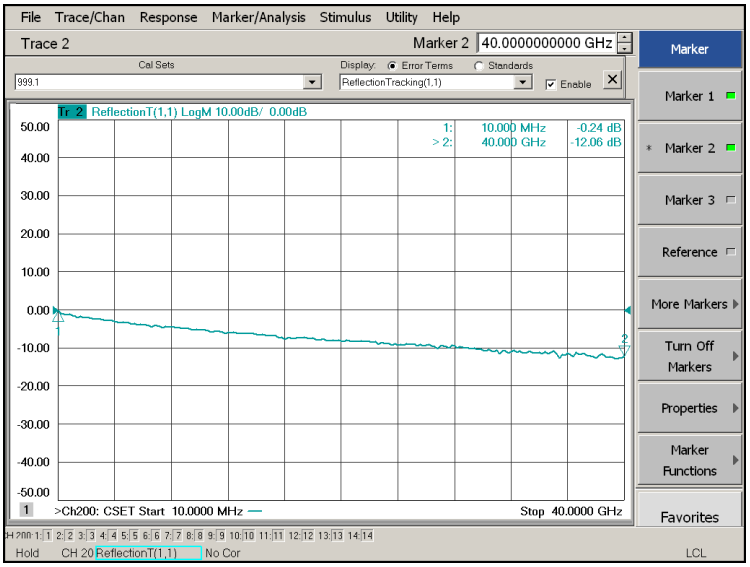
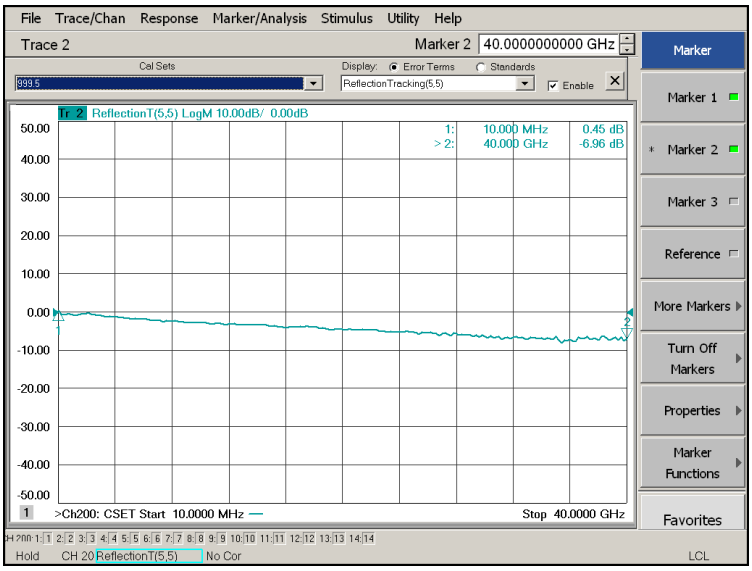


Figure 55 PNA-X and Test Set Reflection Tracking Trace (Port 3 - 12)



Verifying Operational Check Failures

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

1. Ensure that the Test Set is turned on and connected properly to the PNA-X.
2. Check all appropriate PNA-X and Test Set connectors for damage, cleanliness, and proper torque.
3. Repeat the relevant 1-Port calibrations.
4. Verify that the PNA-X is operating properly and meeting its published specifications. If the PNA-X is connected to the Test Set it will fail the Operational Check. Refer to "Network Analyzer Requirements" on page 4.

14-Port Interface Cable Verification

1. Connect the Test Set to the PNA-X and select Multiport mode.
2. Verify the Source interface RF cables (SRC OUT and CPLR THRU).
   a. Remove the Receiver and CPLR ARM interface cables and install the standard PNA-X jumpers.
   b. Connect an RF cable from Port 1 to Port 2 on the PNA-X.
   c. Set the PNA-X to measure Trace S12 and S21 and verify that there are no power holes. If S12 has a power hole check the Port-2 Source interface cables and Test Set connectors for damage. If S21 has a power hole check the Port-1 Source interface cables and Test Set connectors for damage.
3. Verify the Receiver interface RF cables (Receiver A IN or B IN and CPLR ARM).
   a. Re-install the Receiver and CPLR ARM interface cables.
   b. Remove the SRC OUT and CPLR THRU interface cables and install the standard PNA-X jumpers.
   c. Connect an RF cable from Port 1 to Port 2 on the PNA-X.
   d. Set the PNA-X to measure Trace S12 and S21, and verify that there are no power holes. If S12 has a power hole check the Port-1 Receiver interface cables and Test Set connectors for damage. If S21 has a power hole check the Port-2 Receiver interface cables and Test Set connectors for damage.
4. If the problem still exists, connect the standard jumpers to the PNA-X (Source and Receiver) and verify the SRC OUT to CPLR THRU and A/B IN to CPLR ARM switch paths.
   a. Set the PNA-X to measure trace S12.
   b. Connect Port-1 to SRC OUT and Port-2 to CPLR THRU connectors on the Test Set. If a power hole still exists refer to "Contacting Keysight" on page 99.
   c. Connect Port-1 to Receiver A IN or B IN and Port-2 to CPLR ARM connectors on the Test Set. If a power hole still exists refer to "Contacting Keysight" on page 99.

24-Port Interconnect Cable Verification

1. Connect the Test Set to the PNA-X and select Multiport mode.
2. Verify the Source Interconnect RF cables (Source Out and CPLR THRU).
   a. Remove the Receiver and CPLR ARM interconnect cables and install the standard PNA-X jumpers.
   b. Connect two RF cables on the PNA-X, Port 1 to Port 2 and Port 3 to Port 4.
   c. Set the PNA-X to measure Trace S12, S21, S34 and S43, and verify that there are no power holes. If S12, or S34 has a power hole check the Port 2, or Port 4 Source interconnect cables and Test Set connectors for damage. If S21, or S43 has a power hole check the Port 1, or Port 3 Source interconnect cables and Test Set connectors for damage.
3. Verify the Receiver Interconnect RF cables (Receiver A IN or B IN and CPLR ARM).
   a. Re-install the Receiver and CPLR ARM interconnect cables.
   b. Remove the Source Out and CPLR THRU interconnect cables and install the standard PNA-X jumpers.
   c. Set the PNA-X to measure Trace S12, S21, S34 and S43. Verify that there are no power holes. If S12 or S34 has a power hole check Port-1, or Port-3 Receiver Interconnect cables and Test Set connectors for damage. If S21, or S43 has a power hole check Port-2, or Port-4 Receiver Interconnect cables and Test Set connectors for damage.
4. If the problem still exists, connect the standard jumpers to the PNA-X (Source and Receiver) and verify the Source Out to CPLR THRU and A/B IN to CPLR ARM switch paths.
   a. Connect two RF cable, one to Port 1 and one to Port 2.
   b. Set the PNA-X to measure trace S12 (all standard jumpers connected).
   c. Connect the Port-1 cable to Source Out and Port 2 cable to CPLR THRU connectors on the Test Set. If a power hole still exists refer to “Contacting Keysight” on page 99.
   d. Connect Port 1 to Receiver A IN or B IN and Port 2 to CPLR ARM connectors on the Test Set. If a power hole still exists refer to “Contacting Keysight” on page 99.

Service Information

This section provides information to troubleshoot and repair the Test Set. Refer to "Keysight Support, Services, and Assistance" on page 99 for information on returning your test set to Keysight Technologies.

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

The following replaceable parts are available from Keysight Technologies "Find-A-Part" system on the web at http://www.keysight.com/my/faces/fapHomePage.jspx.

Table 21 Available Replacement Parts (SPO)

Description	Keysight Part Number
Switch, Multiport (40 GHz terminated)	87106-60043
Fuse (5 A 250 V non-time delay Socket)	2110-0709
Fuse (8 A 250 V non-time delay 0.0146 Ohm)	2110-0342
RF Jumper	N5245-20155
Guard, Jumper Cables	N5242-00030
PWR Supply (AC/DC SWG 650W 9- Output)	0950-4729
Coupler	5087-7793
PNA-X Locking Feet	5023-0132
Test Set I/O Cable	N4011-21002
Fan (rear panel)	87050-60027
DUT Control Board	U3020-63223

The following replaceable parts may be ordered by sending an email request to ctd-soco_support@keysight.com. Be sure to include test set model, options, and serial number. Some parts may have long lead times.

Table 22 Replaceable Parts (H10)

Description	Keysight Part Number
RF Cable, Semi-rigid	U3024-20045
RF Cable, Semi-rigid	U3024-20046
RF Cable, Semi-rigid	U3024-20047
RF Cable, Semi-rigid	U3024-20048
RF Cable, Semi-rigid	U3024-20049
RF Cable, Semi-rigid	U3024-20050
SW Interface Board, programmed	U3025-60062
Rear Locking Link (right)	N5242-20138
Rear Locking Link (left)	N5242-20139
Dress Nut (couplers)	N5230-20081
PNA-X Test Set Rear Lock Feet (right)	N5242-20138
PNA-X Test Set Rear Lock Feet (left)	N5242-20139
Front Panel LED Board (programmed)	N5261-63005
Test Set Control Board (programmed)	N5261-60006
Screw-Pan Head Machine with thread patch, Torx-T15 M3.5 with 0.6 thread, 12 mm-LG	0515-2317
Port Label Page	U3040-80001
U3024AH10 User's and Service Guide	U3024-90001

Theory of Operation

The following is a description of the operation of the U3024AH10. Reference the U3024AH10 block diagram shown in Figure 56 on page 76. This section assumes the user has a general understanding of couplers, switches, and network analyzers.

RF Switch Components

S10, S11, S20, and S21 are all mechanical switches (87106-60043). The frequency range is DC to 40 GHz. The switches select the RF paths from the PNA-X source and receiver through interface cables to Test Set port couplers that provide 20 watt input power handling capability. Refer to the "System Block Diagrams" on page 76.

S10 - Source to Odd Ports (1-11)

Switch 10 provides control of the Source path to PNA-X Port 1 and the Test Set odd ports (3 - 11). In the state shown in the block diagram, switch 102 routes the RF source back to the PNA-X Port 1 and all unused Test Set odd ports (3 - 11) source paths are terminated.

S20 - Source to Even Ports (2-12)

Switch 20 provides control of the Source path to PNA-X Port 2 and the Test Set even ports (4 - 12). In the state shown in the block diagram, switch 202 routes the RF source back to the PNA-Port 2 and all unused Test Set even ports (4 - 12) source paths are terminated.

S11 - Receiver to Odd Ports (1-11)

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

S21 - Receiver to Even Ports (2-12)

Switch 21 provides control of the B Receiver path to PNA-X Port 2 and the Test Set even ports (4 - 12). In the state shown in the block diagram, switch 402 routes the coupler arm from the PNA-X Port 2 to the B Receiver and all unused Test Set even ports (4 - 12) coupler arm paths are terminated.

RF Coupler Components

Test Set port couplers (5087-7724) provide the signal separation of the source and receiver paths. The Test Set ports can either stimulate or receive a signal to the DUT.

Figure 56 14-Port System Configuration

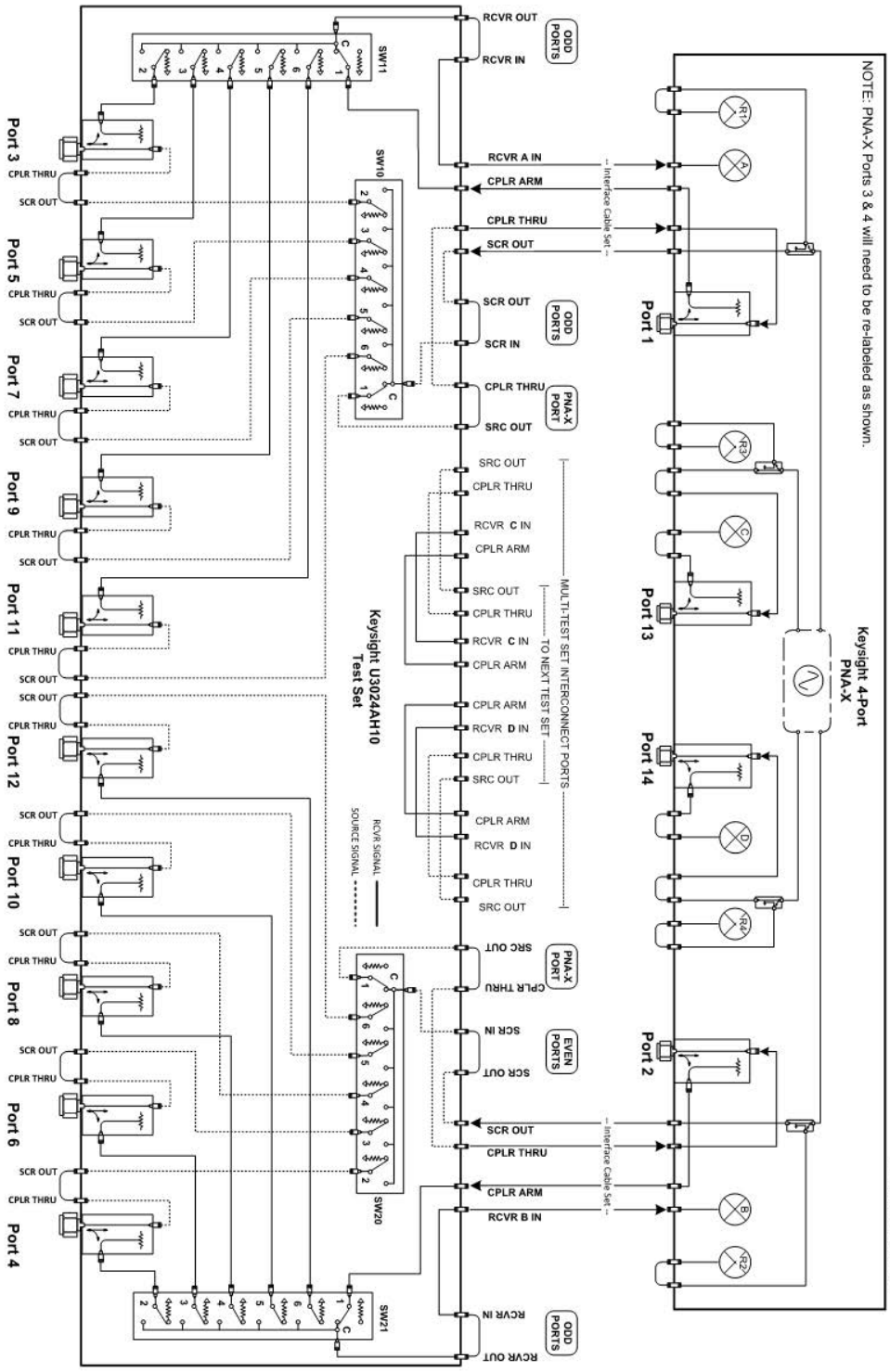


Figure 57 24-Port System Configuration

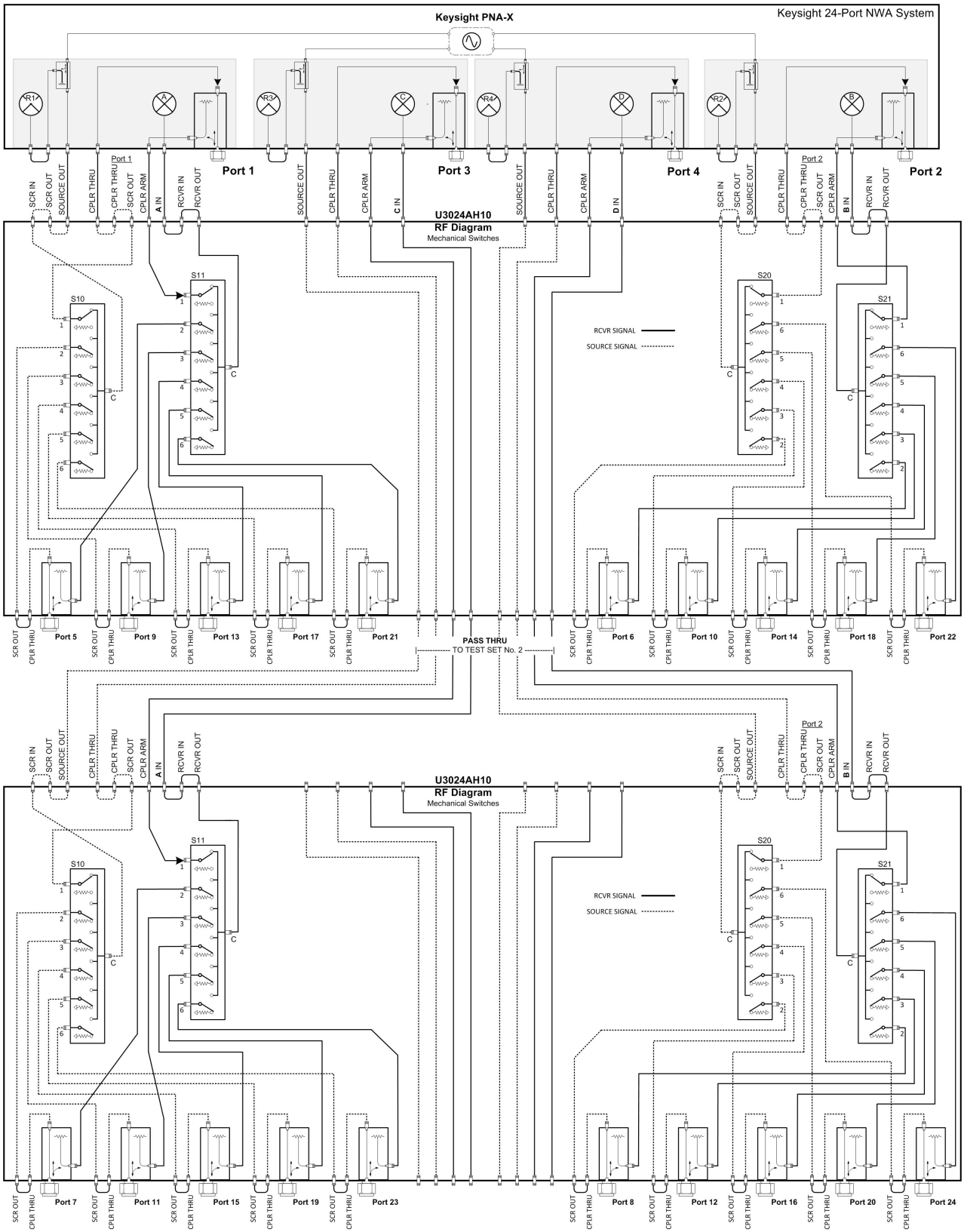


Figure 58 2-Way High Power Configuration (1 Watt)

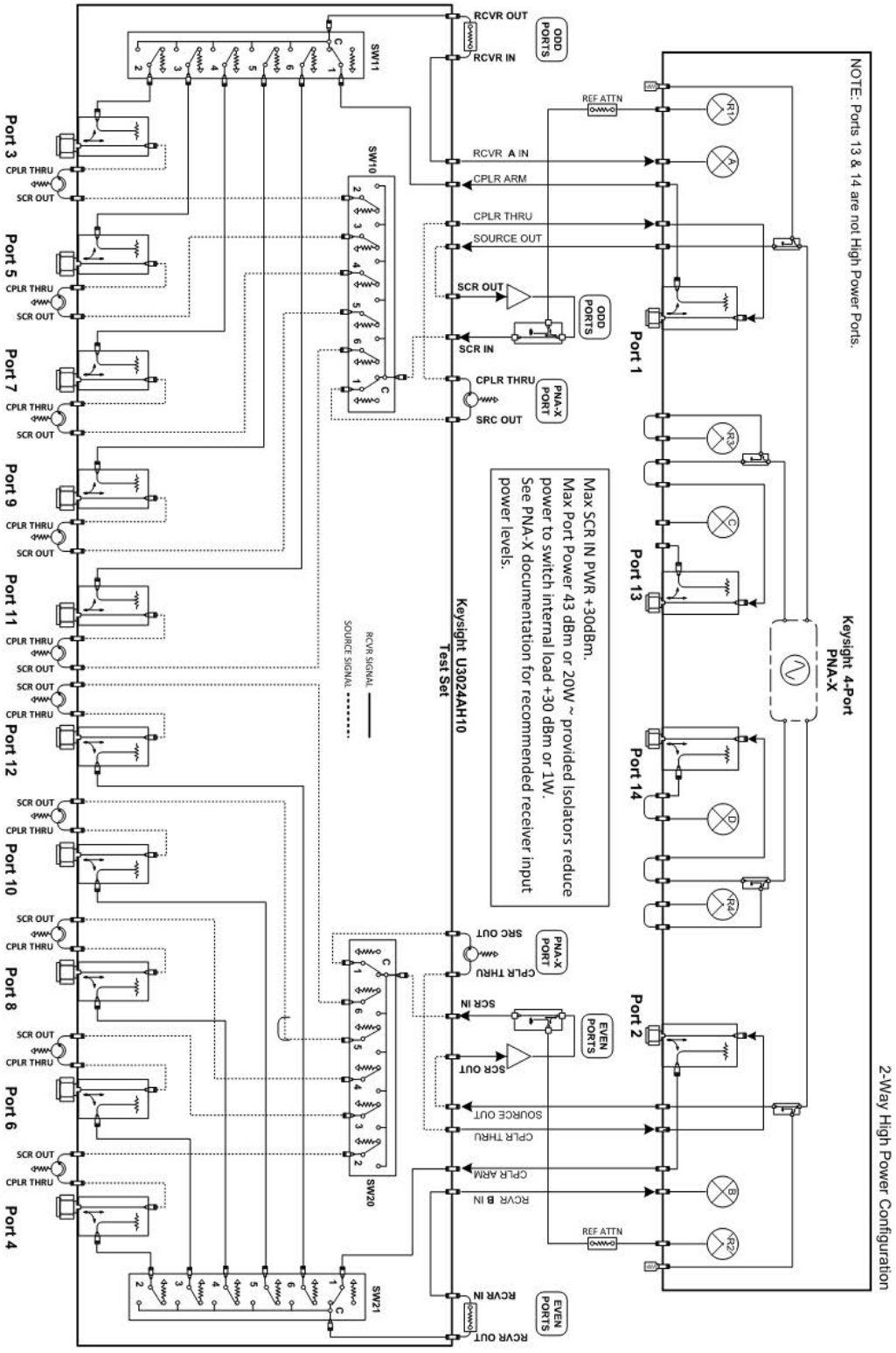


Figure 59 Odd Port High Power Configuration (1 Watt)

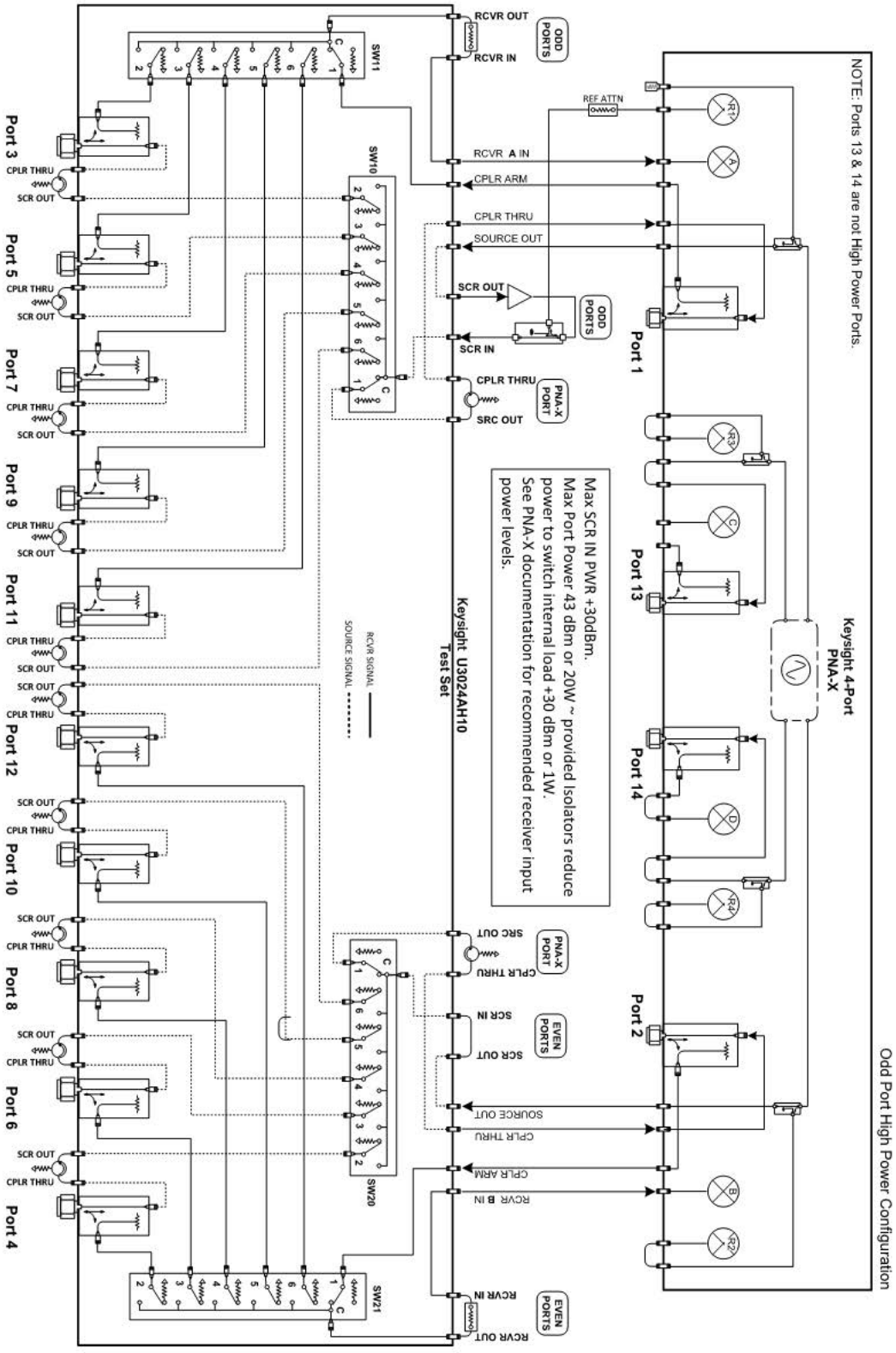
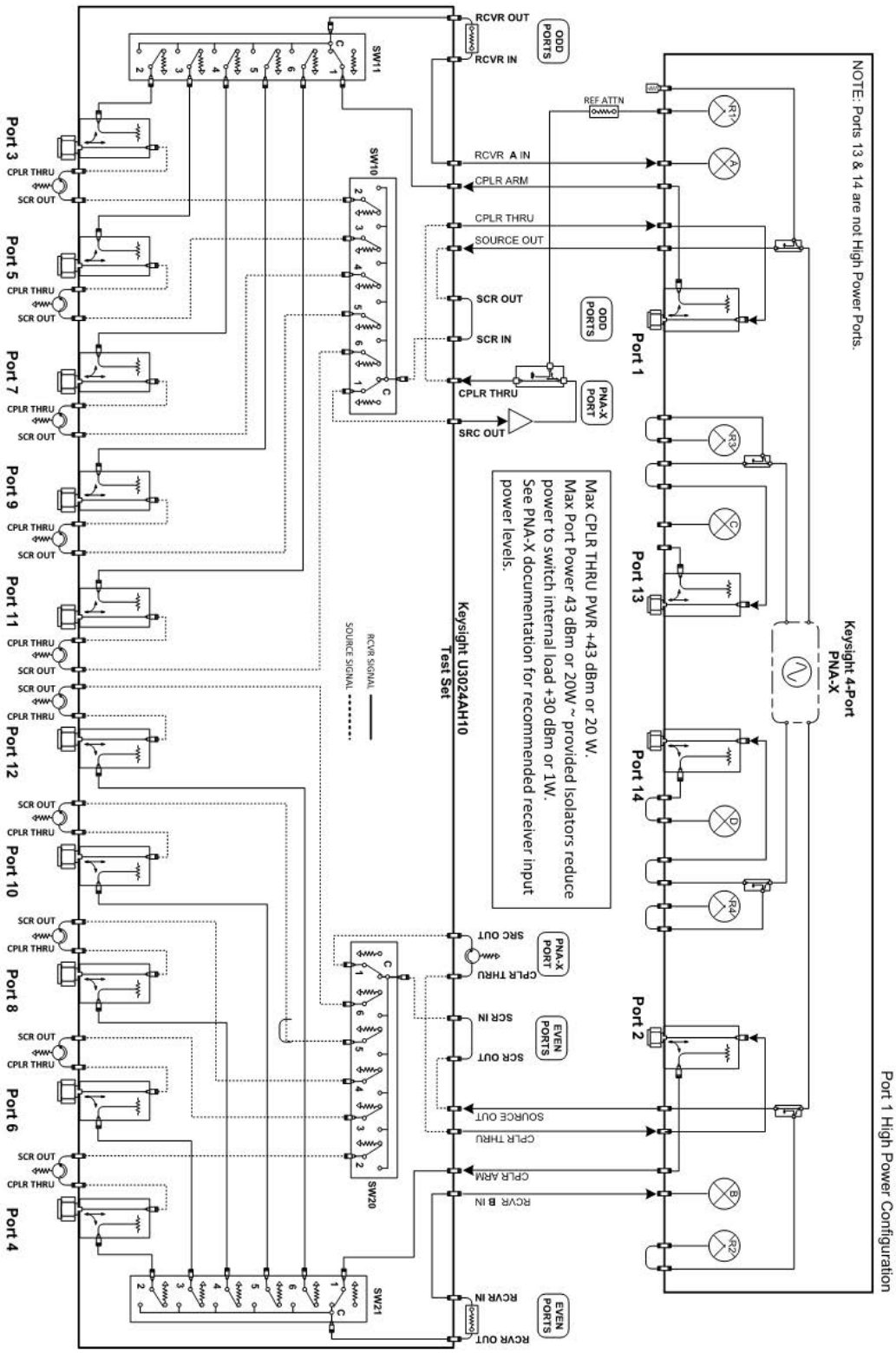


Figure 60 Port 1 High Power Configuration (1 Watt)



Troubleshooting the Test Set

If the U3024AH10 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.tm.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 www.keysight.com/find/service.

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 99.

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

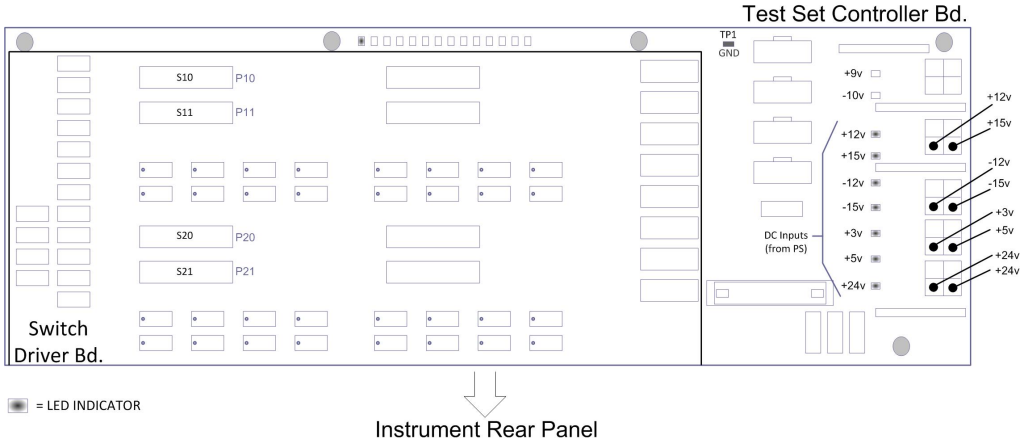
Fan is not Operating

Suspect a power supply problem or failed fan, and perform the following troubleshooting.

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 being opened.**

1. Verify the front panel power switch (3101-4058) is operational.
2. Verify that the AC line voltage is correct (100 to 240 V at 50/60 Hz) and that the power cord is not damaged. If the power cord is damaged, replace it. If the AC line voltage is incorrect, use another receptacle.
3. Verify that the fuse (2110-0709) in line module is not blown. There is a spare fuse in the line module. Refer to Figure 5 on page 14. If the fuse is working, continue to step 4.
4. Remove the top cover. Verify that the supply LED indicators, on the test set control board (N5261-60006) are illuminated (Figure 61 below). The +9 and +10 V supplies will not be on. If the LEDs are illuminated, replace the fan (87050-60027). Refer to Figure 68 on page 91.

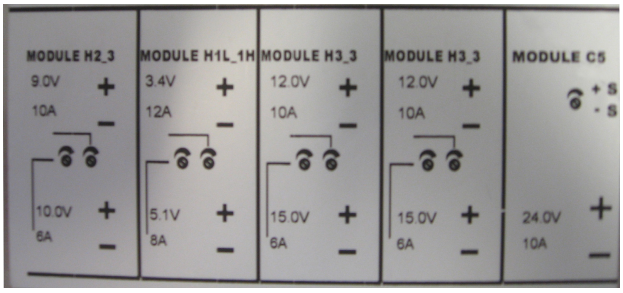
Figure 61 DC Power LEDs



5. If the LEDs are off, verify the voltages (+24, +5, +3, -15, -12, +15 and +12 Volt) on the Test Set Controller board. If the voltages are not correct, verify that J11 - J14 cables are connected correctly on both the power supply and controller board. Refer to Figure 68.

6. If the J11 - J14 cables are connected properly, measure the voltages on the power supply screw terminals. See the power supply voltages in Figure 55 below.

Figure 62 Power Supply



7. If power supply voltages are not present, verify and/or replace the two 8 amp fuses (2110-0342) in the line fuse assembly. Refer to Figure 69 on page 92.

   a. If the fuses are correct, replace the power supply (0950-4729).

Front Panel LEDs (R, S, or Active) are not Illuminated

If the Test Set fan and power supplies are operating the following procedures can be used to verify the failure. Suspect the Test Set Controller Board (N5261-60006) or Front Panel LED Assembly (N5261-60005).

1. Verify the Test Set I/0 cable (8120-6818) is installed correctly. See Figure 12 on page 19.
2. Using 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 4.
3. Using the I/O command values, confirm the correct address and data values are used. Refer to "Address and Data Values" on page 45.
4. Remove the top cover. Verify that the supply LED indicators, on the test set control board (N5261-60006), are illuminated. The +9 and +10 V supplies will not be on.
5. If the LEDs are off, verify the voltages (+24, +5, +3, -15, -12, +15 and +12 Volt) on the Test Set Controller board. If the voltages are not correct, verify that J11 - J14 cables are connected correctly on both the power supply and controller board. Refer to "Fan is not Operating" on page 81.
6. Verify at least one of the status LEDs is on. If not, replace the controller board (N5261-60006).
7. If the controller board status LEDs are on, and the Active LED is on, suspect the front panel LED boards (N5261-60005) or the ribbon cables (N5261-60001). If only one set of front panel LEDs are not working, connect the ribbon cable from one of the working front panel LED boards to the front panel LED board assembly that is not working. Replace if necessary.

Test Ports are not Switching

If the test ports are not switching, the following procedures can be used to verify the failure. The procedures assume power supplies, controller board and front panel LEDs are working. Suspect the switch interface board (U3025-60062), ribbon cable connection or coax switch (87106-60043).

1. Inspect the ribbon cable connections from the test port switches to the Switch Interface board (U3025-60062).
2. Send a test set I/O command and verify that the mechanical switches are make a clicking sound. If there is no sound, replace the Switch Interface board (U3025-60062) or the suspected switch (87106-60043).
3. If the switches are operating, send a Test Set I/O command to verify the path for each port. See "Address and Data Values" on page 45.
4. Substitute a known good switch, or connect a known good ribbon cable to a suspect switch and retest. Replace if necessary.

Source and Receiver Path Checks

If you suspect an RF signal path problem is within the Test Set, the following procedure is provided to check all RF signal paths through the Test Set using your PNA-X. 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' shape jumper cables to Ports 1 and 2.
- Ensure all sixteen front panel Test Set 'U' jumper cables are installed.
- You will need two 40 GHz 2.4 mm RF Flex cables and a 2.4 mm (f/f) adapter.

Equipment Setup

- Power ON the Test Set and the PNA.
- Preset the PNA to "Standalone Mode."
- Confirm the frequency range is set to 10 MHz - 40 GHz.
- Connect RF Flex cables to PNA Ports 1 and 2. Connect the cables together with a 2.4 mm adapter.
- Configure the PNA to measure S21 and normalize the response trace.
- Set the PNA to "Interface Control Mode" with the front panel keys: Channel > Hardware Setup > More > Interface Control... , select "Enable Interface Control" box.

NOTE The <addrs>.<data> entries noted in the following Test Instructions table (Table XX below) will be used to configure the RF switches for this testing. After making your entry, select **<OK>** to execute the command. To return 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, as shown in the following Test Instruction tables (Tables 24 to 28). An uncorrected response trace should be displayed that resembles the S21 response similar to those indicated in the table.

Table 23 RF Signal Path Insertion Loss (S21) Summary

RF Path Description	Signal	Insertion Loss (Typical)
SRC OUT to Ports 3-12	Source	Figure 63
RCVR A/B IN to Ports 3-12	Receiver	Figure 64
SRC IN to CPLR THRU	Source	Figure 65
A/B IN to CPLR ARM	Receiver	Figure 65
Pass Thru Access Ports	Source/Receiver	Figure 66

Source Signal Path Insertion Loss Test

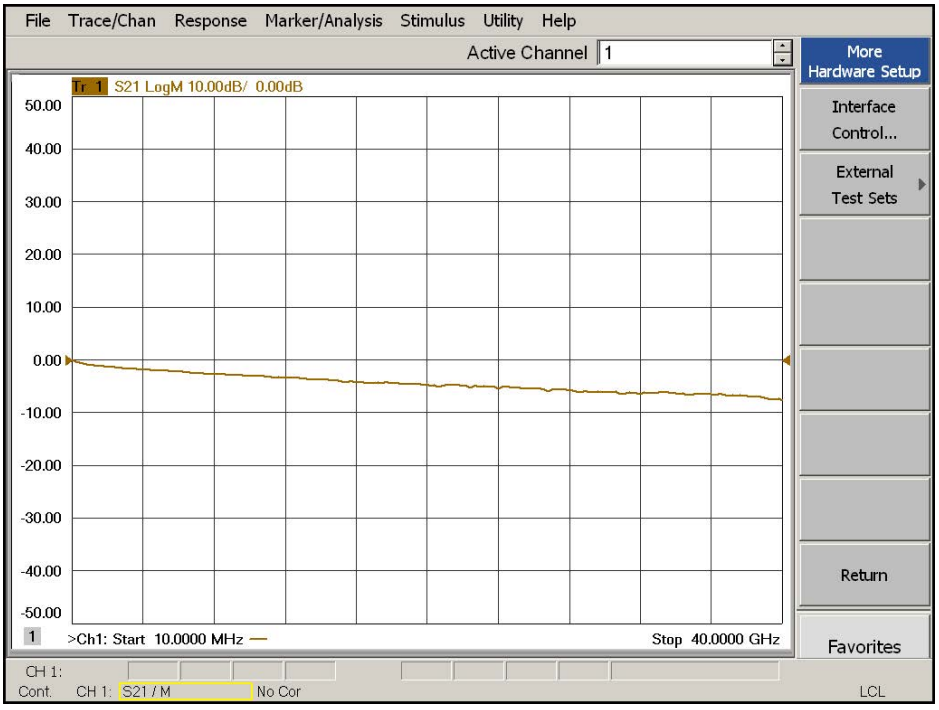
Connect the RF Flex cables to a front panel test port and Source OUT access port as indicated in Table 24 below and check that the S21 response is similar to Figure 63 below.

Table 24 Source Signal Path Test Instructions

Path #	RF Path Description	Control Mode Entry <addrs>.<data>	Path Components	Insertion Loss (Typical)
	Left Side (Odd Ports)			
1	SRC OUT to Port 3 [1]	0.1	P3 CPLR, S10	Figure 63
2	SRC OUT to Port 5	0.2	P5 CPLR, S10	
3	SRC OUT to Port 7	0.3	P7 CPLR, S10	
4	SRC OUT to Port 9	0.4	P9 CPLR, S10	
5	SRC OUT to Port 11	0.5	P11 CPLR, S10	
	Right Side (Even Ports)			
6	SRC OUT to Port 4	16.1	P4 CPLR, S20	Figure 63
7	SRC OUT to Port 6	16.2	P6 CPLR, S20	
8	SRC OUT to Port 8	16.3	P8 CPLR, S20	
9	SRC OUT to Port 10	16.4	P10 CPLR, S20	
10	SRC OUT to Port 12	16.5	P12 CPLR, S20	

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

Figure 63 SRC OUT to Ports 3-12 Path Response



Receiver Signal Path Insertion Loss Test

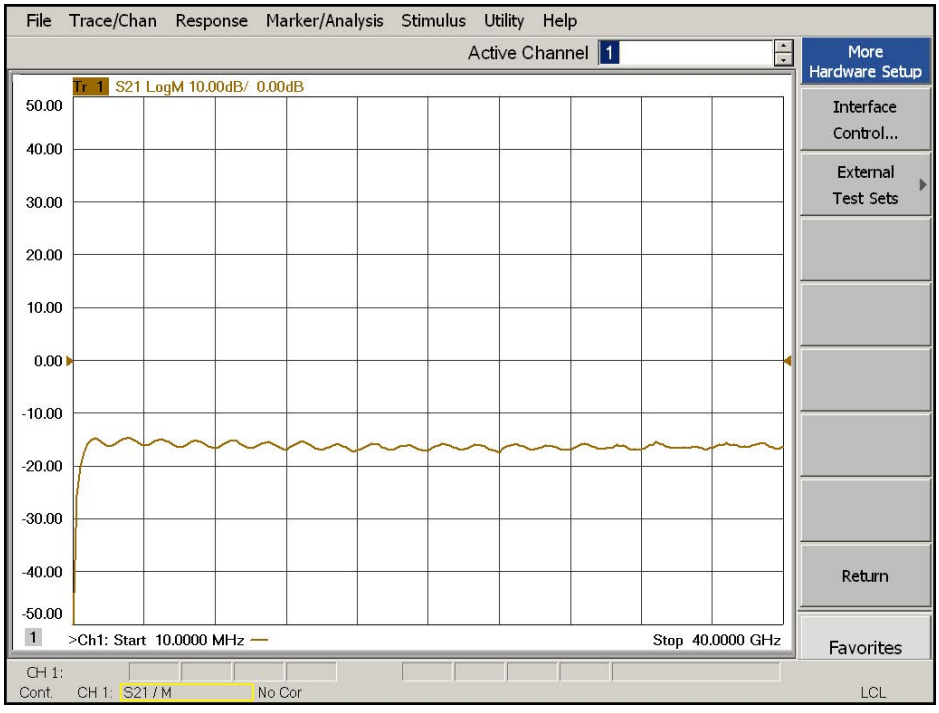
Connect the RF Flex cables to the test port and RCVR A/B IN ports as indicated in Table 25 below and check that the S21 response is similar to Figure 64 below.

Table 25 Receiver Signal Path Test Instructions

Path #	RF Path Description	Control Mode Entry <addrs>.<data>	Path Components	Insertion Loss (Typical)
	Left Side (Odd Ports)			
1	RCVR A IN to Port 3 [1]	0.16	P3 CPLR, S11	Figure 64
2	RCVR A IN to Port 5	0.32	P5 CPLR, S11	
3	RCVR A IN to Port 7	0.48	P7 CPLR, S11	
4	RCVR A IN to Port 9	0.64	P9 CPLR, S11	
5	RCVR A IN to Port 11	0.80	P11 CPLR, S11	
	Right Side (Even Ports)			
6	RCVR B IN to Port 4	16.16	P4 CPLR, S21	Figure 64
7	RCVR B IN to Port 6	16.32	P6 CPLR, S21	
8	RCVR B IN to Port 8	16.48	P8 CPLR, S21	
9	RCVR B IN to Port 10	16.64	P10 CPLR, S21	
10	RCVR B IN to Port 12	16.80	P12 CPLR, S21	

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

Figure 64 RCVR A/B IN to Ports 3-12 Path Response



Source Bypass Signal Path Insertion Loss Test

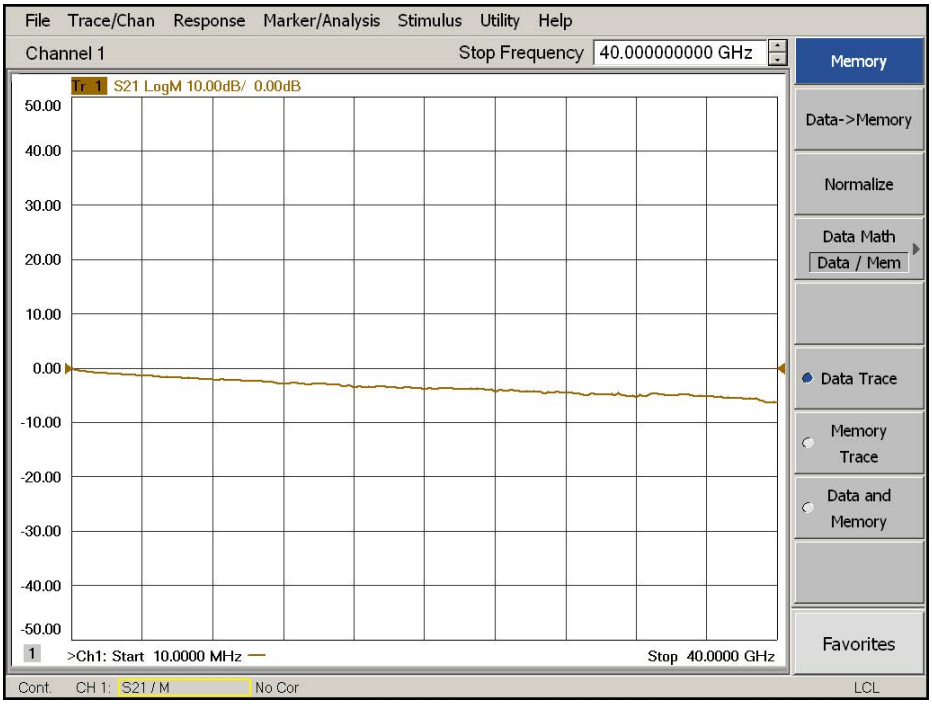
Connect the RF Flex cables to the SRC OUT and CPLR THRU ports as indicated in Table 26 below and check that the S21 response is similar to Figure 65 below.

Table 26 Source Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode Entry <addrs>.<data>	Path Components	Insertion Loss (Typical)
1	Left Side (Odd Ports)	SRC OUT to CPLR THRU [1]	0.0	S10	Figure 65
2	Right Side (Even Ports)	SRC OUT to CPLR THRU	16.0	S20	

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

Figure 65 Source and Receiver Bypass Path Response



Connect the RF Flex cables to the receiver A/B IN and CPLR ARM ports as indicated in Table 27 below and check that the S21 response is similar to Figure 65 above.

Table 27 Receiver Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode Entry <addrs>.<data>	Path Components	Insertion Loss (Typical)
1	Left Side (Odd Ports)	RCVR A IN to CPLR THRU [1]	0.0	S11	Figure 65
2	Right Side (Even Ports)	RCVR B IN to CPLR THRU	16.0	S21	

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

Pass Thru Access Ports Signal Path Insertion Loss Test

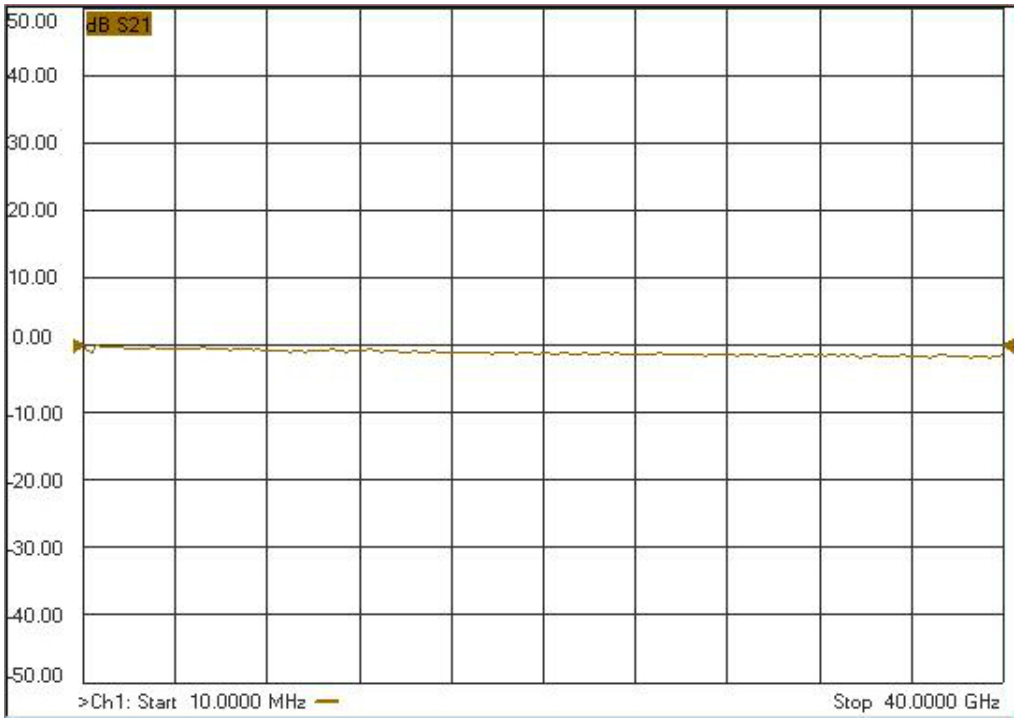
Connect the RF Flex cables to each of the eight pairs of Pass Thru ports as indicated in Table 28 below and check that the S21 response is similar to Figure 66 below.

Table 28 Pass Thru Access Port Signal Path Test Instructions

Path #	RF Path Description	Path Components	Insertion Loss (Typical)
	Left Side (Odd Ports)		
1	RCVR C IN to RCVR C IN[1]	Internal Cable	Figure 66
2	CPLR ARM to CPLR ARM		
3	CPLR THRU to CPLR THRU		
4	SRC OUT to SRC OUT		
	Right Side (Even Ports)		
5	RCVR D IN to RCVR D IN	Internal Cable	Figure 66
6	CPLR ARM to CPLR ARM		
7	CPLR THRU to CPLR THRU		
8	SRC OUT to SRC OUT		

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

Figure 66 Pass Thru Access Ports Path Response



RF Performance Fails

If the U3024AH10 operates correctly, but RF performance fails the operational test. The following procedures can be used to isolate the failed component. Suspect the coax switches (87106-60043), RF cables, or coupler (5087-7722).

NOTE **The RF performance of the U3024AH10 depends on the performance of the PNA. Ensure the PNA is meeting specification before continuing.**

1. Verify that the test set and PNA SOURCE, RCVR, CPLR THRU, and CPLR ARM connectors are clean and that the center pins are not damaged.
2. Verify the interface and internal RF cables are clean and not damaged. "Verifying Operational Check Failures" on page 71.
3. Review the "Operational Check (ECal)" on page 64 and verify the results for the port that is failing.
4. Reflection tracking trace shows a power hole, or is below the test limit line, perform the switch path test for the port that is failing. Refer to "Operational Check (ECal)" on page 64.
5. Directivity trace fails (above -10dB), replace the coupler (5087-7722).
6. Source or load match fails (above -10 dB), replace the coax switch (87106-60043).
7. Isolation is poor between ports, inspect the RF connections. If it continues to fail, replace the coax switch (87106-60043). The RF cables require proper torque (10 in-lb) and can be damaged by overtightening.

Control Lines are not Working

If the Test Set operates correctly but the control lines are not functioning, the following procedures can be used to verify the component failure. Suspect the DUT CONTROL BD (E5091-66503).

1. Verify that you are not in 24-Port Multiport mode.
2. Verify that the control voltage pins on the DUT control are connected correctly. Refer to "Setting the Control Lines with Address and Data Values" on page 48.
3. Verify that the control pot is centered (5V). Refer to Figure 4 on page 13.
4. Verify the ribbon cable connection.
5. Replace the DUT control board (E5091-66503).
6. Replace the test set control board (N5261-60006).

Figure 67 Test Set Electrical Diagram

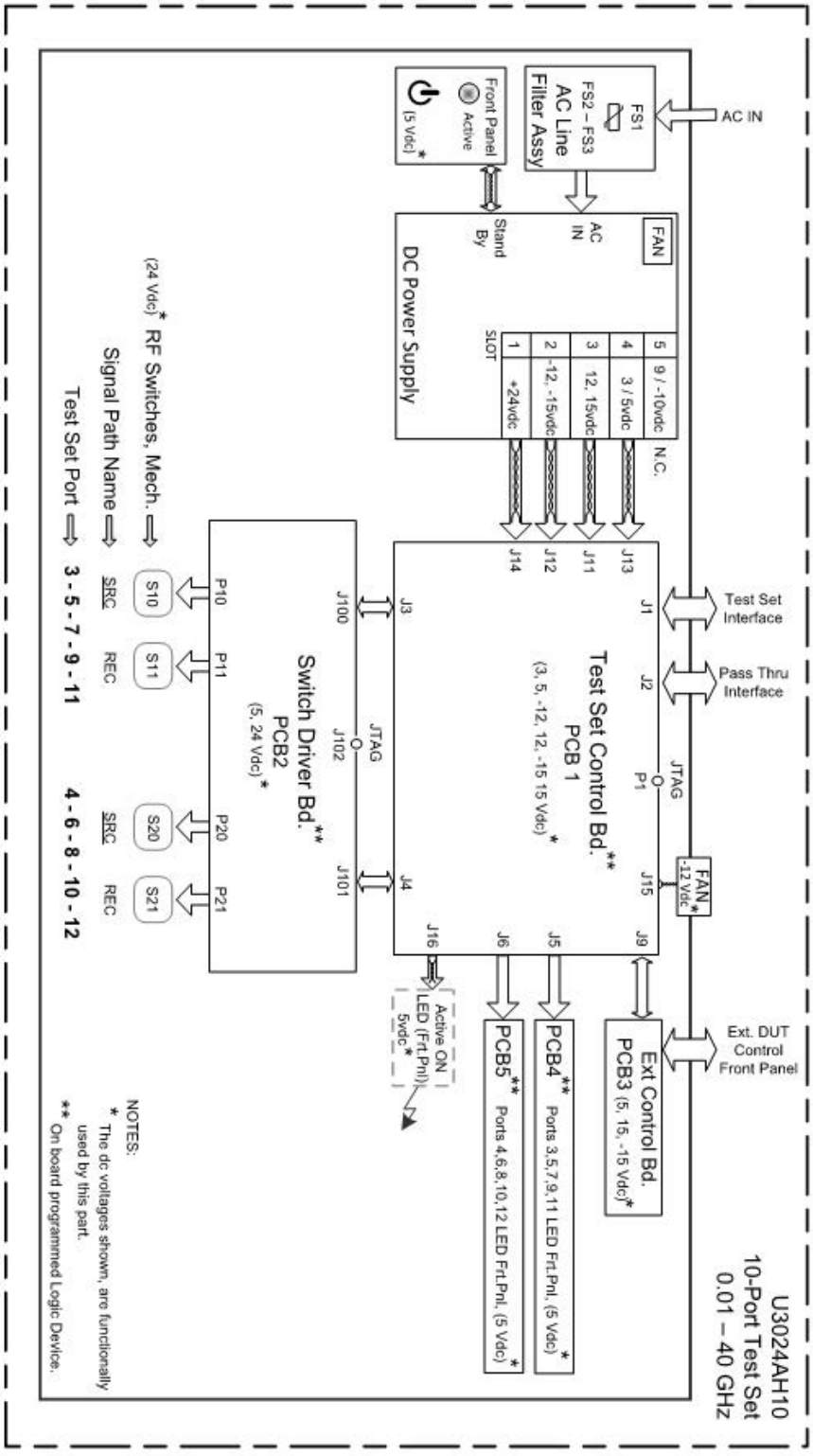


Figure 68 Top View

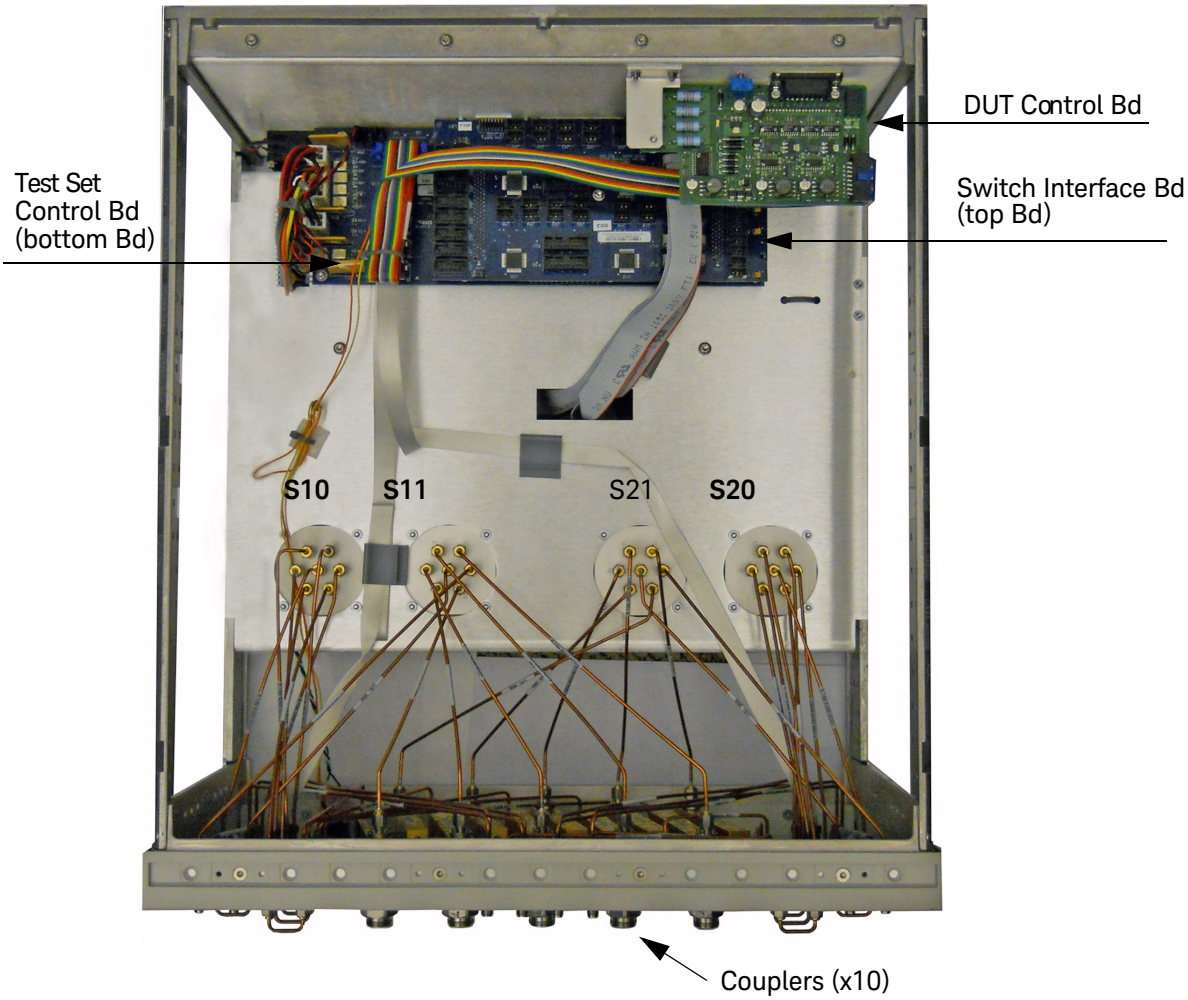
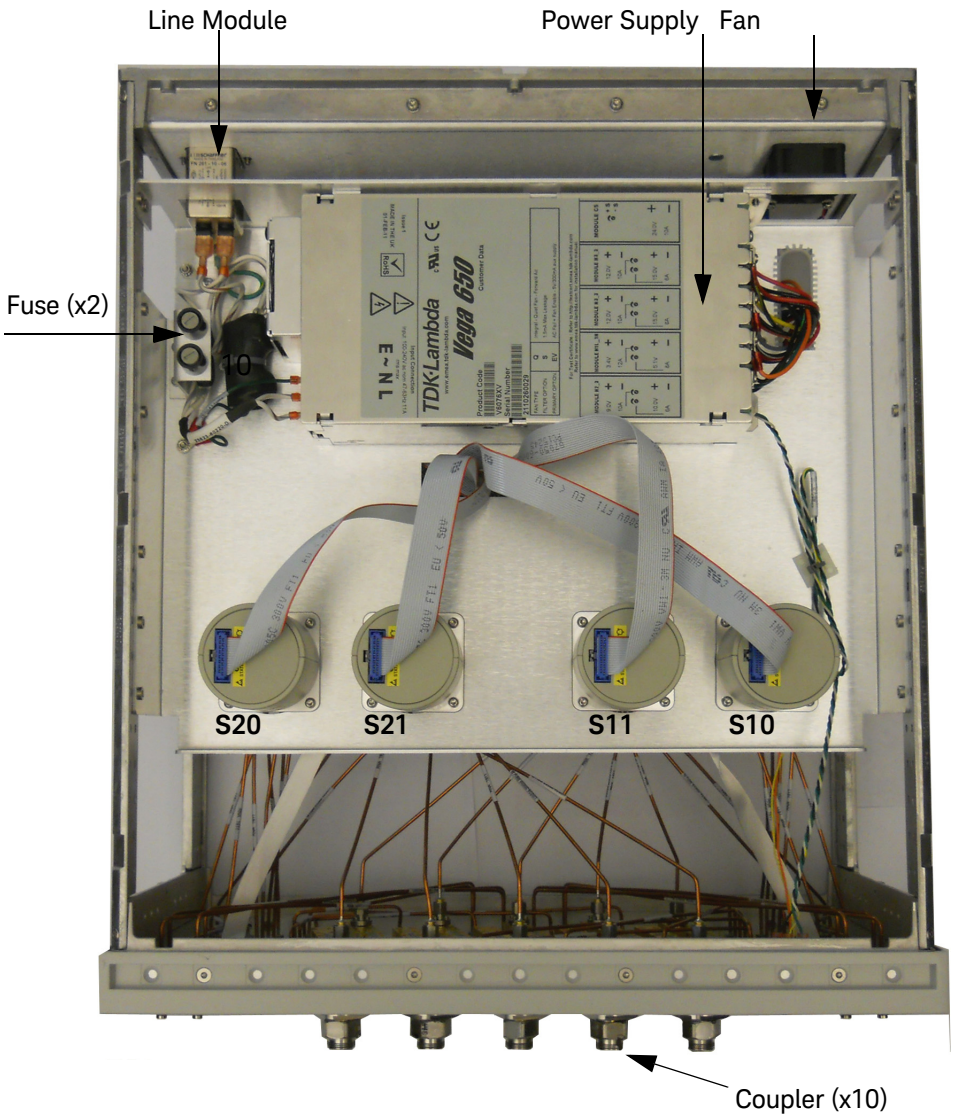


Figure 69 Bottom View



Safety and Regulatory Information

Introduction

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

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 inserted only into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the product, is likely to make the product dangerous. Intentional interruption is prohibited.**

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

Declaration of Conformity

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

Statement of Compliance

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

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

Servicing

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).**

Connector Care and Cleaning Precautions

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

WARNING **To prevent electrical shock, disconnect the Keysight Technologies U3024AH10 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.**

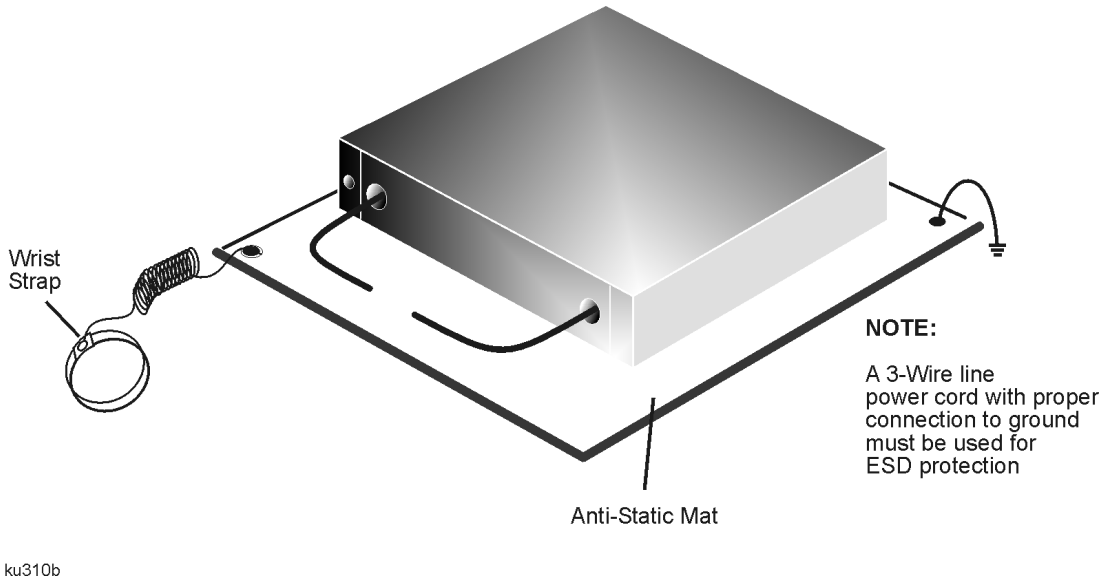
WARNING **If flammable cleaning materials are used, the material shall not be stored, or left open in the area of the equipment. Adequate ventilation shall be assured to prevent the combustion of fumes, or vapors.**

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 70 ESD Protection Setup



Regulatory Information

Instrument Markings

Listed below are definitions of markings that may be found on or with 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.

This symbol indicates that the input power required is AC.

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

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 marking is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all relevant directives.

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.

ISM1-A

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

ICES/NMB-001

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.

China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.

Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.

South Korean Certification (KC) mark. It includes the marking's identifier code in the format shown.

Battery Collection

Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Keysight Technologies for disposal. Refer to "Contacting Keysight" on page 99 for assistance.

EMC Compliance

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

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, Class A
- AS/NZS CISPR 11
- ICES/NMB-001
  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

This instrument complies with the essential requirements of the European Low Voltage Directive.

Acoustic Statement (European Machinery Directive)

Acoustic noise emission
LpA <70 dB
Operator position
Normal operation mode per ISO 7779

To find a current Declaration of Conformity for a specific Keysight product, go to:
https://regulations.about.keysight.com/DoC/default.htm

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 on the Internet 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

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

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

- To improve turn-around time, return your instrument along with your PNA-X 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 5, April 2022
Supersedes: January 2020

U3024-90001

KEYSIGHT TECHNOLOGIES

U3024-90001
www.keysight.com