Keysight Technologies U3022AE10 Multiport Test Set Extension

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KEYSIGHT TECHNOLOGIES

User's and Service Guide

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Extension User's and Service Guide

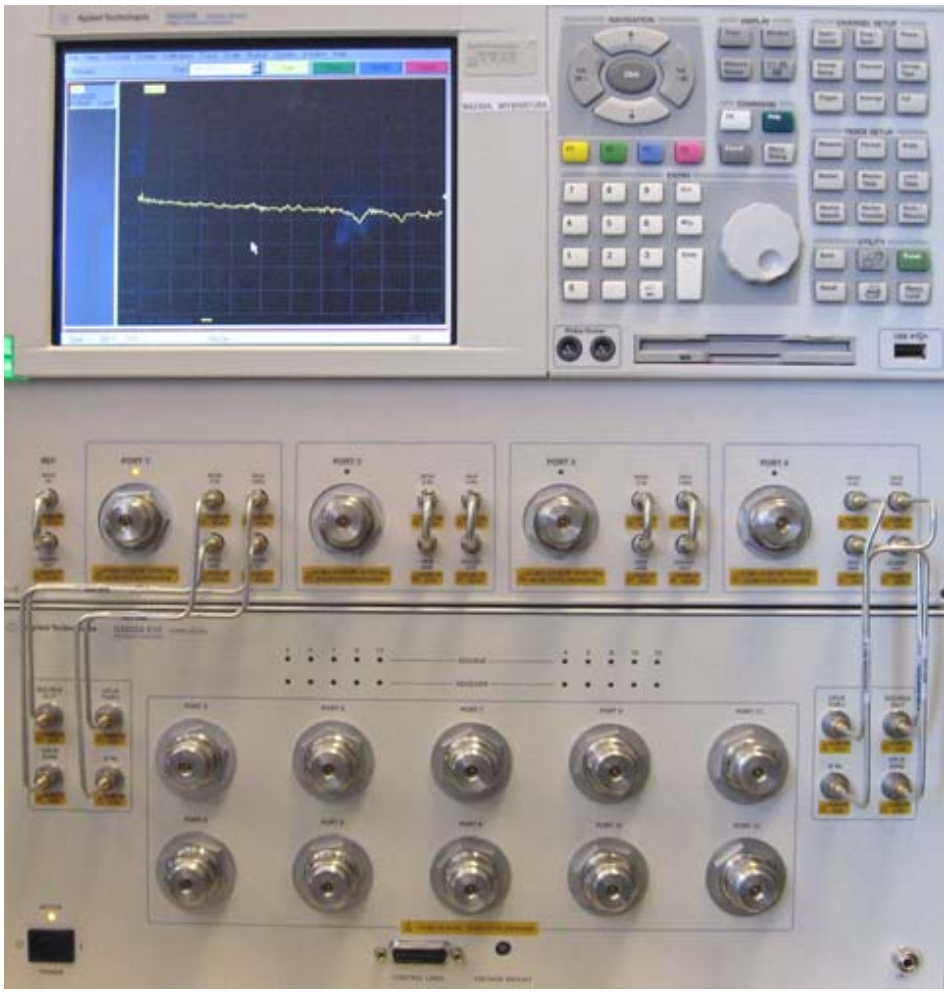
U3022AE10

KEYSIGHT TECHNOLOGIES

Introduction

This document describes how to use and service the U3022AE10 Multiport Test Set.

Figure 1 4-Port PNA-L with U3022AE10*

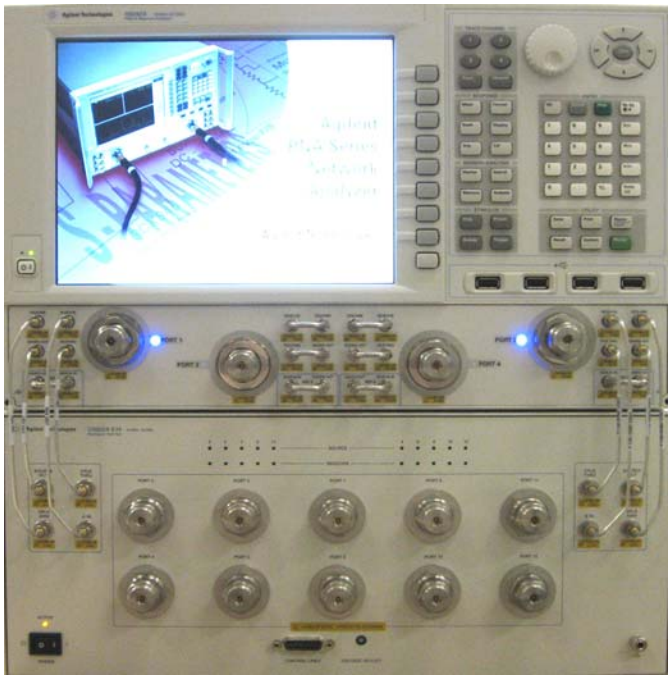


* Shown in older color format.

Figure 2 2-Port PNA-X with U3022AE10*

* Shown in older color format.

Figure 3 4-Port PNA-X with U3022AE10*



* Shown in older color format.

Description

The U3022AE10 is a Multiport Test Set designed to be configured with a 2 or 4-Port PNA, PNA-L or PNA-X for a 12 or 14-Port network analyzer measurement system.

- 10 test ports (3.5 mm male connectors)
- Low Loss Mechanical RF switching
- Frequency Range of Operation:
  - 300 kHz - 20 GHz (Standard Opt 700)
  - 10 MHz - 20 GHz (Opt 001 or 002)
  - 300 kHz - 26.5 GHz (Opt 026)
  - Test Set I/O interface for operational control. An external personal computer is not required.

The network analyzers will be referred to throughout this document as the PNA, PNA-L or PNA-X. Analyzer will be used for general information that pertains to all of the network analyzers. The U3022AE10 will be referred to as the test set.

NOTE The "B" Model analyzers have the darker Keysight color format. The Test Set color format has changed to match this Keysight color.

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 94. Keep the damaged shipping materials (if any) for inspection by the carrier and a Keysight Technologies representative.

Measurement Application Note

Low Loss DUT Measurements

Low loss trace ripple is a product of RF switch repeatability and calibration technique. Low insertion loss measurements may exhibit uncertainty ripple residing on the measurement response. Due to a different number of RF switches in each test port signal path, the maximum cumulative switch repeatability you may experience for a system test port is indicated in Table 1 below.

Table 1 Test Port Repeatability Maximums (dB)

Test Port	300 KHz - 26.5 GHz
1 - 12	0.06

Switch Configuration Command Speed

When writing address and data values to the test set directly, include a 15 ms wait before issuing another address and data set. The delay of 15 ms 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.

PNA and PNA-X Receiver Compression Note

Systems configured with PNA or PNA-X series Network Analyzers will show compression at the beginning of the frequency range when power level is increased. Typically, this will occur when power level is increased above 5dBm. This occurs because the PNA and PNA-X analyzers use couplers at the test port and the multiport extension test set has a directional bridge at the test port. The PNA and PNA-X receivers are calibrated at the factory, and due to the higher coupling factor, the coupler at low frequency, the receiver gain is set high to compensate. The multiport test set directional bridge has a lower coupling factor at low frequencies, which results in compression when power level of the PNA/PNA-X is increased. We recommend you increase the receiver attenuation in the PNA and PNAX to reduce this receiver compression issue.

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 eight test ports, it is recommended to use PLTS Software N1930B to manage/control any advanced network analyzer measurement applications and their large data files.

Table 2 provides a listing of other network analyzer option requirements. The analyzer's frequency range must be equal to or exceed that of the test set so that the measurement system covers the full frequency range of the test set. The test set files indicated in Table 2 must be installed into this network analyzer file directory location: C:\Program Files (x86)\Agilent\Network Analyzer\TestSets.
For the "B" model PNA-X: C:\Program Files (x86)\Agilent\Keysight\Network Analyzer\Keysight\TestSets.

Table 2 Configuration Requirements

2-Port Network Analyzer	Series	Options	Test Set File	System Figures
N5222A/B	PNA	201, 217 or 219	U3022ae10_pnax_p2.tsx	Figure 2 on page 9
N5232A/B	PNA-L	216	U3022ae10_p2.tsx	-
N5242A/B	PNA-X	200	U3022ae10_pnax_p2.tsx	Figure 2 on page 9
4-Port Network Analyzer	**Series**	**Options**	**Test Set File**	**System Figures**
N5222A/B	PNA	401, 417 or 419	U3022ae10_pnax_p4.tsx	Figure 3 on page 9
N5232A/B	PNA-L	416	U3022ae10_p4.tsx	Figure 1 on page 8[a]
N5242A/B	PNA-X	400	U3022ae10_pnax_p4.tsx	Figure 3 on page 9

a. Figure 1 on page 8 does not show the actual analyzer, but the port configuration is similar.

Ensure the network analyzer has the latest version of firmware installed. The following web site links will provide necessary information needed:

- Network Analyzer Firmware - http://na.support.keysight.com/pna/firmware/firmware.html
- U3022AE10 Test Set Files - http://na.support.keysight.com/multiport/testsetsupport.html

Available Options

Test Set Options

The test set has four available options:
Refer to "System Block Diagrams" on page 70.

- Option 001 Adds RF amplifiers to improved dynamic range (10 MHz to 20 GHz).
- Option 002 Adds RF amplifiers and bias-tees for each of the 10 test ports (10 MHz to 20 GHz).
- Option 700 Standard, 300 kHz to 20 GHz frequency range.
- Option 026 Extended frequency range from 300 kHz to 26.5 GHz.

Rack Mounting Kits

Installation instructions are included in the option package.

- U3022AE10-1CM, Rack Mount Kit without Handles (1CM114A*) 5063-9216
- U3022AE10-1CN, Front Handle Kit (1CN103A*) 5063-9229
- U3022AE10-1CP, Rack Mount Kit with Handles (1CP106A*) 5063-9236

  * New dark color version (Keysight Palette 2015)

Network Analyzer Interface Kit Options

The U3022AE10 requires one of the following kits to interface the test set with your network analyzer. The interface kit model option includes the hardware lock-link and cable kit listed in Table 3.

Table 3 Interface Kit Options

12-Port System	Interface Kit Option	Hardware Lock-link Kit	Cable Kit - Conn. Type
N5222A/B Opt 201, 217 or 219 (PNA)	U3021PN3-242	U3021-60002[c]	U3021-60016, SMA m/m[d]
N5242A/B Opt 200 (PNA-X)	U3021PN3-242	U3021-60002[c]	U3021-60016, SMA m/m[d]
14-Port System	**Interface Kit Option**	**Hardware Lock-link Kit**	**Cable Kit - Conn. Type**
N5222A/B Opt 401, 417 or 419 (PNA)	U3021PN3-242	U3021-60002[c]	U3021-60016, SMA m/m[d]
N5232A/B Opt 416 (PNA-L)	U3021PN3-430	U3021-60001[a]	U3021-60015, SMA m/m[b]
N5242A/B Opt 400 (PNA-X)	U3021PN3-242	U3021-60002[c]	U3021-60016, SMA m/m[d]

a. Refer to "Hardware Lock-link Kit Installation (U3021-60001)" on page 21.
b. Refer to "N5232A/B RF Interface Cable Connections" on page 27.
c. Refer to "Hardware Lock-link Kit Installation (U3021-60002)" on page 24.
d. Refer to "N5222A/B and N5242A/B RF Interface Cable Connections" on page 29.

General Specifications

Specifications for the test set are characteristic for the system performance of the network analyzer and the test set. Actual performance of the system is based on the customer's network analyzer and options that are used with the test set. A functional certificate is only offered for the test set.

An N-Port calibration should be performed for optimum measurement accuracy.

A periodic calibration is not required. The Operators Check should be performed after System Setup, or if performance is in question.

When connected to an analyzer, this test set will degrade the performance at the test ports. The internal switch paths reduce test port power to the receivers. This affects the test port power of the analyzer and also reduces dynamic range. The reflection tracking values measured in the "Cal Kit Operational Check" on page 60 can be subtracted from the analyzers dynamic range to determine the approximate performance of the system.

Power Requirements

Verify that the required AC power is available before installing the test set to the PNA.

- 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 analyzer.
- U3022AE10 maximum power is 350 W.

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 your network analyzer's standard documentation for environmental requirements.

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.

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 Measurements

Accuracy–enhanced (error–corrected) measurements require the ambient temperature of the analyzer 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 analyzer 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.

CAUTION The network analyzer is heavy. It is recommended that two individuals, or a mechanical lift be used to lift or transport the instrument.

Table 4 Instrument Dimensions

Model	Weight	Height	Width	Depth
U3022AE10	11.4 kg (25 lb)	19.1 cm (7.5 in)	42.5 cm (16.7 in)	43.2 cm (17 in)

Frequency Range and Power Levels

NOTE When the test set is configured with your network analyzer, the system frequency range of operation will be determined by the frequency range limits of this combination.

CAUTION It is recommended that you do not operate components near damage levels (+30 dBm). The power levels must be 3 dB below maximum level to ensure no damage. Do not apply any DC voltage to the Access or Test Set ports.

Table 5 Recommended Maximum Power Levels

U3022AE10 Test Port RF Power Levels:	
PORT 3-10	+27 dBm
U3022AE10 Access Ports:	
SOURCE OUT	+27 dBm
CPLR ARM	+27 dBm
CPLR THRU	+27 dBm
RCVR A IN and B IN	+12 dBm
Damage Power Levels to U3022AE10 Access and Test Ports:	
Max Level to Port 1 & 2 Test Ports	+30 dBm

NOTE Refer to your analyzer's specifications to determine the maximum input power levels for the access and test ports, or to optimize the power levels in the receivers.

NOTE Damage and maximum levels are not necessarily the optimum level.

Typical Reflection Tracking

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

NOTE Typical specifications are based on 1 to 2 units performance. Refer to Table 6 and Table 7.

Table 6 Typical Reflection Tracking PNA-L

Frequency	Standard 700	Option 001 and 002[a]	
		PNA Ports	Test Set Ports
300 kHz to 10 MHz	-1[b]	+5	+6
10 MHz to 4 GHz	-3	+4	+6
4 GHz to 6 GHz	-4	+3	+6
6 GHz to 10.5 GHz	-5	+3	+6
10.5 GHz to 13.5 GHz	-6	+3	+6
13.5 GHz to 15 GHz	-7	+4	+6
15 GHz to 20 GHz	-8	-2	0

a. Low end is limited to 10 MHz.
b. Generally improves at 3 MHz to -6 dB.

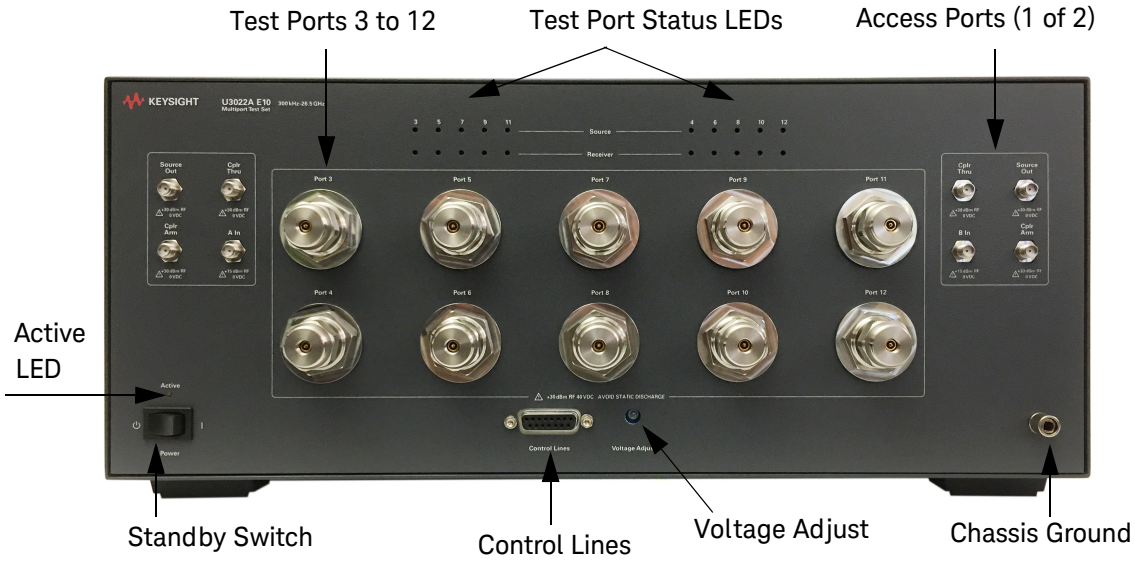
Table 7 Typical Reflection Tracking PNA and PNA-X

Frequency	Standard 700	Option 001 and 002[a]	
		PNA Ports	Test Set Ports
10 MHz to 50 MHz	-1	+7	+8
50 MHz to 500 MHz	-2	+7	+8
500 MHz to 3.2 GHz	-3	+5	+3
3.2 GHz to 10 GHz	-5	+3	+2
10 GHz to 16 GHz	-7	+3	+2
16 GHz to 20 GHz	-8	-2	-3
20 GHz to 24 GHz	-10	-	-
24 GHz to 26.5 GHz	-12	-	-

a. Upper end is limited to 20 GHz.

Front and Rear Panel Features

Figure 4 U3022AE10 Front Panel



Test Ports 3.5 mm (male) Port 3 - 12

Test Port Status LEDs An illuminated LED indicates an active port in Source or Receiver mode. On the front panel “S” indicates Source test ports and “R” indicates Receiver test ports.

Access Ports – SMA Bulkhead (female)

- CPLR ARM
- SOURCE OUT
- CPLR ARM
- A IN
- B IN

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).

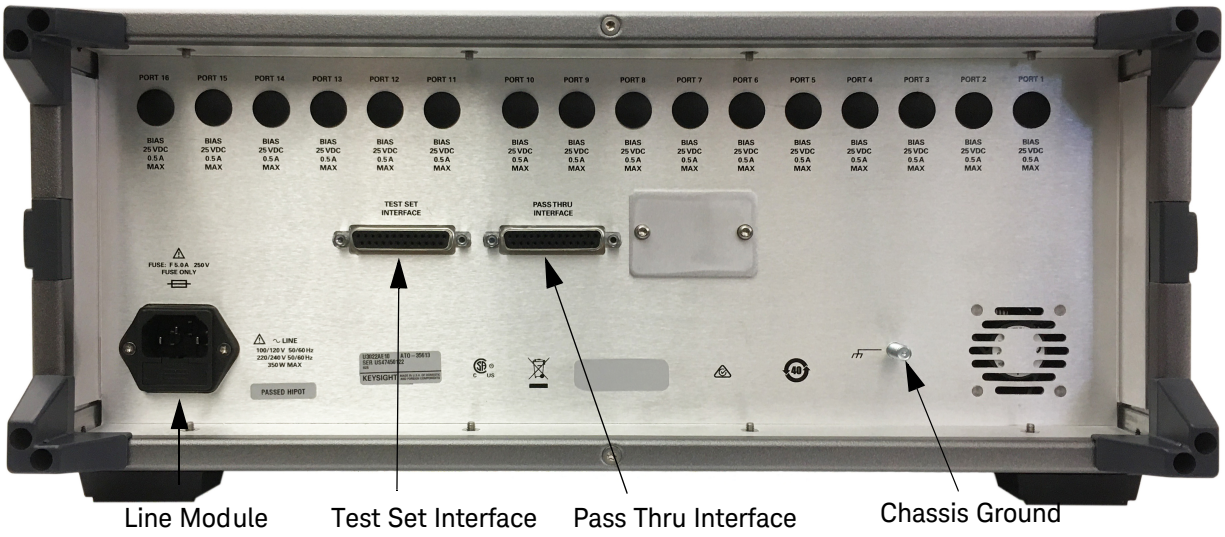
Control Lines and Voltage Adjust For further information pertaining to control lines and voltage adjustments see “Control Lines” on page 54.

Standby Switch The switch is only a Standby switch, not a AC line power switch.The main power cord can be used as the system disconnecting device. It disconnects the mains circuits from the mains supply.

Active LED When the Test Set is connected and addressed by a PNA-X, the LED is ON (illuminated). The LED is OFF (not illuminated) when the Test Set is in Standby, or not addressed by the PNA-X.

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

Figure 5 U3022AE10 Rear Panel



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).

Pass Through Interface Connection to another test set.

Test Set Interface The Test Set I/O connector is used to send address and data to the test set from the network analyzer.

Line Module This assembly houses the line cord connection, line fuse, and line voltage selector. Remove the line module cover to replace or change the fuse. Line voltage selection is automatic and no setting is required.

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.

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

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

Figure 6 Line Module and Fuse

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

Hardware Lock-link Kit Installation (U3021-60001)

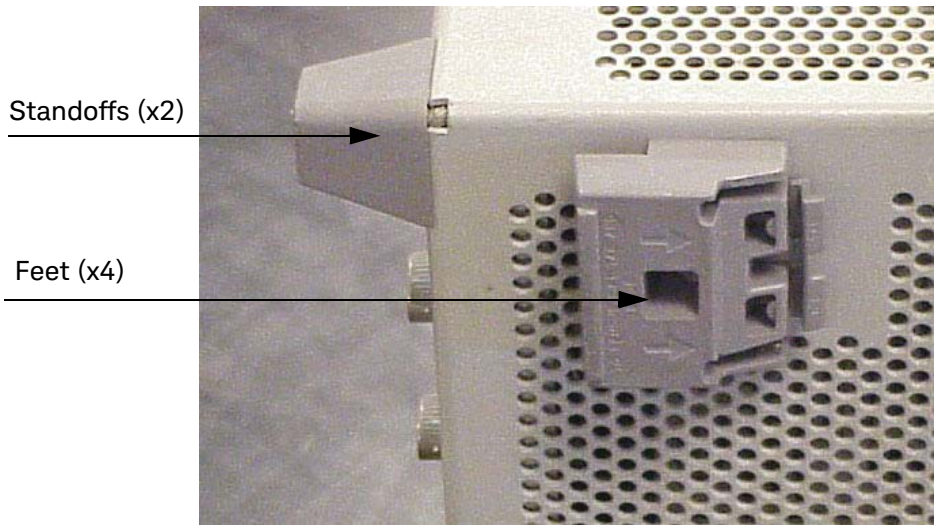
If your system is to be rack mounted, this installation procedure does not have to be performed.

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.**

Locking the Test Set to the PNA-L

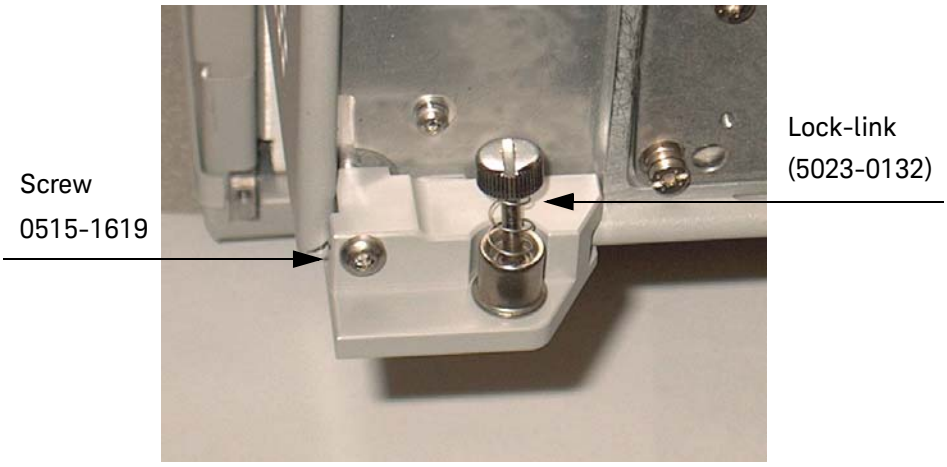
1. The lock-link kit (U3021-60001) includes items to mechanically interface the test set to the analyzer.
2. Remove the feet from the bottom of the analyzer.
3. Remove the 2 lower standoffs from the rear panel on the analyzer.

Figure 7 Rear Bottom Feet



4. Install the two rear lock-links (5023-0132) onto the PNA-L, where the standoffs were removed.

Figure 8 Install Lock-links to PNA-L

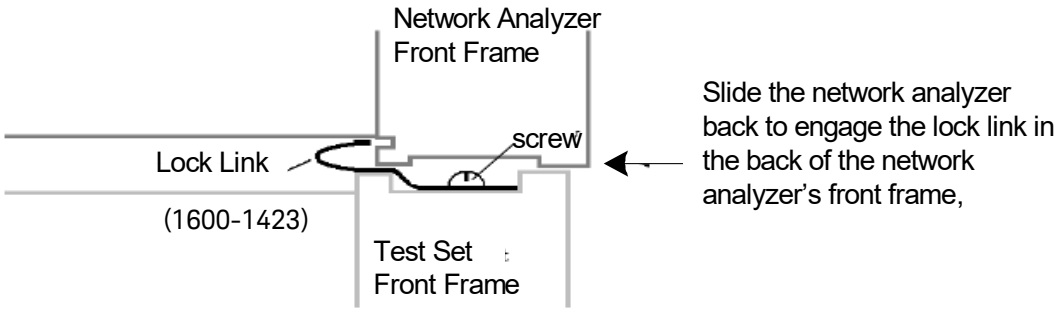


5. Remove the top two standoffs from the rear panel on the test set.
6. Install the top left and right rear lock-links from the kit (5063-9253) using screws (0515-1244).

Figure 9 Install Rear Lock-links to the Test Set

7. Place the PNA-L on top of the test set and ensure that the front frame of the analyzer is positioned slightly forward of the locks that are attached to the test set. Slide the analyzer back so the locks engage the front frame.

Figure 10 Locking the Analyzer



8. Secure the PNA-L's lower lock-links to the test set's upper lock-link, using the spring–loaded screws. If the analyzer's lock-links are not aligned with the screw holes, loosen the screws securing the lock-links to the instrument slightly to align and tighten.

Figure 11 Lock-Link Screws

NOTE

The Lock-link kit (U3021-60001) includes hardware to attach the PNA-L to the test set. Refer to "Network Analyzer Interface Kit Options" on page 13 and "Contacting Keysight" on page 94 for ordering information.

- PNA-L - 5023-0132 (Kit includes lock-links and screws)
- Test Set - 5063-9253 (Kit includes lock-links and screws).

Hardware Lock-link Kit Installation (U3021-60002)

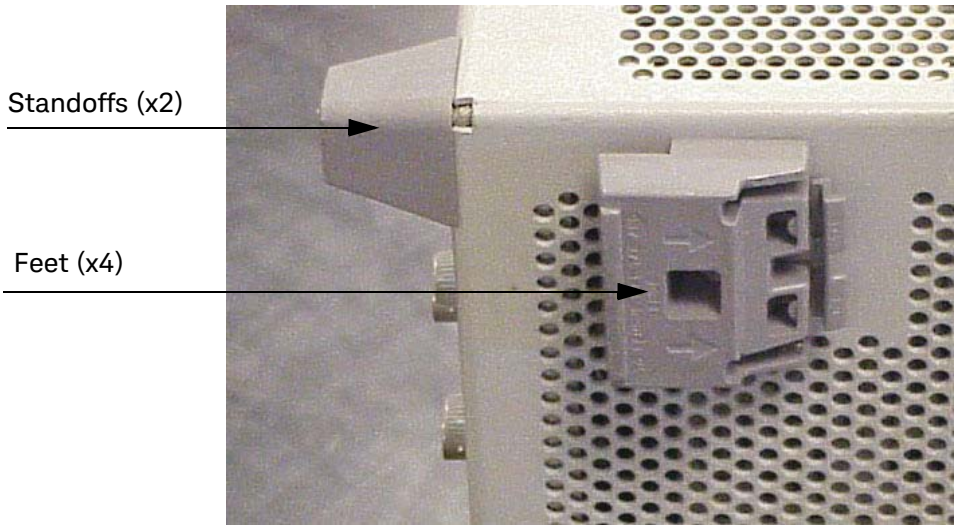
If your system is to be rack mounted, this installation procedure does not have to be performed.

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.**

Locking the Test Set to the PNA or PNA-X

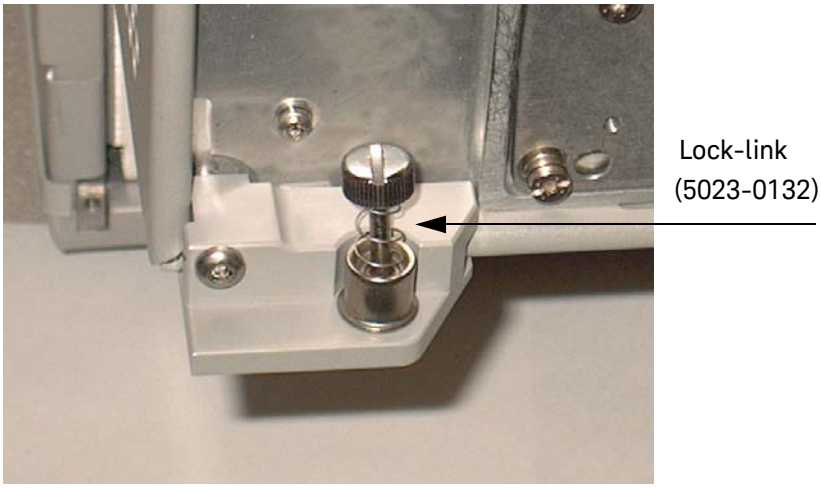
1. The lock-link kit (U3021-60002) includes items to interface the test set to the PNA or PNA-X.
2. Remove the feet from the bottom of the analyzer.
3. Remove the 2 lower standoffs from the rear panel on the analyzer.

Figure 12 Rear Bottom Feet



4. Install the two rear lock-links (5023-0132) onto the PNA or PNA-X, where the standoffs were removed.

Figure 13 Install Lock-links on PNA or PNA-X

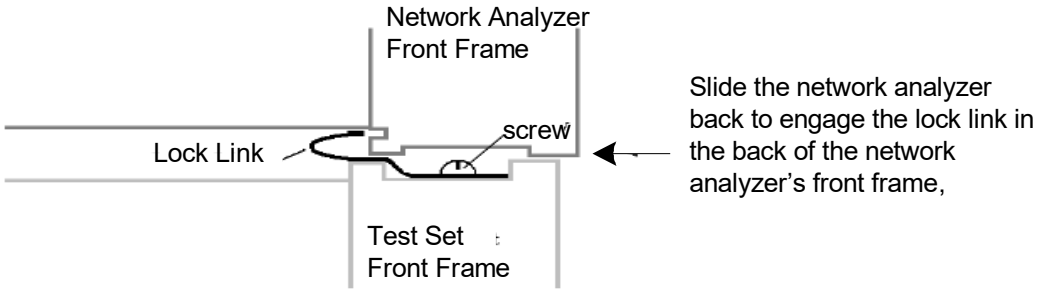


5. Remove the top two standoffs from the rear panel on the test set.
6. Install the two rear lock-links onto the Test Set. Looking at the front panel, the N5242-20138 is the right foot and the N5242-20139 is the left foot. Two screws (0515-2317) are included with this option.

Figure 14 Install Lock-links to Test Set

7. Place the PNA or PNA-X on top of the Test Set and ensure that the front frame of the analyzer is positioned slightly forward of the locks that are attached to the Test Set. Slide the analyzer back so the locks engage the front frame of the analyzer.

Figure 15 Locking the Analyzer



8. Secure the PNA or PNA-X lower lock-links to the Test Set upper lock-link, using the spring–loaded screws. If the analyzer's lock-link are not aligned with the screw holes, loosen the screws securing the lock-link to the instrument slightly to align and tighten.

Figure 16 Lock-Link Screws

NOTE

The lock-links kit (U3021-60002) includes hardware to attach the PNA or PNA-X to the test set. Refer to "Network Analyzer Interface Kit Options" on page 13 and "Contacting Keysight" on page 94 for ordering information.

- PNA or PNA-X- 5023-0132 (Kit includes lock-links and screws)
- Test Set - N5242-20138 (right foot) and N5242-20139 (left foot) and screw (0515-2317) for use with the PNA or PNA-X.

N5232A/B RF Interface Cable Connections

4-Port Analyzer

Figure 17 on page 28 illustrates the cable configuration of the 4-Port analyzer. The cables have been supplied with kit (U3021-60015), see Table 8 on page 28.

Cable Connection Procedure

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x4) on the PNA-L. The RCVR R1 to SOURCE OUT reference loop jumpers (x1) remain on the front panel.
2. Connect the RF interconnect cables, supplied with this option, from the analyzer to the test set. Torque each cable to 8 in-lb. Refer to Table 8 and Figure 17 on page 28.

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

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

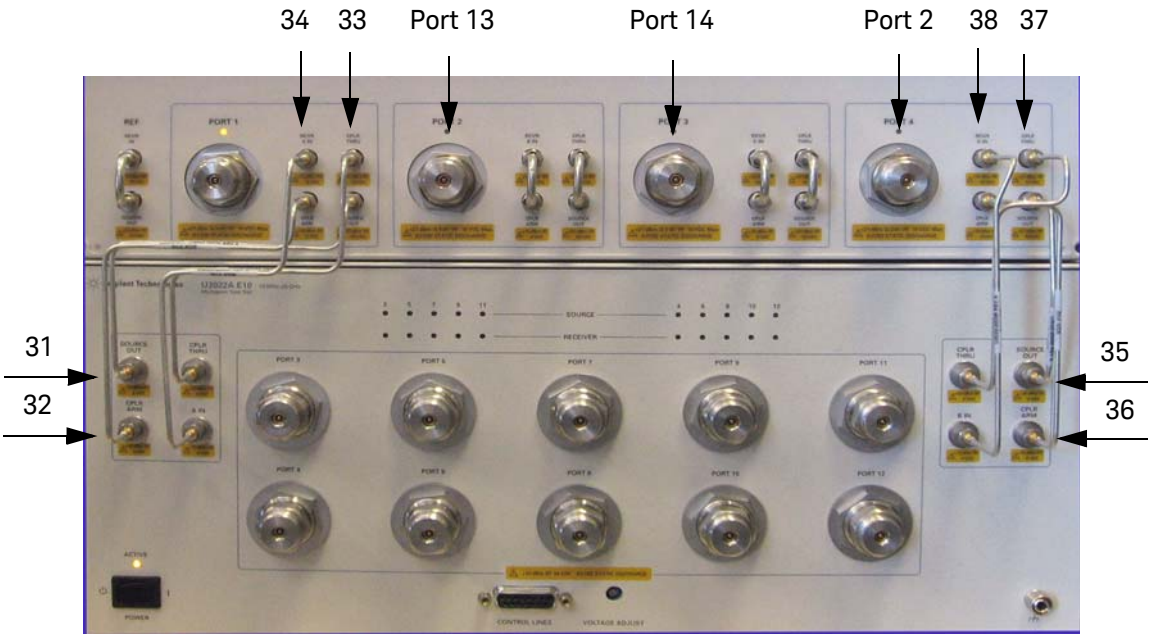
3. Add the front panel port labels from the cable kit (U3021-60015) over the analyzer's port numbers.
   - Port 13 over Port 2 (U3022-80002)
   - Port 14 over Port 3 (U3022-80003)
   - Port 2 over Port 4 (U3022-80004)

Table 8 14-Port RF Cable Connections (U3021-60015)

RF Cables	From: Analyzer	To: Test Set
U3022-20031	SOURCE OUT	SOURCE OUT
U3022-20032	CPLR ARM	CPLR ARM
U3022-20033	CPRL THRU	CPRL THRU
U3022-20034	RCVR A IN	A IN
U3022-20035	SOURCE OUT	SOURCE OUT
U3022-20036	CPLR ARM	CPLR ARM
U3022-20037	CPRL THRU	CPRL THRU
U3022-20038	RCVR D IN	B IN

Figure 19 indicates the final two digits of the part number for each cable.

Figure 17 14-Port Interface Connections



N5222A/B and N5242A/B RF Interface Cable Connections

Figure 18 illustrates the cable configuration of the test set to the analyzer. The cables have been supplied with Cable Kit (U3021-60016).

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers on the analyzer. The RCVR R1-R4 to SOURCE OUT reference loop jumpers remain on the front panel.
2. Add the front panel port labels to the analyzer. Refer to Figure 19 on page 30.
   - Port 13 over Port 3 (U3022-80002)
   - Port 14 over Port 4 (U3022-80003)
3. Connect the RF interconnect cables from the analyzer to the test set in the order listed. As you are connecting each cable, torque to 8 in-lb. The longer, straight end of each cable is connected to the test set. Refer to Table 9 below and Figure 19 on page 30.

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

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

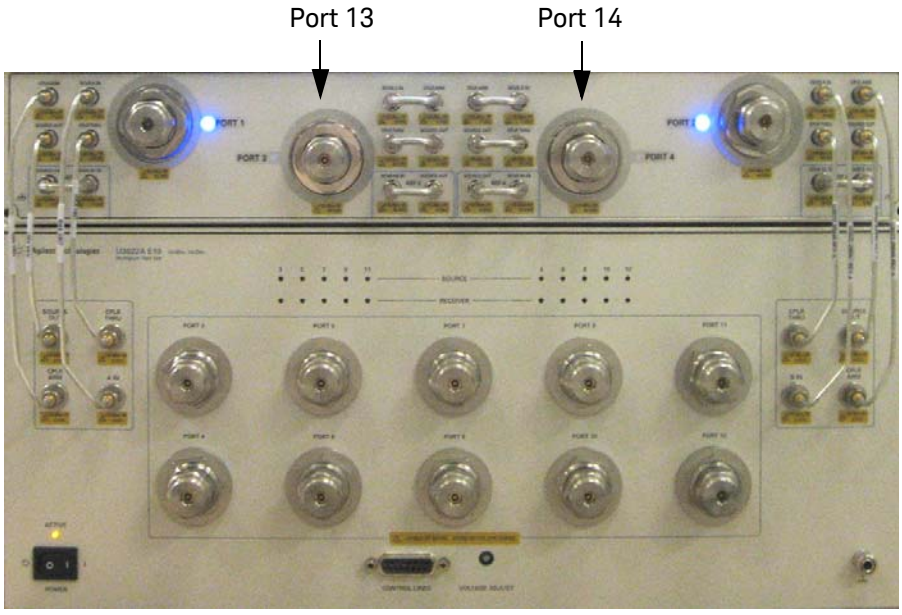
Table 9 RF Interface Cable Connections (U3021-60016)

Numeric Order	RF Cables	From: Analyzer	To: Test Set
1	U3042-20042	Port 1, CPLR ARM	CPLR ARM
2	U3042-20043	Port 1, SOURCE OUT	SOURCE OUT
3	U3042-20044	Port 1, RCVR A IN	A IN
4	U3042-20045	Port 1, CPLR THRU	CPLR THRU
5	U3042-20046	Port 2, CPLR THRU	CPLR THRU
6	U3042-20047	Port 2, RCVR B IN	B IN
7	U3042-20048	Port 2, SOURCE OUT	SOURCE OUT
8	U3042-20049	Port 2, CPLR ARM	CPLR ARM

Figure 18 and Figure 19 illustrate the final two digits of the part number for each cable. The cables must be connected in the numeric order listed in Table 9 on page 29.

Figure 18 12-Port RF Interface Cable Connections

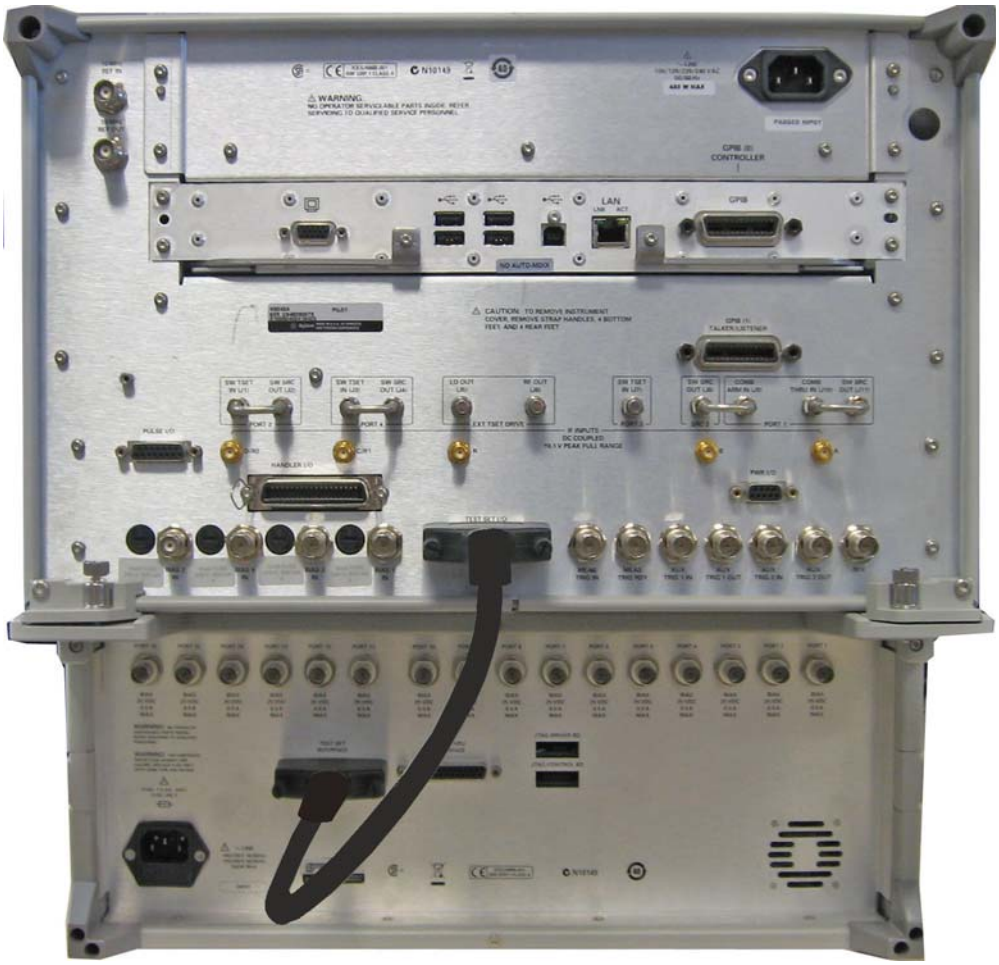
Figure 19 14 Port RF Interface Cable Connections



Test Set I/O Cable Installation

1. Connect the analyzer's Test Set I/O cable (N4011-21002) to the Test Set Interface connector on the rear panels, similar to Figure 20.

Figure 20 Test Set I/O Cable Connection



System Operational Check

The following procedure will confirm that the RF interface cables between the test set and analyzer are installed and the system is working correctly. Ensure that your analyzer is calibrated by measuring the short on each port before connecting the test set.

Before beginning this procedure you should complete the following steps:

- Stack the analyzer on top of the test set.
- Install the Test Set I/O cable on the rear panel.
- Install all of the RF interface cables on the front panel.
- Install the included female 3.5 mm short (85052-60007) to Port 1 on the analyzer.

Equipment Setup

- Turn on the test set and network analyzer.
- Preset the analyzer and complete the following settings:
  - Set to Multi-Port Mode
  - Frequency range: 10 MHz to 20 or 26.5 GHz
  - IFBW: 1 kHz
  - Scale: 10 dB/Div
  - Set the PNA to measure S11
  - Ensure the RF path of the analyzer is in Default mode. Refer to "RF Path Configuration with Option 029" on page 42.

Verify Results

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

Table 10 Reflection Response Results

Reflection Port	Response Trace	Cable Path Diagram
Port 1 to 2	Figure 20 on page 31 & Figure 22 on page 33	Figure 23 on page 34
Ports 3 to 12	Figure 23 and Figure 24 on page 34	Figure 25 on page 35

NOTE The trace ripple (peak-peak variation will be higher than when using an ECal Module due to variation in your Short's performance. If response is in question perform "Cal Kit Operational Check" on page 60.

Figure 21 Typical Reflection Response Ports 1-2 (Standard)

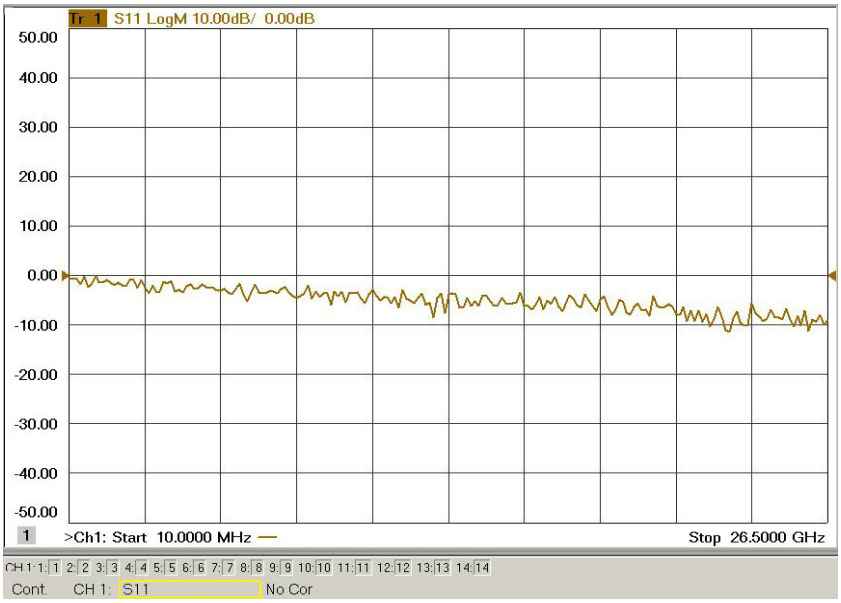


Figure 22 Typical Reflection Response Ports 1-2 (Option 001)

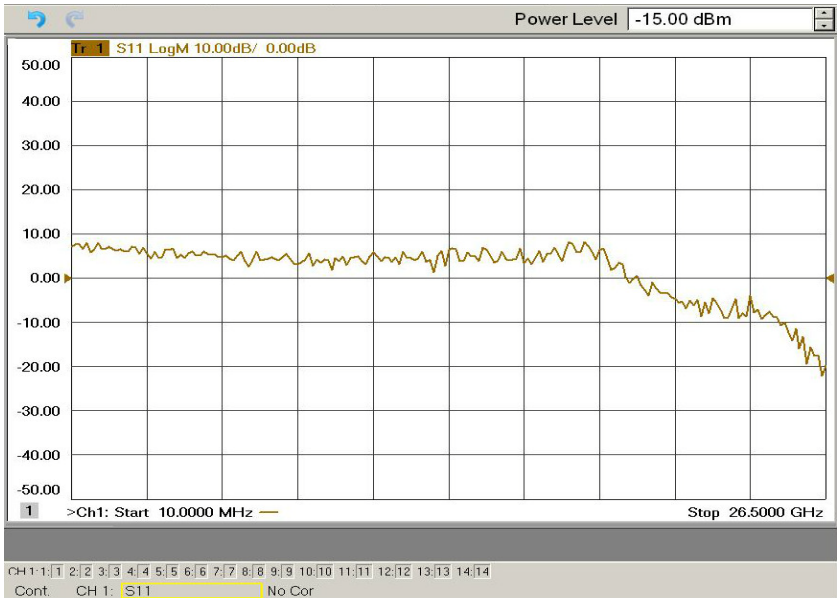


Figure 23 Reflection Response Signal Path Diagram Ports 1-2

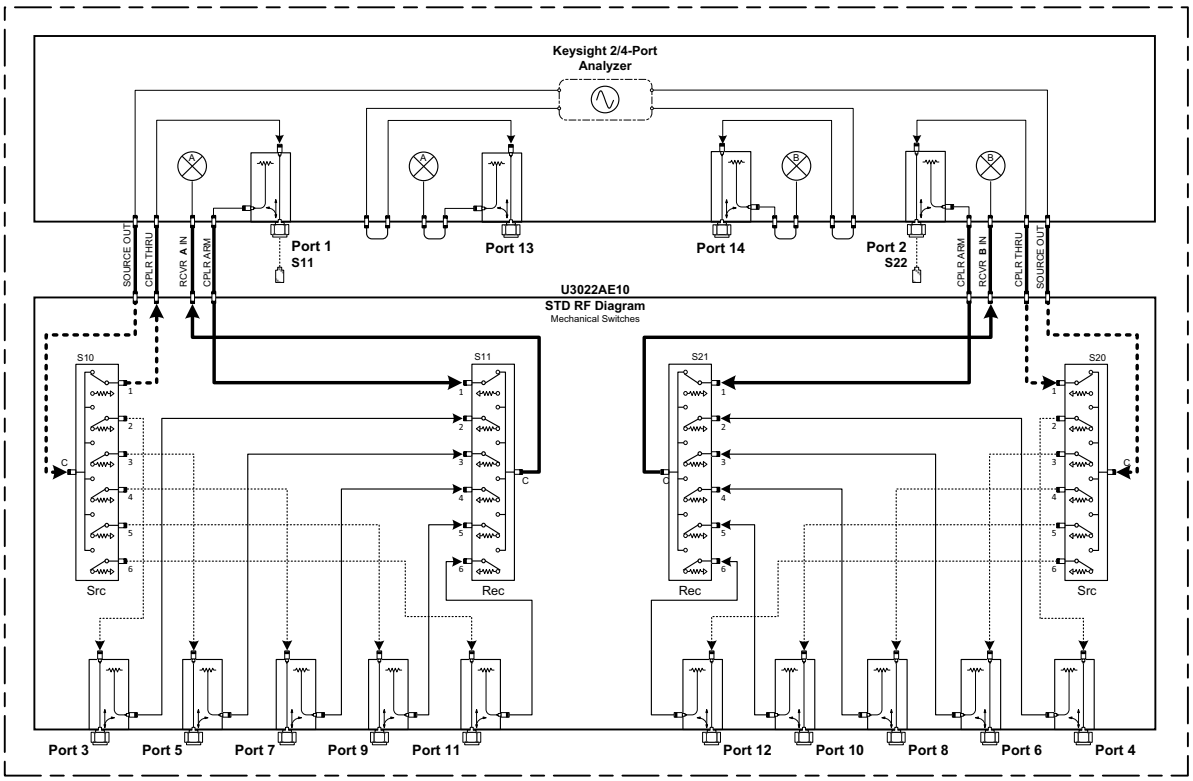


Figure 24 Typical Reflection Response Ports 3-12 (Standard)

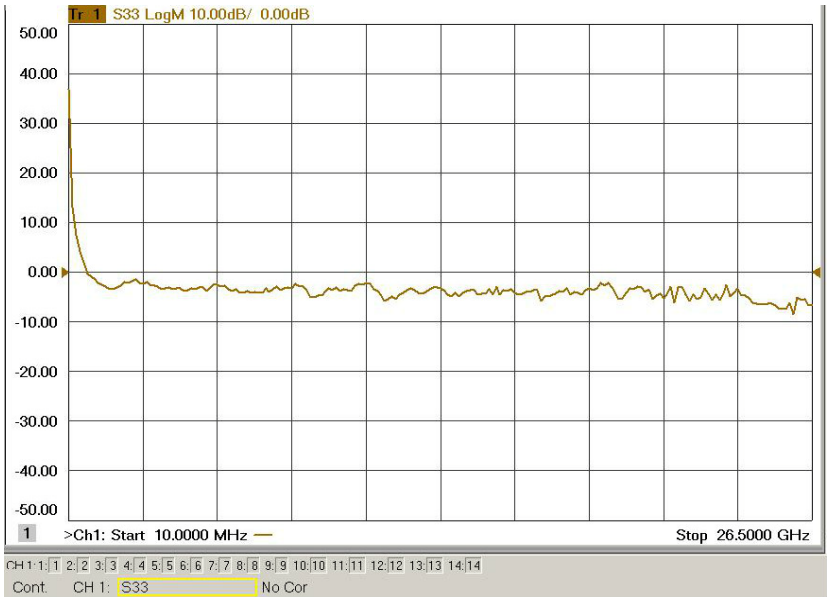


Figure 25 Typical Reflection Response Ports 3-12 (Option 001)

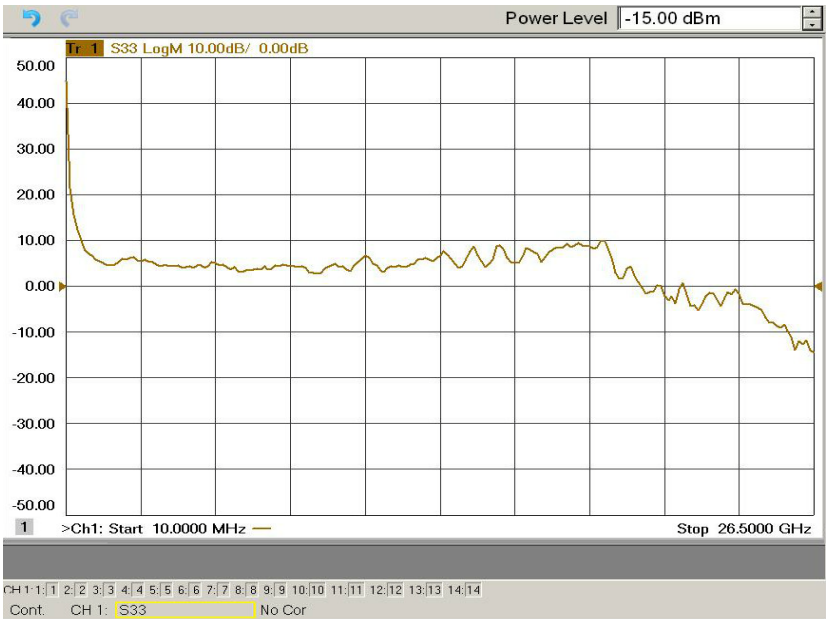
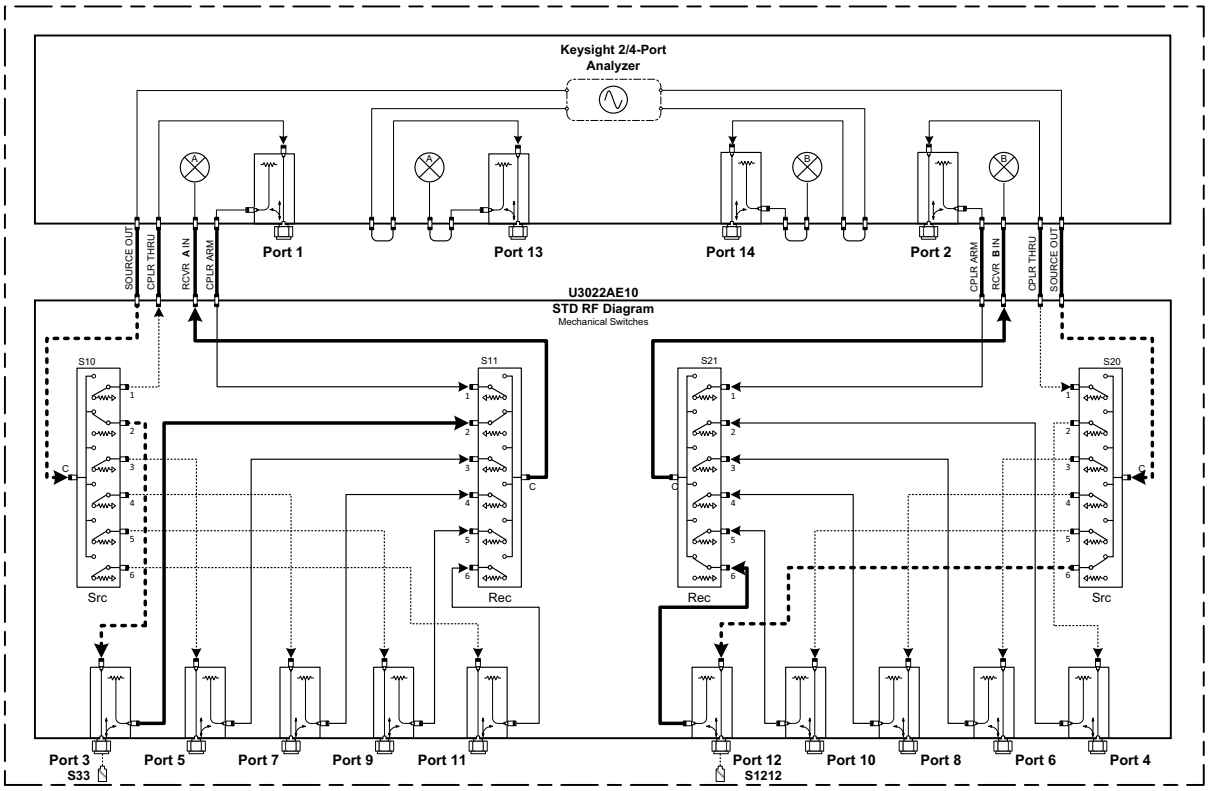


Figure 26 Reflection Response Signal Path Diagram Ports 3-12



Controlling the Test Set with N5222A/B, N5232A/B or N5242A/B

This section will describe how to operate the test set with the analyzer.

NOTE The internal firmware of the analyzer has not been modified for this test set option. Power levels may differ from those indicated on the network analyzer when the test set is connected.

The test set is considered a “secondary” instrument. A PNA, PNA-X or PNA-L must be used to control the test set. There are three methods to control the test set. Multiport mode is recommended due to calibration and ease of use.

- “Multiport Mode (Option 551)” on page 37
- “Interface Control Mode” on page 45
- “SCPI Control Mode” on page 49

Typeface Key Conventions

The following key conventions are used throughout this document.

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

Multiport Mode (Option 551)

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

Ensure the test set file needed for your analyzer are installed into network analyzer file directory: c:\ProgramFiles\Keysight\Network Analyzer\testsets

Refer to "Network Analyzer Requirements" on page 11.

How to Access Multiport Mode

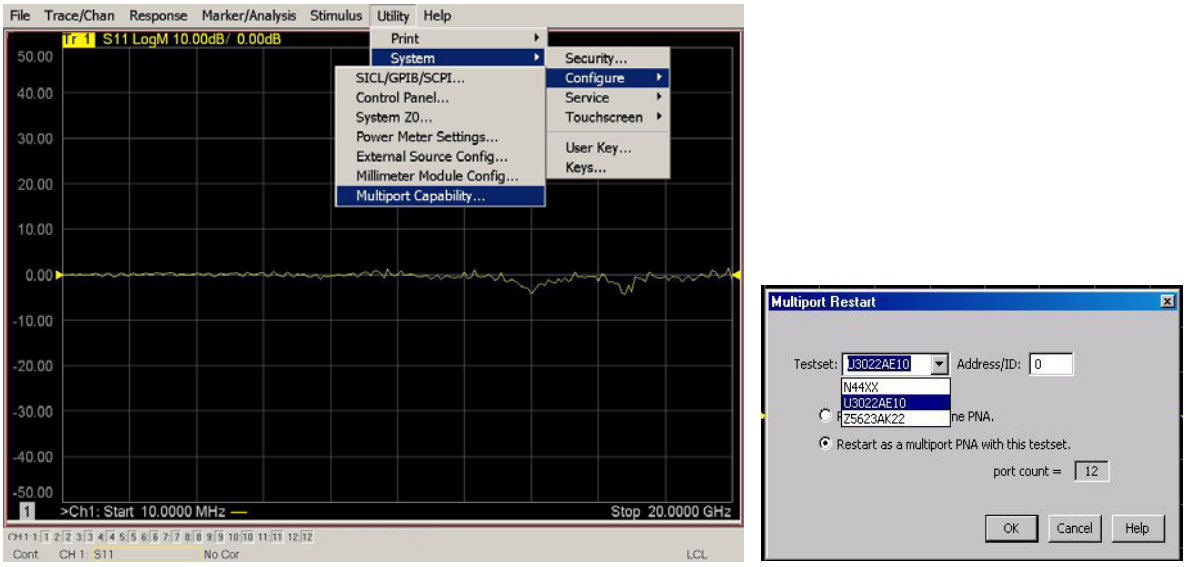
1. The Option 551 must be installed for multiport capability. To access the multiport application select **Utility** › **System** › **Configure** › **Multiport Capability** -OR- ***(Instrument*** › ***Setup*** › ***External Hardware*** › ***Multiport*** › ***Multiport Configuration...)***.
2. Select **U3022AE10** (12-Port System) from the drop-down menu and select **Restart as a multiport PNA with this testset** › **OK**. The analyzer 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 analyzer's hard drive. The current version of the test set files are available on the web at http://na.support.keysight.com/multiport/testsetsupport.html.

Copy the appropriate file to
c:\Program Files (x86)\Agilent\Network Analyzer\TestSets

For the "B" Model PNA-X, copy to
c:\Program Files (x86)\Agilent\Keysight\Network Analyzer\Keysight\TestSets

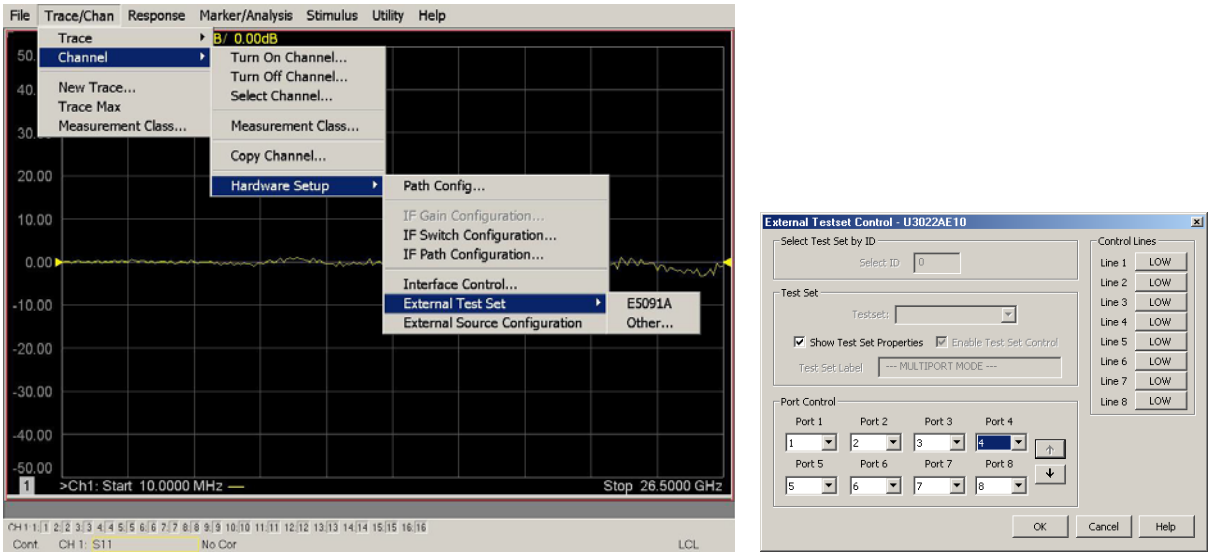
Figure 27 Selecting Multiport Mode



External Test Set Control Feature

To verify that the network application has the test set interface features, select **Trace/Chan** > **Channel** > **Hardware Setup** > **External Test Set** > **Other** -OR- ***(Instrument*** > ***Setup*** > ***External Hardware*** > ***External Device...*** > ***Multiport*** > ***Other Test Set Setup...)***. The test set will be displayed as **External Test Set Control-U3022AE10**.

Figure 28 External Test Set Control



This menu will allow the physical Ports 1 thru 8 to be identified as any port for your convenience. For example, Port 5 can be re-named Port 2.

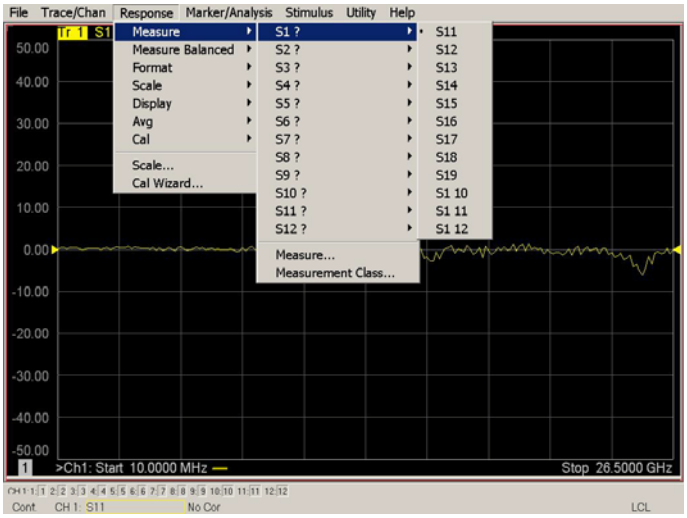
The **External Test Set Control-U3022AE10** also allows control of the DUT control lines, refer to "Control Lines" on page 54. To change the state from LOW to HIGH, select the graphical user interface (GUI) for the specific control (LINE 1 to 8), click **OK**. Each line can be controlled separately.

Select the port control down arrow for Ports 9 thru 12.

Trace Measure S-Parameter

S-Parameter selection can be accomplished using **Response** > **Measure**. Use the drop-down menu to select 1 of 144 S-Parameters for the 12-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.

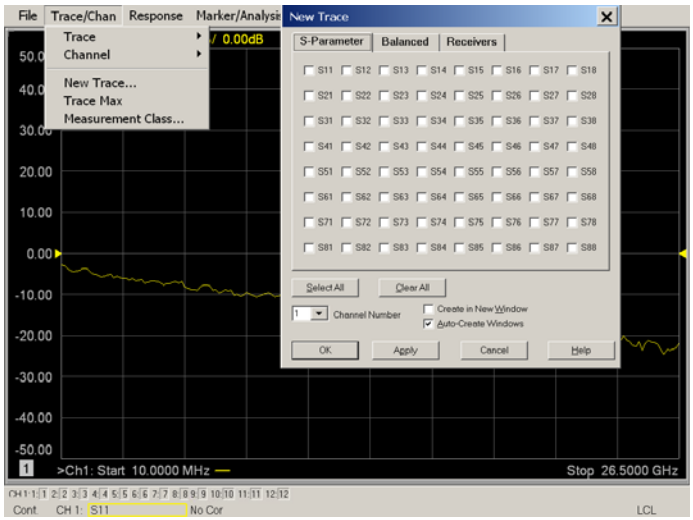
Figure 29 S-Parameter Measurement



New Trace Measure S-Parameter

S-Parameter Tab: Multiple S-Parameters can be made from the **New Trace** menu. In the drop-down menu select **Trace/Chan** > **Trace** > **New Trace** -OR- ***(Instrument* > *Trace* > *New Trace)***. The dialog box allows the selection of any of the 144 S-Parameters.

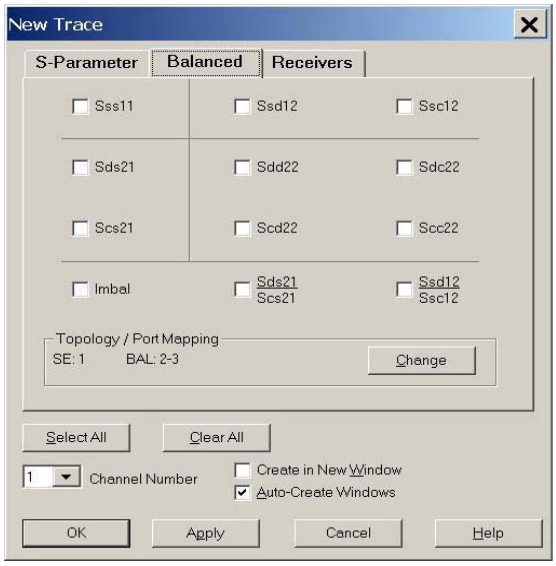
Figure 30 New S-Parameter Measurement



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

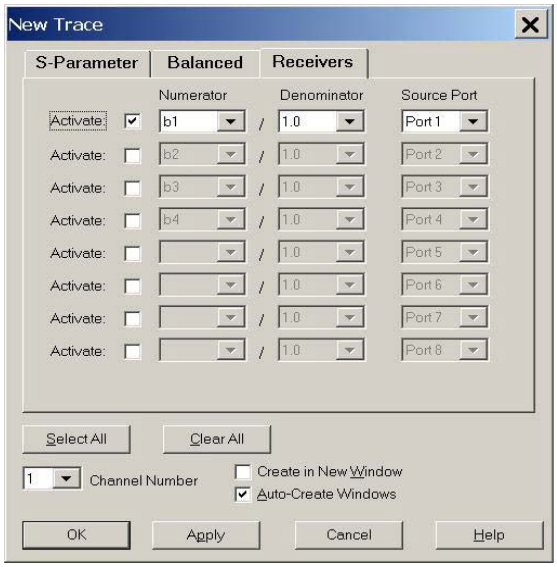
For more information on balanced (differential) component measurement, refer to the Application Note 1373-1 and 1373-2 (5988-5634EN and 5988-5635EN) at http://www.keysight.com. In the search menu type “Multiport and Balanced.”

Figure 31 Selecting Balanced Measurements



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

Figure 32 Receiver Measurements

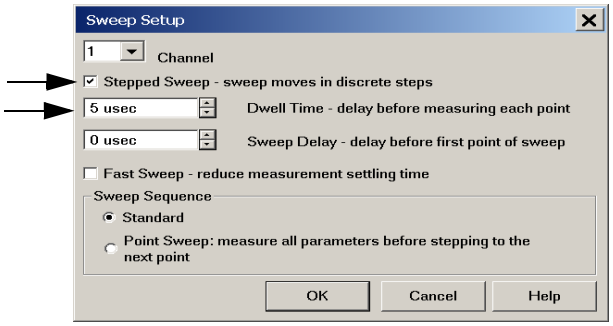


Sweep Setup for Multiport and Standalone Modes

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

1. On the analyzer select **STIMULUS** > **Sweep** > **Sweep Setup**.
2. Select **Stepped Sweep (sweep moves in discrete steps)**.
3. Set the **Dwell Time** to **5 µs** > **OK**.

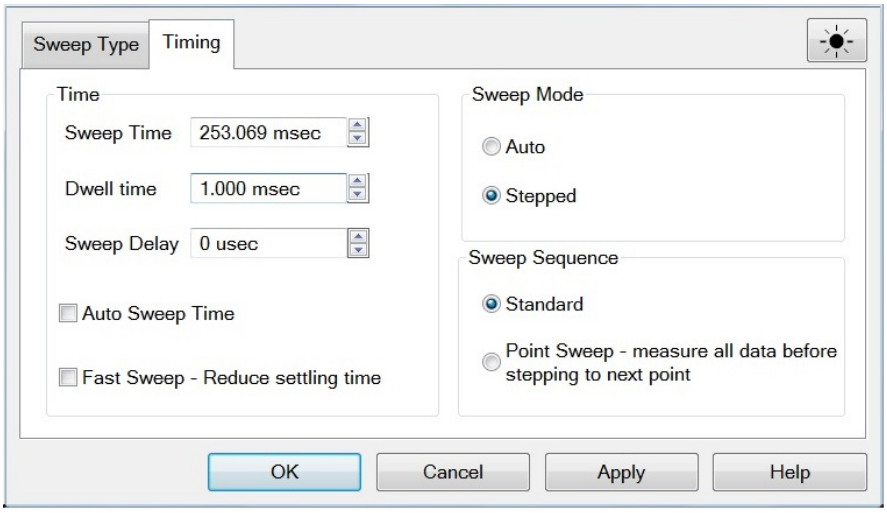
Figure 33 Sweep Setup



Sweep Setup for PNA-X N52xxB Models

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

Figure 34 Sweep Setup, N52xxB

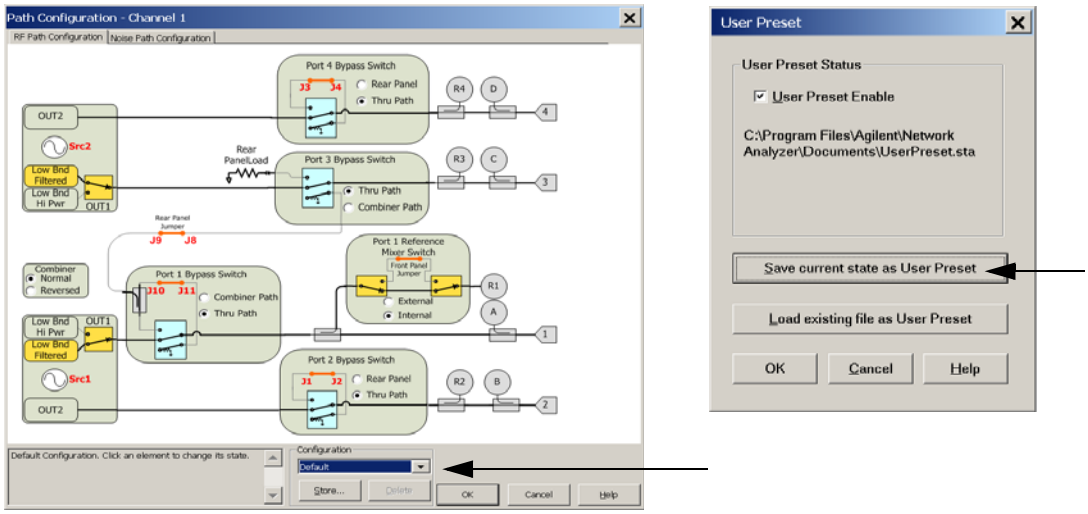


RF Path Configuration with Option 029

NOTE

If the analyzer has Option 029 or H29 (noise figure capability) verify that the path configuration is set to Default. If it is not in Default configuration, ports 5 and 9 will not operate correctly. Select **Trace/Chan** > **Channel** > **Hard ware Setup** > **Path Config**... -OR- ***(Instrument*** > ***Setup*** > ***Internal Hardware*** > ***RF Path Config...)*** and in the drop-down menu select **Default** > **OK**. Save this configuration as a User Preset by selecting **Save** > **User Preset** > **Save current state as User Preset**. Do not use the factory Preset (User Preset Off); the analyzer will return to Option 029 path configuration.

Figure 35 RF Path Configuration



N-Port Calibration

It is recommended that you perform an ECal characterization to minimize the connections required for multiple port calibration. The N4691B Option M0F is recommended with cable (85133F) if you are calibrating at the analyzer 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** -OR- ***(Response > Cal > Cal Sets & Cal Kits > Characterize ECals...)***.

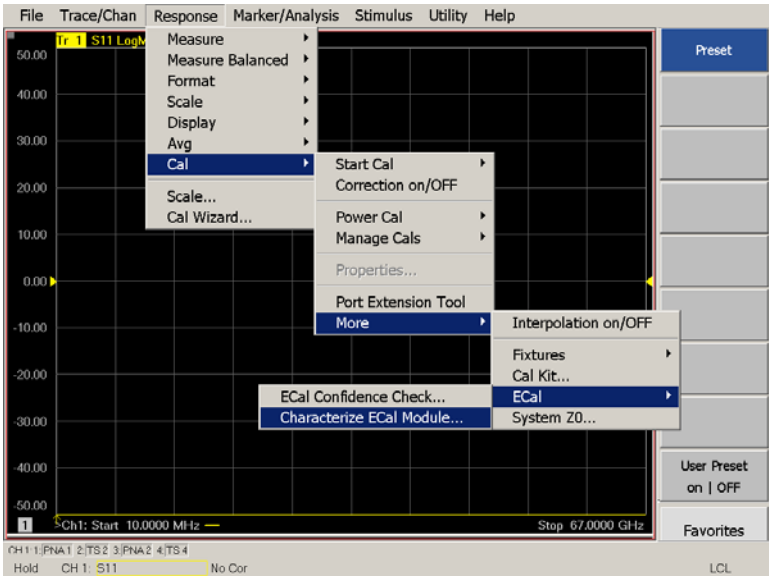
Calibrate at the end of the test port RF cables and any adapters that are used to connect the DUT. This removes the effect on the measurement of the DUT. Failure to do this will create ripple and other measurement errors.

NOTE

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

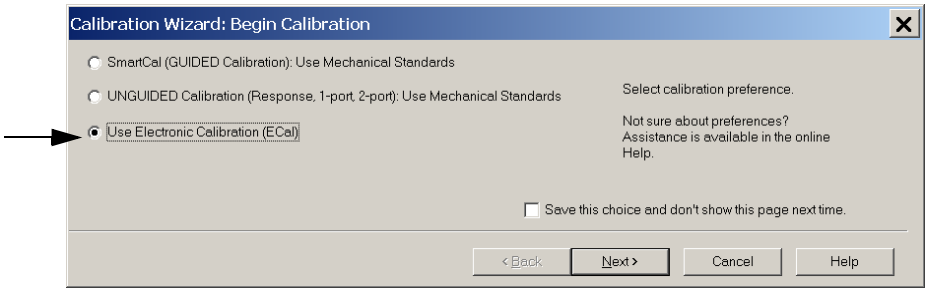
1. To perform an ECal characterization select **Response** > **Cal Wizard** > **Characterize ECal Module** -OR- ***(Response > Cal > Other Cals > ECal...)***.
2. Follow the prompts and save the ECal characterization file. Refer to the Help menu for characterizing information.

Figure 36 ECal Characterization and Calibration Wizard



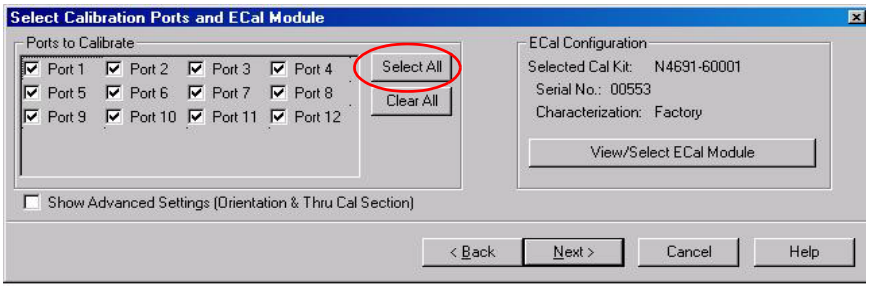
3. On the analyzer select **Response** > **Cal Wizard** -OR-
   (Response** > **Cal** > **Other Cals...).
   a. If using a mechanical cal kit, select **SmartCal (Guided Calibration)** > **Next**.
   b. If using an ECal module, connect the ECal to an available USB port and select **Use Electronic Calibration (ECal)** > **Next** -OR-
   (Response** > **Cal** > **Other Cals** > **ECal...).

Figure 37 Begin Calibration



4. Continue following the Cal Wizard prompts. In the “Select Calibration Ports and ECal Module” dialog box press **Select All**, or select the ports you are calibrating and press **Next**. If an ECal characterization has been done, select **View/Select ECal Module** and select the previously saved user file from step 3.

Figure 38 12-Port Calibration



5. 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**.
6. At the Calibration Completed prompt, select **Save As User Calset**, type the name and **Save**. See Figure 50 on page 63.
7. 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 analyzer is in standard (non-multiport) mode.

NOTE

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

Interface Control Mode

NOTE

Interface Control mode will not function properly when using multiport mode. Multiport mode will reset the switch path commands of the interface control. It is recommended that the network analyzer be restarted in stand-alone mode if the interface control is being used. Select **Utility** > **System** > **Configure** > **Multiport Capability**. In the dialog box select **Restart as a standalone PNA** > **OK**

Overview of the Interface Control

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 analyzer's Help menu, "Rear Panel Tour" and "Interface Control."

- 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 Help menu.

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

How to Access Interface Control Settings

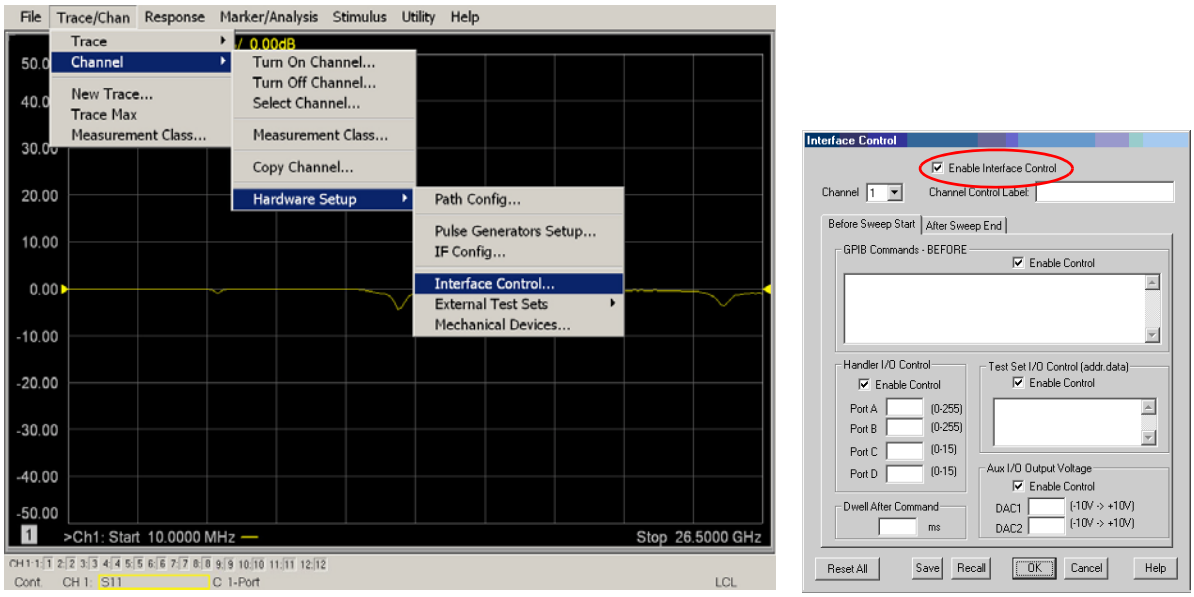
This section will describe how to setup and operate the test set with the analyzer.

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

NOTE

The analyzer includes the Interface Control application and rear panel connection. Please review this application before connecting the test set to the network analyzer. Information regarding this application can be found in the Help menu, Interface Control.

Figure 39 Interface Control Application



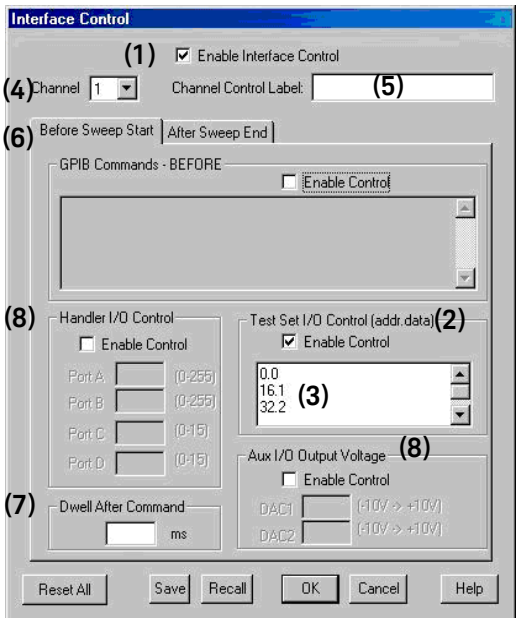
Using Interface Control Mode

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

NOTE

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

Figure 40 Interface Control



Enable Interface Control: (1) Enables and disables ALL Interface Control communication. When cleared (default setting) Interface Control is disabled and NO data is sent. To send data, the individual interfaces must also be enabled.

Test Set I/O Control (addr.data): (2) Provides control of the Test Set I/O Interface on the rear panel of the analyzer. Used to control your test set.

Only positive integers are allowed to select switch positions or states of DUT control interface lines. Refer to "Address and Data Values" on page 52.

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

Address and Data example: **addr.data (3)**

0.0
16.1
32.2

Channel: (4)	Specifies the channel number for dialog settings. Each channel is configured individually. The drop-down list illustrates the channels that currently have measurements. There must be at least one displayed trace for the Test Set I/O Interface to function.
Channel Control Label: (5)	Specifies the label to be displayed on the analyzer's screen during the channel sweep.
Before Sweep Start – After Sweep End Tabs: (6)	Commands (GPIB, I/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 sweep, the "Enable Interface Control" check box must be selected and commands entered in both the Before Sweep Start and After Sweep End tabs. The **Before Sweep Start** data is sent before the first trace on the channel begins sweeping. The **After Sweep Start** data is sent after the last trace on the channel sweep is completed.
Dwell After Command: (7)	Specifies a wait time, in milliseconds, after all commands to all interfaces are sent. Any positive integer is allowed. This is used to allow all external devices to settle before beginning a measurement. An erratic trace could indicate that more settling time is necessary.
Handler I/O Control and Aux I/O Output Voltage: (8)	Provides I/O interface control through the rear panel of the PNA. Refer to the PNA Help menu for further information.
Reset All:	Sets all fields on all channels to their default values.
Save and Recall:	Saves and recalls the contents of the dialog box. If the "Interface Control" dialog box is populated with settings during an Instrument State Save, the settings are automatically recalled with the instrument state settings. Interface control uses an *.xml file type. An example file is stored on the PNA hard drive. You can recall it into the dialog, or you can open and edit it with a word processor, such as Word Pad.
OK:	Applies the settings and closes the dialog box.
Cancel:	Does not apply changes that were made and closes the dialog box.
Help:	Provides additional information for using the interface control application.

SCPI Control Mode

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

Overview of the SCPI Control

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

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

How to Access the Command Processor

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

Figure 41 Command Console for 'A' Model Analyzers

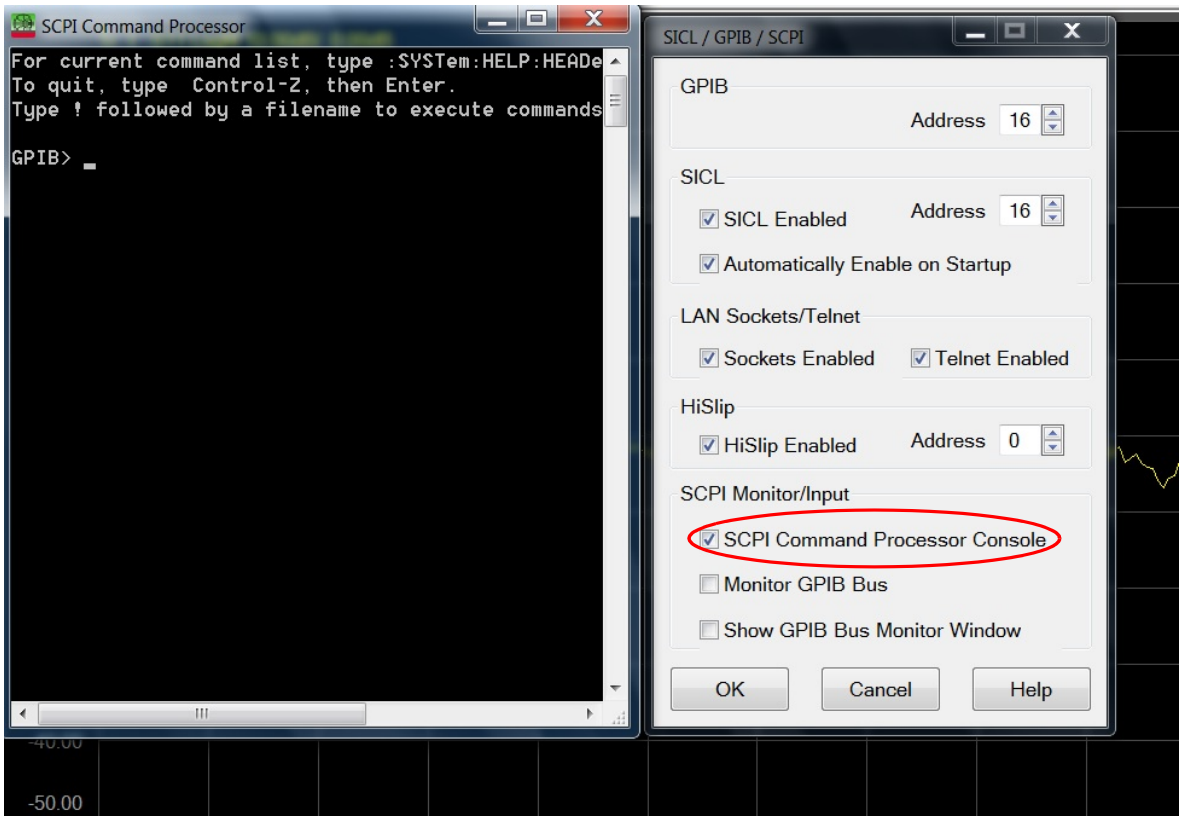
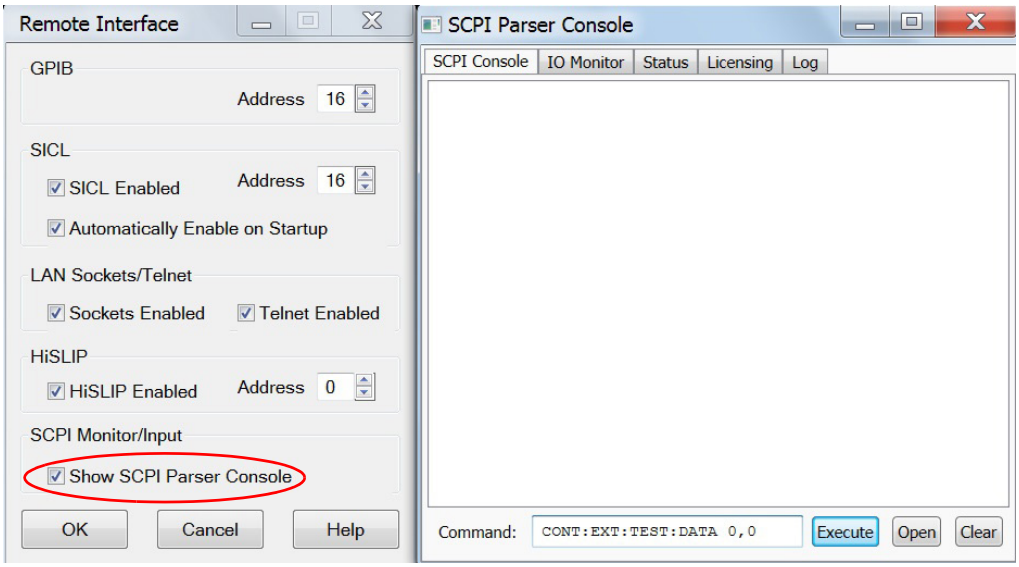


Figure 42 Command Console for 'B' Model Analyzers



SCPI Command Processor Console

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

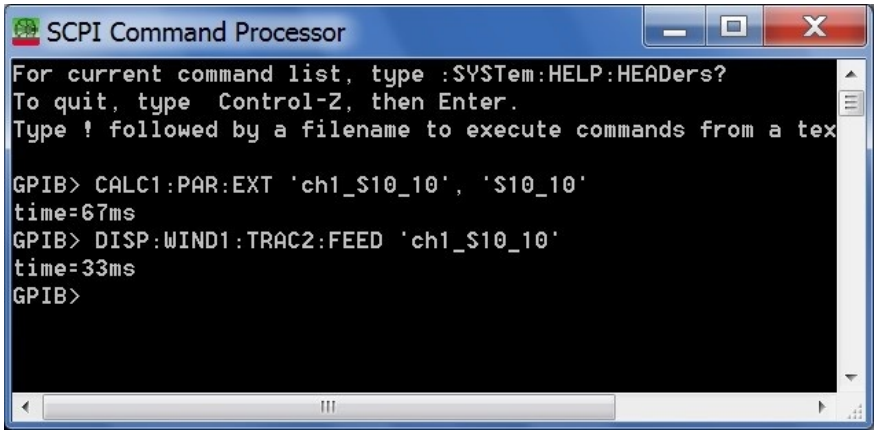
Method 1 - Using GPIB/SCPI Command Values

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

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

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

Figure 43 Method 1 - Using GPIB/SCPI Command Values



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

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

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

DISP:WIND1:TRAC2:FEED 'ch1_S10_10'

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

‘ch1_S99’ ‘ch1_S22’ ‘ch1_S9_10’ ‘ch1_S10_9’

Method 2 - Using the Test Set Address and Data Values

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

The Address and Data values for the Test Set can be found in the “Address and Data Values” section on page 52.

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

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

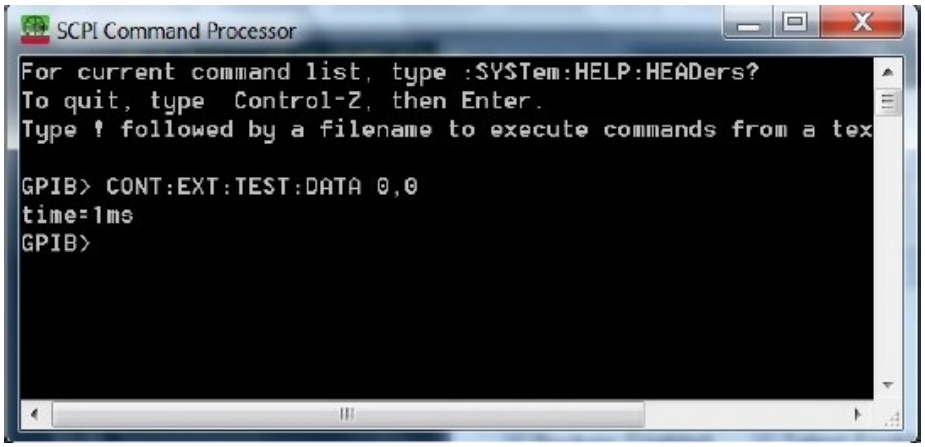
For example:

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

CONT:EXT:TEST:DATA 0,0

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

Figure 44 Method 2 - Using Test Set Address and Data Values



Address and Data Values

Setting the Test Port Paths with Address and Data

Refer to Table 11 below and Figure 45 on page 53 for information to set the internal switch paths of the test set.

The address is the first value in the Test Set I/O control or GPIB data command. The second value controls the source and receiver paths of the ports. To select a test set port configuration both switches must be set to complete the source and receiver paths. To do this you must add the data values together to determine the data command value for each port, which is the second number in the Test Set I/O or GPIB command. Refer to "Interface Control Mode" on page 45 and in "SCPI Control Mode" on page 49.

Example 1: If the ports have the same address, only one command is needed.

Port 3 is the Source and Port 11 is the Receiver.

Source Port 3 = address 0, data 1 and Receiver Port 11 = address 0, data 80. The data values are added together, the entry will be 0.81.

Example 2: Refer to Figure 45 on page 53.

If the ports have different addresses, two separate address data commands must be used.

Port 7 is the Source and Port 8 is the Receiver

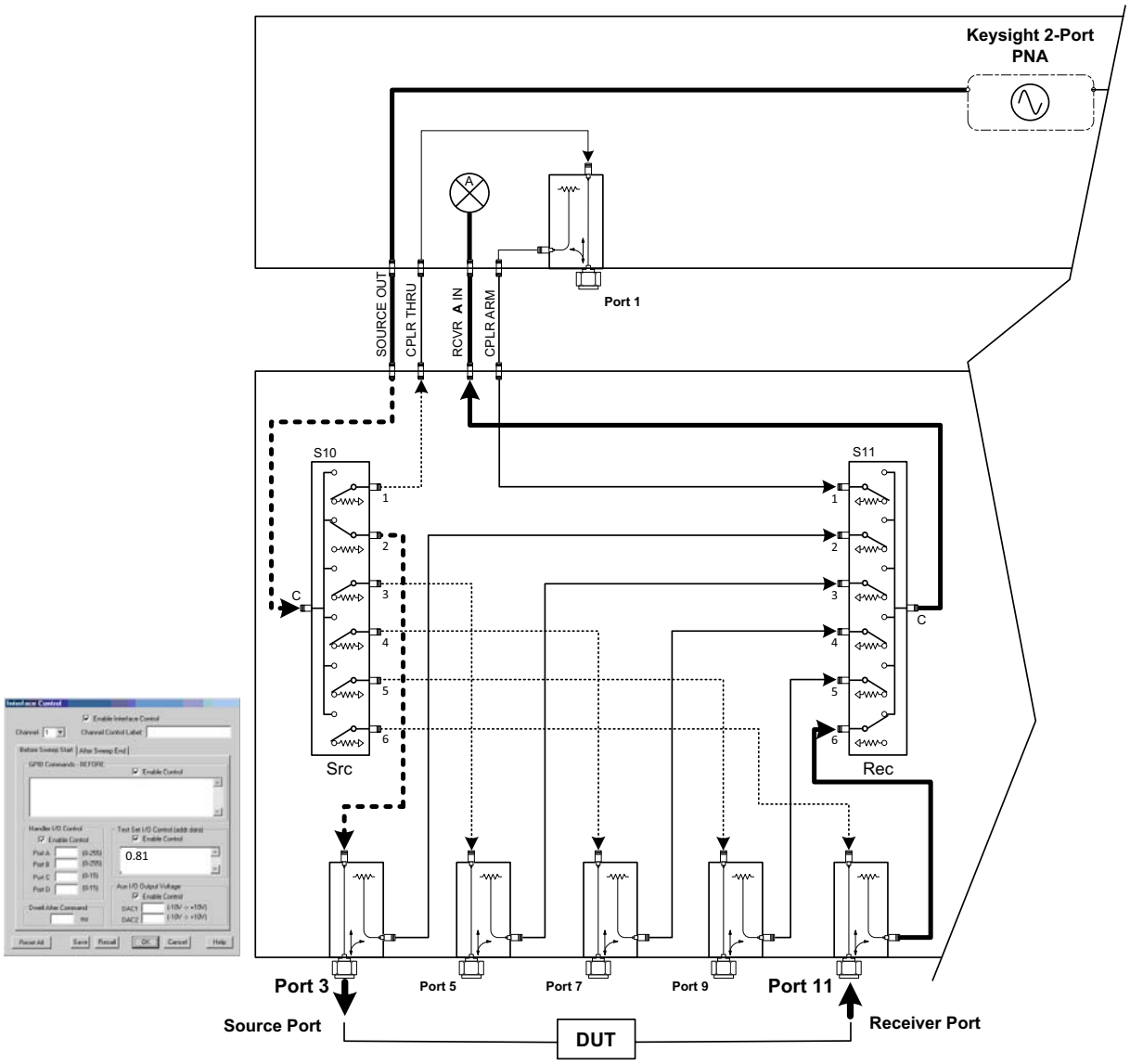
Source Port 7 = address 0, data 3 and Receiver Port 8 = address 16, data 48.

Two separate commands must to be sent, you may use the same dialog box. The entry will be 0.3 in one command line, and 16.48 in the second line.

Table 11 Test Port Address and Data Values

Address		**Source Path**						**Receiver Path**					
	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

Figure 45 Address and Data Example 1 (Port 3 and 11)



Control Lines

The 15 pin female D-Sub connector on the front 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 Feature" on page 38 and "Setting the Control Lines with Address and Data Values" on page 58. See Table 12 below for DUT control line specifications.

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 46 and Table 13 on page 55 for control line pin location and description. Refer to "Internal Voltage Supply Configuration" on page 56 and "External Voltage Supply Configuration" on page 57 for configurations.

Table 12 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 46 DUT Control Line Pin Assignment (rear panel view)

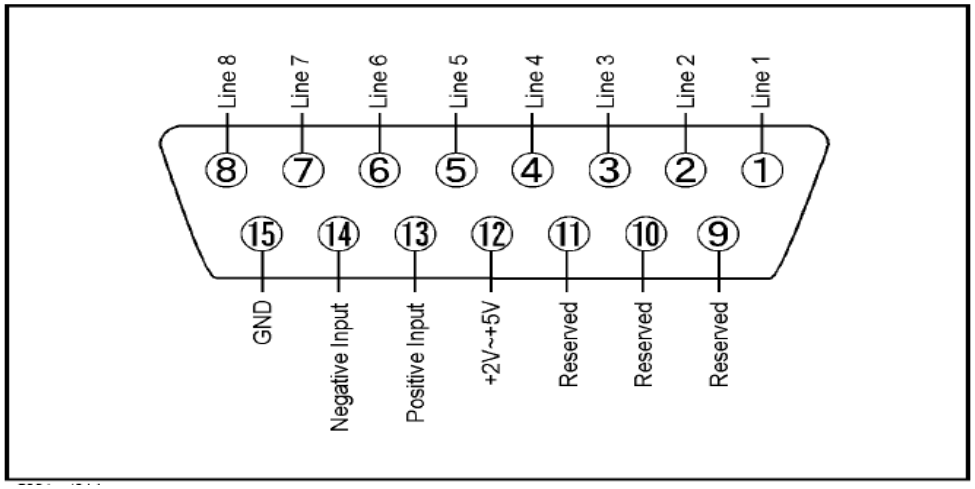


Table 13 DUT Control Line Interface Connector Pin Assignment

Pin	Signal Name	Description
1	Line 1	Control Line Output of the voltage from pin 13 or pin 14.
2	Line 2	Control Line Output of the voltage from pin 13 or pin 14.
3	Line 3	Control Line Output of the voltage from pin 13 or pin 14.
4	Line 4	Control Line Output of the voltage from pin 13 or pin 14.
5	Line 5	Control Line Output of the voltage from pin 13 or pin 14.
6	Line 6	Control Line Output of the voltage from pin 13 or pin 14.
7	Line 7	Control Line Output of the voltage from pin 13 or pin 14.
8	Line 8	Control Line Output of the 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

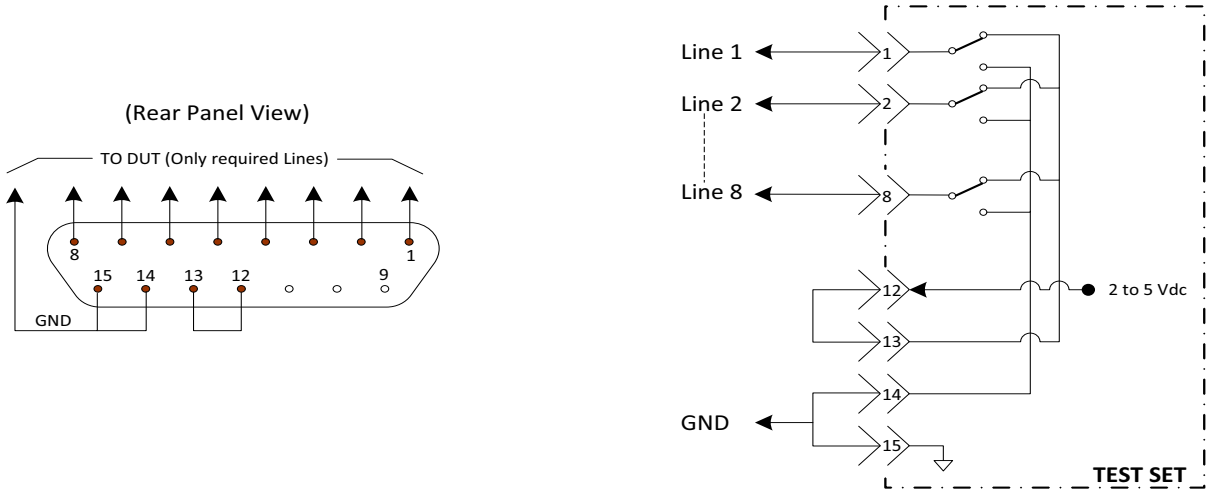
The output voltage of pin 12 can be adjusted from +2 to +5 V. Perform the following procedure to set the voltage:

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 45 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 47 Internal DC Power Configuration (rear panel view)



External Voltage Supply Configuration

Figure 48 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.

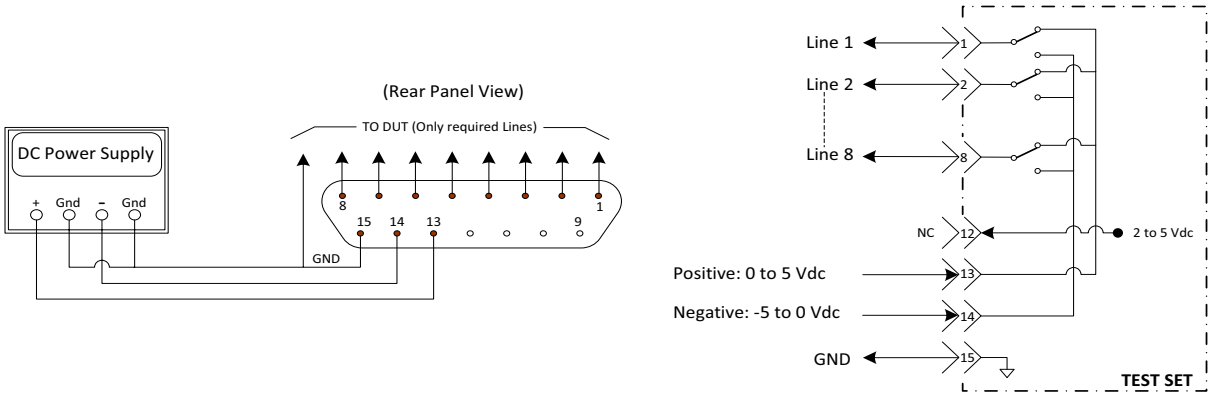
Turning **on** the Test Set using an External Power Supply.

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 48 Test Set to the DUT and External DC Power Supply



Setting the Control Lines with Address and Data Values

This section describes how to control the rear panel DUT control lines.

NOTE The following control feature will function only while the PNA is in its Standalone Mode.

Setting the PNA to Standalone Mode

1. Select **Utility** > **System** > **Configure** > **Multiport Capability** -OR-
   (Instrument > ***Setup*** > ***External Hardware*** > ***Multiport*** > ***Multiport Configuration...)***.
   In the dialog box, select **Restart as a standalone PNA** > **OK**.

As described in "Setting the Test Port Paths with Address and Data" on page 52, the <address>.<data> values are determined in a similar manner, with the following exceptions:

- Table 16 will be used.
- The <address> value is always = 112

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 high 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

After a power reset all DUT control lines are initially configured to a logic high state or connected to Pin 13, refer to Figure 47 on page 56. To reset all control lines to logic high, without having to reset the power switch on the test set, make the following entry:

Front panel PNA Interface Control Mode line entry = **112.0 > OK**.

Always determine which control lines you want set to a logic zero, the other remaining lines will automatically be set to a logic high. Note the <data> value of these lines and calculate the SUM of their <data> values.

Listed are two examples to illustrate this concept. Refer to Figure 26 on page 35, shown with all lines = logic high.

Example 1

To change lines 1 and 8 to equal logic Low, all others logic high.

1. Line 1 (<address> = 112 and <data> = 1)
2. Line 8 (<address> = 112 and <data> = 128)
3. The SUM of the <data> values = 129
4. Front panel PNA Interface Control Mode line entry = 112.129 > OK.

Example 2

From Example 1 to only change Lines 2 and 3 to equal logic low, all others logic high.

1. Line 2 (<address> = 112 and <data> = 2)
2. Line 3 (<address> = 112 and <data> = 4)
3. The SUM of the <data> values = 6
4. Front panel analyzer Interface Control Mode line entry = 112.6 > OK.

NOTE

Since all control lines have the same <address>, only one "<address>.<data>" command line is needed to control all 8 lines.

Cal Kit Operational Check

The following procedure can be used to confirm that the test set and network analyzer are operational. The operation verification limits provided ensure that your test set and network analyzer are operating properly. Refer to "General Specifications" on page 14.

Equipment Required

The test set requires that the user be familiar with the equipment and components listed in Table 15.

This section provides an equipment list and setup of the network analyzer and test set.

Table 15 Equipment List

Description	Qty
N4693A 2.4 mm ECal Module 10 MHz - 50 GHz (Option 00F or M0F) or N4691A 3.5 mm ECal Module 10 MHz to 26.5 GHz (Option 00F or M0F) or N4691B 3.5 mm ECal Module 300 kHz to 26.5 GHz (Option 00F or M0F) or Mechanical cal kit 85052B or 85052D	1
N5232A/B 4-Port Network Analyzer (Option 416 and 551) or N5242A/B 4-Port Network Analyzer (Option 400 and 551) or N5242A/B 2-Port Network Analyzer (Option 200 and 551)	1
Set of interconnect cables (analyzer to test set), see Table 3 on page 13.	1

Verification Limits

Specifications for the Test Set are typical. System performance for the network analyzer and test set are only characteristic and intended as non-warranted information. Only a functional certificate is provided for the test set.

It is recommended that you return your instrument to Keysight Technologies for servicing or repair if the test set and network analyzer performance exceed the operational verification limits.

Table 16 Typical Verification Limit for Reflection Tracking[a] (Ports 1-12)

Frequency	N5232A/B		N5242A/B	
	Standard	Option 001	Standard	Option 001
10 MHz to 4 GHz	-3 dB	+4 dB	-3 dB	+3 dB
4 GHz to 6 GHz	-4 dB	+3 dB	-5 dB	+2 dB
6 GHz to 10 GHz	-5 dB	+3 dB	-5 dB	+2 dB
10 GHz to 15 GHz	-7 dB	+3 dB	-7 dB	+2 dB
15 GHz to 20 GHz	-8 dB	0 dB	-8 dB	-3 dB
20 GHz to 26.5 GHz	-	-	-12 dB	-

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

NOTE If you suspect that your test set configuration is not operating properly, ensure that all front RF jumper interconnect cables are correctly attached

Cal Kit 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.

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

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

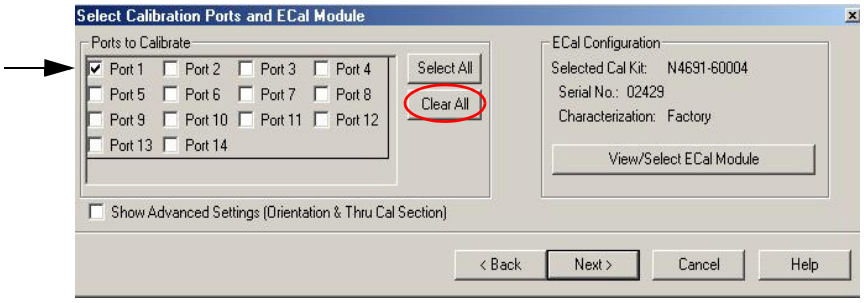
Preparing the Network Analyzer

1. Connect the test set to the analyzer using the interconnect cables as shown in "Hardware Lock-link Kit Installation (U3021-60001)" on page 21 and "Hardware Lock-link Kit Installation (U3021-60002)" on page 24.
2. Turn on the test set.
3. Select **Response** > **Cal** > **Manage Cals** > **Cal Set** -OR- ***(Cal Sets & Cal Kits*** > ***Cal Set...)***. Delete or rename any Cal Sets titled "999.1" thru "999.12" (12-Port), although it is unlikely that you will find Cal Sets with these names.
4. Verify that the network analyzer is in Multiport mode. See the bottom of the measurement window, similar to Figure 51 on page 64.
   a. If only four S-Parameters are listed, select **Utility** > **System** > **Configure** > **Multiport Capability** -OR- ***(Instrument*** > ***Setup*** > ***External Hardware*** > ***Multiport*** > ***Multiport Configuration...)***. Select **Restart as multiport PNA with this testset** and select **U3022AE10** (12-Port) from the drop-down menu > **OK**. Refer to Figure 27 on page 37.
5. Press **[Preset]**.
6. Verify that the **[Start Frequency]** is set to **[300 kHz or 10 MHz]**.
7. Set the **[Stop Frequency]** to **[20 GHz or 26.5 GHz]**.
8. Select **[Power]** > **Power Level** and enter **[0 dBm]**.
9. Select **Response** > **Avg** > **IF Bandwidth** > **100 Hz** > **OK**.
10. Select **Stimulus** > **Sweep** > **Number of Points** > **401**.
11. Connect the ECal module to an available USB port on the front or rear panel. This procedure assumes you are using a ECal. If you are not, see "1-Port Calibration and Verification Procedure" on page 63, step 2.
12. Allow the ECal module, test set and analyzer 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. Torque to 8 in-lb. For further information refer to the Help menu.
2. Perform a 1-Port Calibration on Port 1. On the analyzer, select **Response** > **Cal** > **Start Cal** > **Calibration Wizard** -OR- ***(Response** > **Cal** > **Other Cals)***.
   a. If using a mechanical cal kit, select **SmartCal (Guided Calibration)** > **Next**.
   b. If using an ECal module, connect the ECal to an analyzer's USB port. Select **Use Electronic Calibration (ECal)** > **Next**.
3. Continue following the Cal Wizard prompts. In the "Select Calibration Ports and ECal Module" dialog box click **Clear All**, then select **Port 1** > **Next** > **Measure**.
4. Ensure the Cal Kit you are using is indicated on the right side of the window.

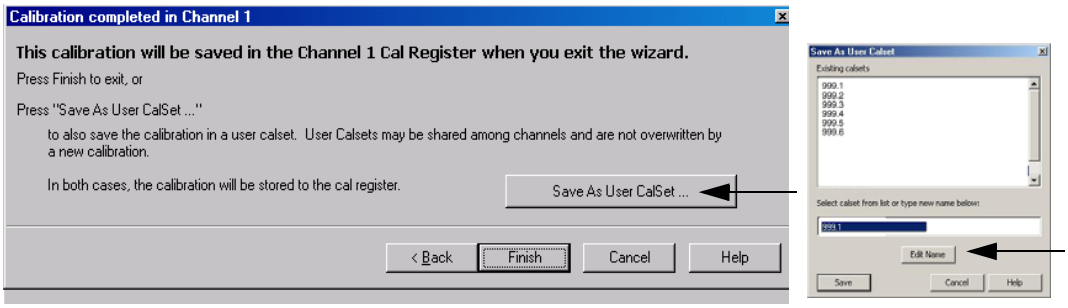
Figure 49 1-Port Calibration



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

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

Figure 50 Calibration Complete

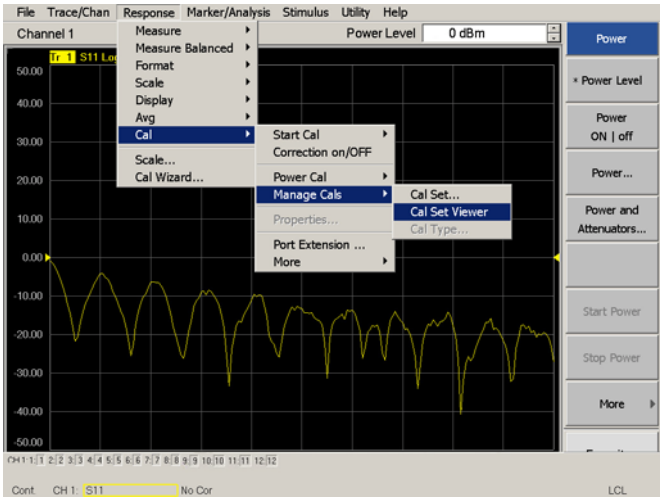


7. Repeat step 1 thru step 6 (1-Port Calibration Procedure) for Ports 2 thru 8. When finished, there should be 8 Cal Sets saved with the titles "999.1" thru "999.12" (12-Port).

Cal Set Verification

1. Select **Trace/Chan** > **Trace** > **Delete Trace** -OR-
   (Instrument > ***Trace*** > ***Delete Trace)***. There should be no traces on the screen.
2. To launch the Cal Set Viewer toolbar. Select
   Response > **Cal** > **Manage Cals** > **Cal Set Viewer** -OR-
   (Response > ***Cal*** > ***Cal Sets & Cal Kits*** > ***Cal Set Viewer [On/Off])***.

Figure 51 Calibration Cal Set Viewer



3. From the Cal Sets drop-down menu, select **999.1** and select **Enable**. Select the **Reflection Tracking(x,x),** where x,x is the port being tested. Ensure that the **Enable** and **Error Terms** check boxes are selected.
4. Compare the Reflection Tracking (1,1) trace to the appropriate limits in Table 16 on page 61. This can be done using Markers.
5. Repeat step 3 and step 4 for Cal Sets "999.1" thru "999.12" (12-Port).

Figure 52 PNA or PNA-X Port 1 & 2 and PNA-L Ports 1-12

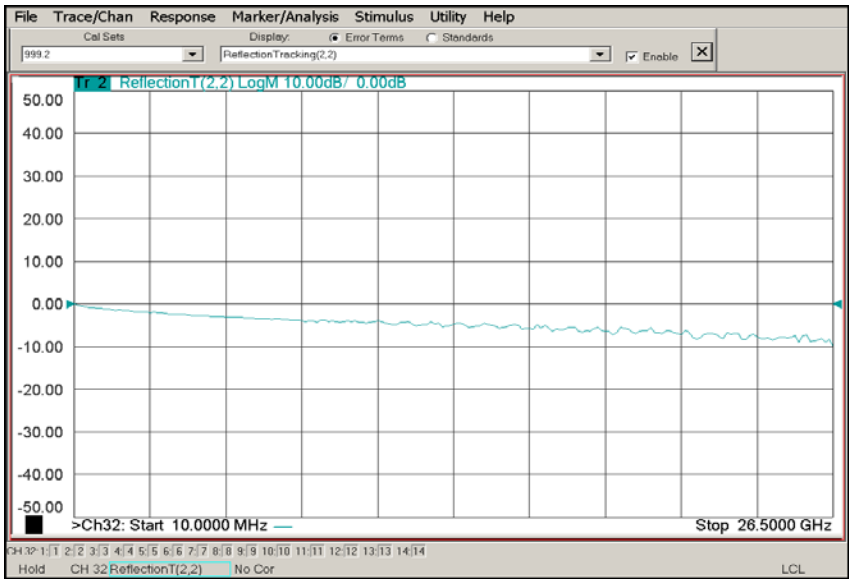


Figure 53 PNA or PNA-X Port 1& 2 and PNA-L Ports 1-12 (Option 001)

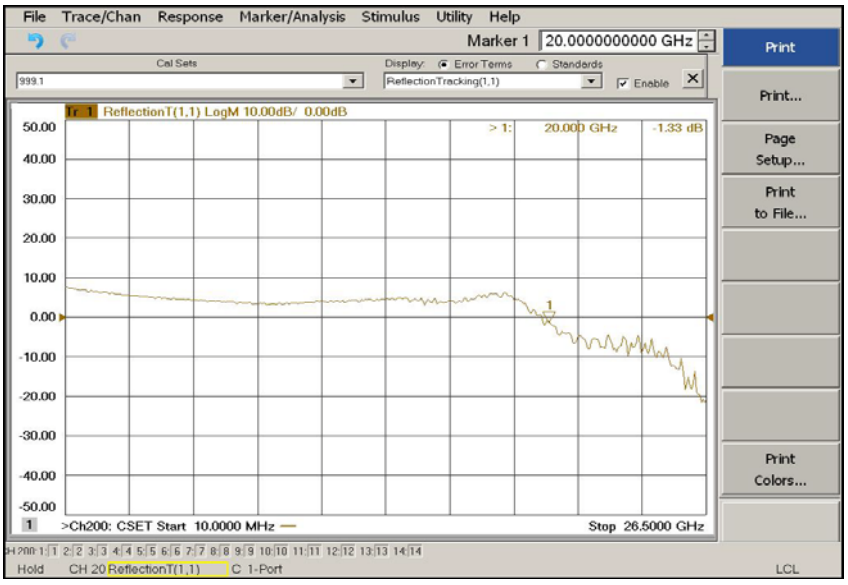


Figure 54 PNA or PNA-X Port 3-12

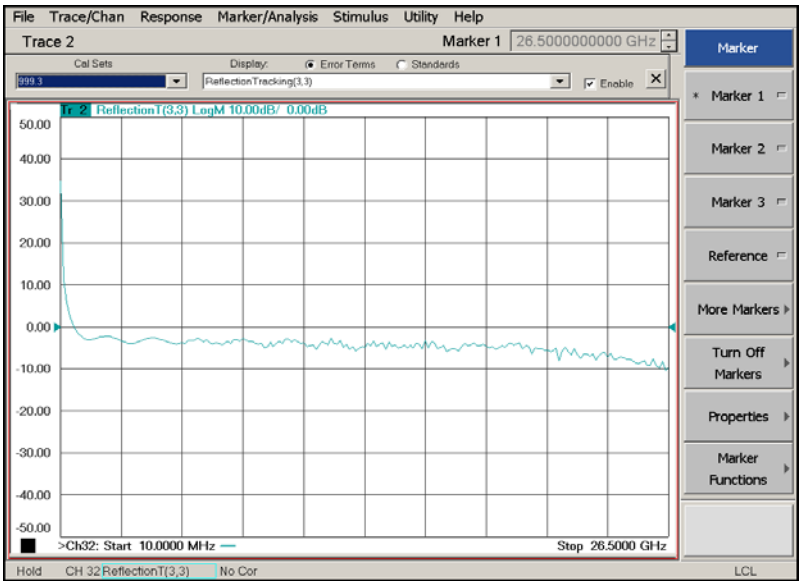
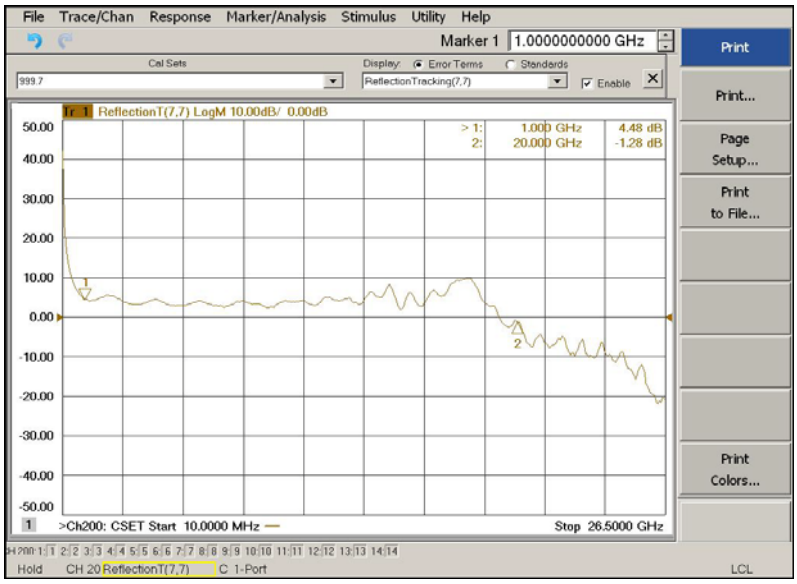


Figure 55 PNA or PNA-X Port 3-12 (Option 001)



NOTE Response from 10 MHz to 500 MHz is normal due to the PNA or PNA-X couplers in comparison to the Test Set bridges. The bridges have more gain in the coupled RF path.

Verifying a Cal Kit Operational Check Failure

If your test results fail the Cal Kit Operational Check Reflection Tracking limits, see Table 6 and Table 7 on page 17. Verify the following:

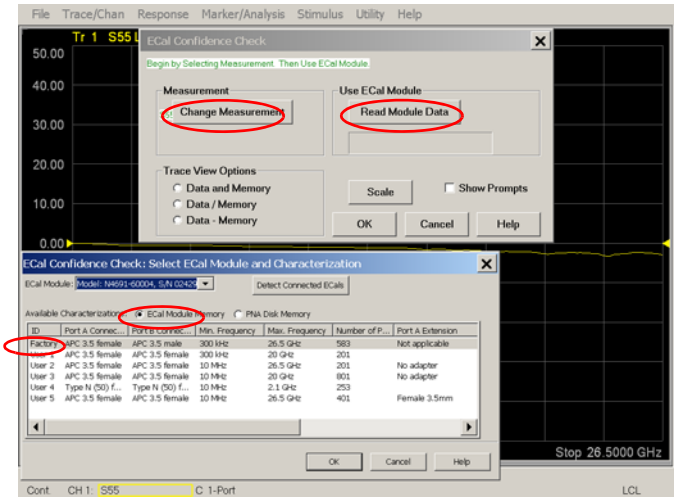
1. Ensure that the test set is on and connected properly to the analyzer.
2. Check all appropriate connectors for damage, cleanliness, and proper torques.
3. Repeat the relevant 1-Port calibrations using another ECal or mechanical standard.
4. Verify that the PNA is operating properly and meeting its published specifications. If the PNA is connected to the test set it will fail the Operational Check. Refer to "Network Analyzer Requirements" on page 11.

ECal Confidence Check

The following ECal Confidence Check is a method to verify the accuracy of a 1-Port calibration performed with mechanical standards or an ECal module. To perform this check, the test port of the ECal module must connect directly to the Test Port being verified (without adapters).

1. Perform a 1-Port Cal of the test set port being tested.
2. Connect the ECal Module to the Port being tested. Terminate any remaining ports on the ECal Module.
3. Select the Cal Set to be verified. Select **[CAL] > Cal Set... > Cal_File > Apply Cal > Close** -OR- ***([CAL] Cal Set & Cal Kit > Cal Set... > Apply Cal)***. If the "Choose Stimulus Settings" prompt appears, select **Change the active channel's stimulus > OK > Close**.
4. Select **[Response] > Cal > More > ECal > ECal Confidence Check** -OR- **(Response > Cal > ECal Confidence Check...)**.
5. Click **Change Measurement** and select the test port S-parameter > **Apply > OK**. Click **Read Module Data**.
6. Select the ECal Module you are using, and select the **ECal Module Memory > Factor > OK**.

Figure 56 ECal Confidence Check



Service Information

Refer to “Contacting Keysight” on page 94.

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 https://www.keysight.com/my/fapHomePage.

Table 17 Available Replacement Parts (SPO)

Description	Keysight Part Number
PNA-X Test Set Rear Lock-link (right)	N5242-20138
PNA-X Test Set Rear Lock-link (left)	N5242-20139
PNA-L Test Set Lock-links	5063-9253
Coupler/Bridge	5087-7716
Coupler/Bridge (RoHS)	5087-7752
Amplifier (Option 001 & 002)	5087-7790
Amplifier (Option 001 & 002), (RoHS)	5087-7750
Bias Tee (Option 002)	5087-7239
Fuse (5 A 250 V non-time delay (20 mm)	2110-0709
Fuse (8 A 250 V non-time delay (1.25 inch)	2110-0342
DUT Control Board	U3020-63223
Fan (rear panel)	87050-60027
RF Switch SP6T, 24 V, (RoHS)	87106-60065

NOTE The following replaceable parts may be ordered by sending an e-mail 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 18 Available Factory Replaceable Parts (E10)

Description	Keysight Part Number
Screw (lock-links)	0515-2317
PWR Supply (AC/DC SWG 650W 9- Output	0950-4729
Lock-link for a PNA & PNA-X	5023-0132
Test Set I/O Cable	N4011-21002
U3042AE10 User's and Service Guide	U3022-90001
Fan (Deck)	U3022-60005
Label printed - Port 13	U3022-80002
Label printed - Port 14	U3022-80003
Label printed - Port 2	U3022-80004
LED Status Board	N5261-63005
LED Status Ribbon Cable	N5261-60001
Switch Interface Board	U3025-63062
Controller Board	N5261-63006
Power Switch and LED	Z5623-60221
14-Port Configuration Interface Cables with SMA Connectors	
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20031
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20032
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20033
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20034
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20035
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20036
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20037
RF Cable, Semi-rigid (N5232A/B Option 416)	U3022-20038
RF Cable, Semi-rigid (N5242A/B)	U3022-20042
RF Cable, Semi-rigid (N5242A/B)	U3022-20043
RF Cable, Semi-rigid (N5242A/B)	U3022-20044
RF Cable, Semi-rigid (N5242A/B)	U3022-20045
RF Cable, Semi-rigid (N5242A/B)	U3022-20046
RF Cable, Semi-rigid (N5242A/B)	U3022-20047
RF Cable, Semi-rigid (N5242A/B)	U3022-20048
RF Cable, Semi-rigid (N5242A/B)	U3022-20049

System Block Diagrams

Figure 57 U3022AE10 RF Block Diagram (12-Port)

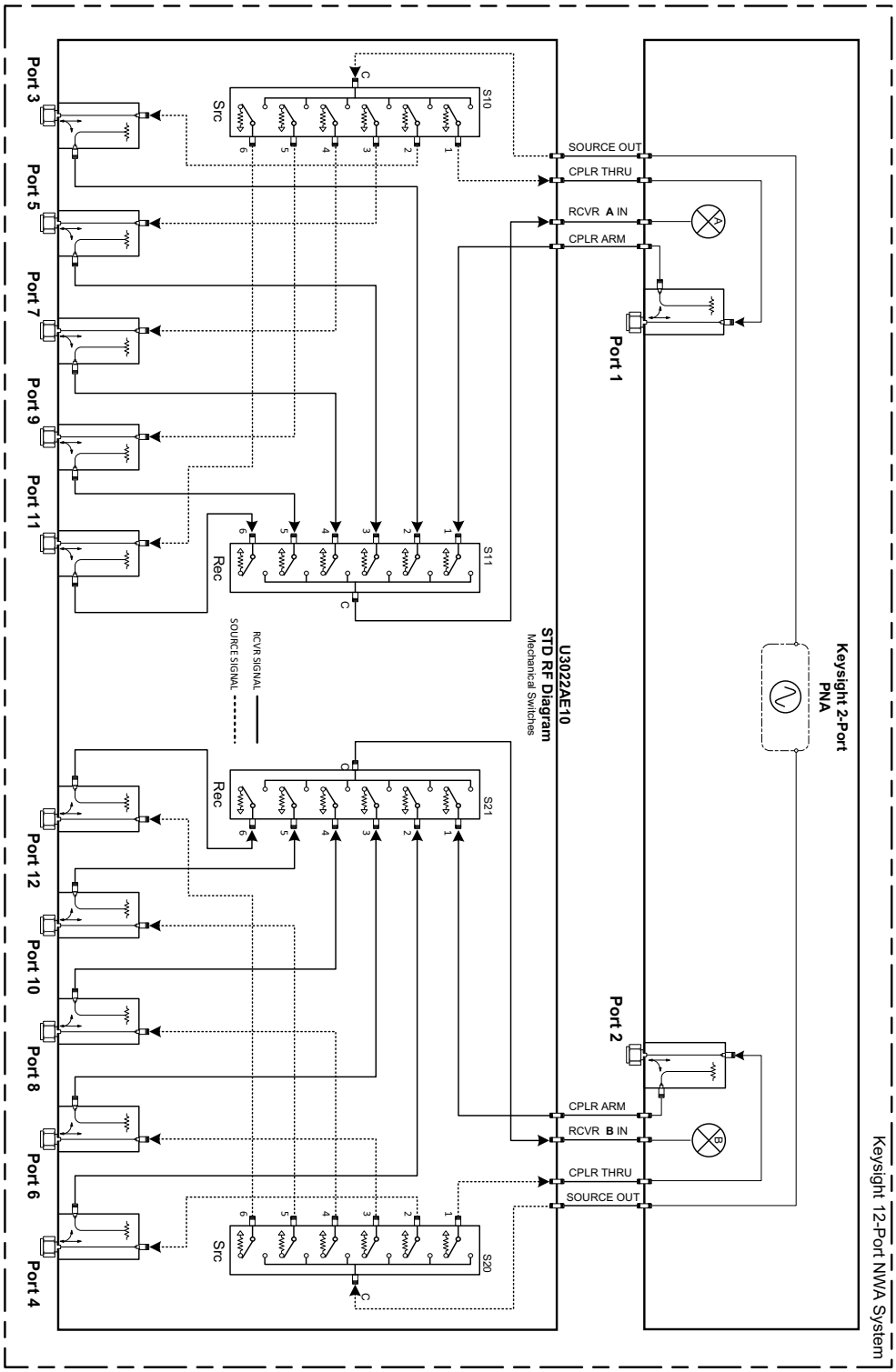


Figure 58 U3022AE10 RF Block Diagram (14-Port)

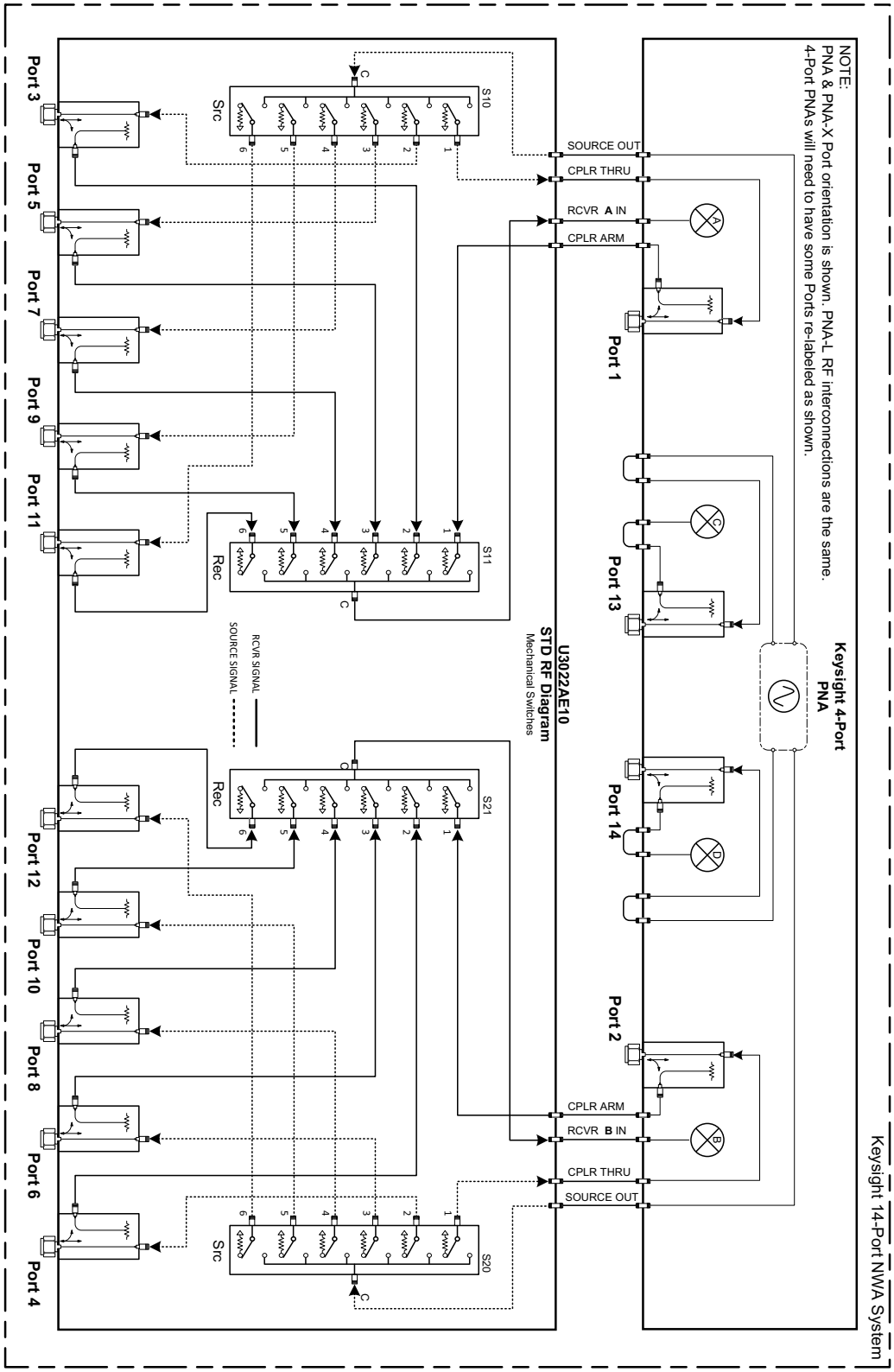


Figure 59 U3022AE10 RF Block Diagram (12-Port, Option 001)

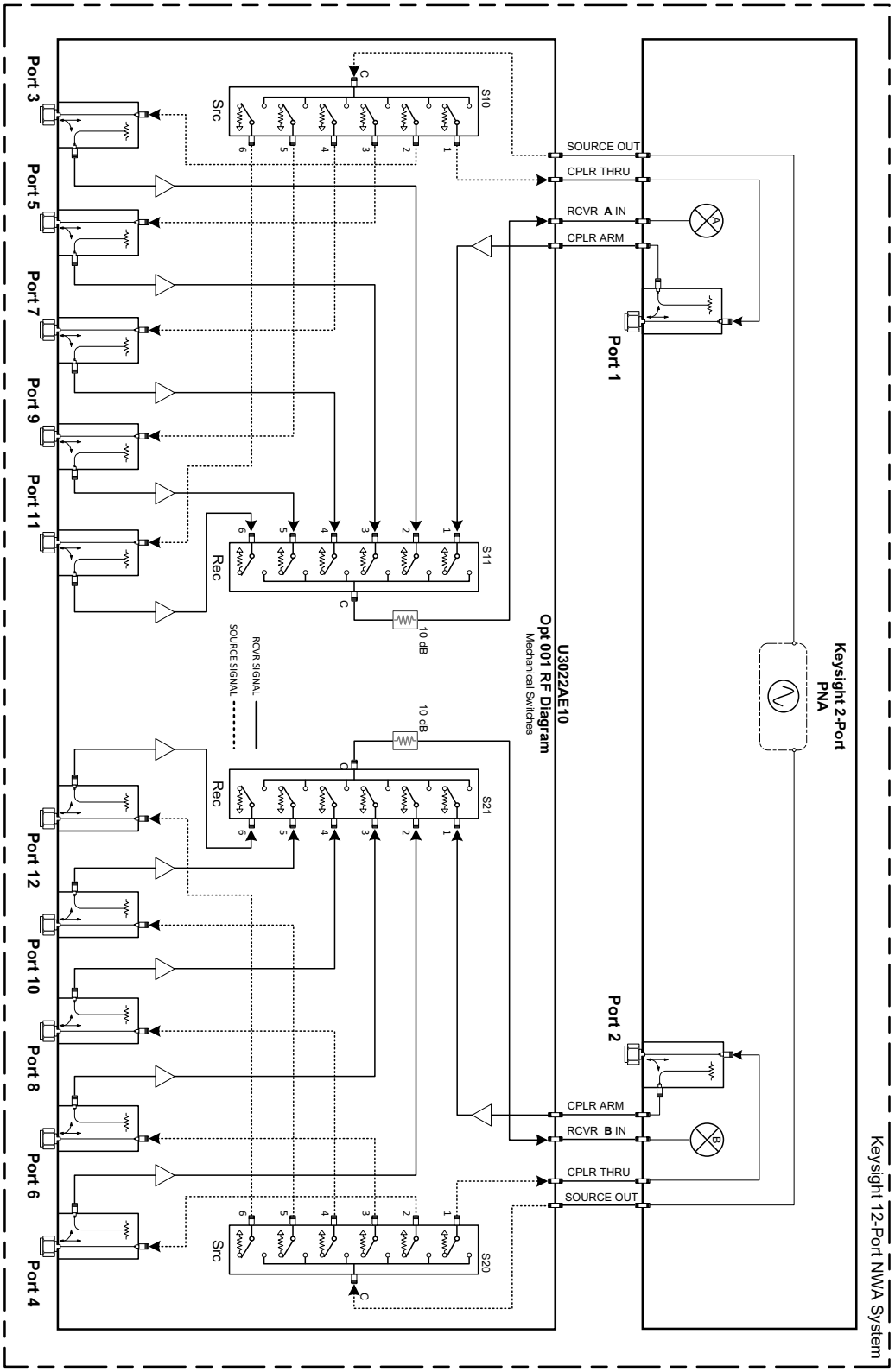


Figure 60 U3022AE10 RF Block Diagram (14-Port, Option 001)

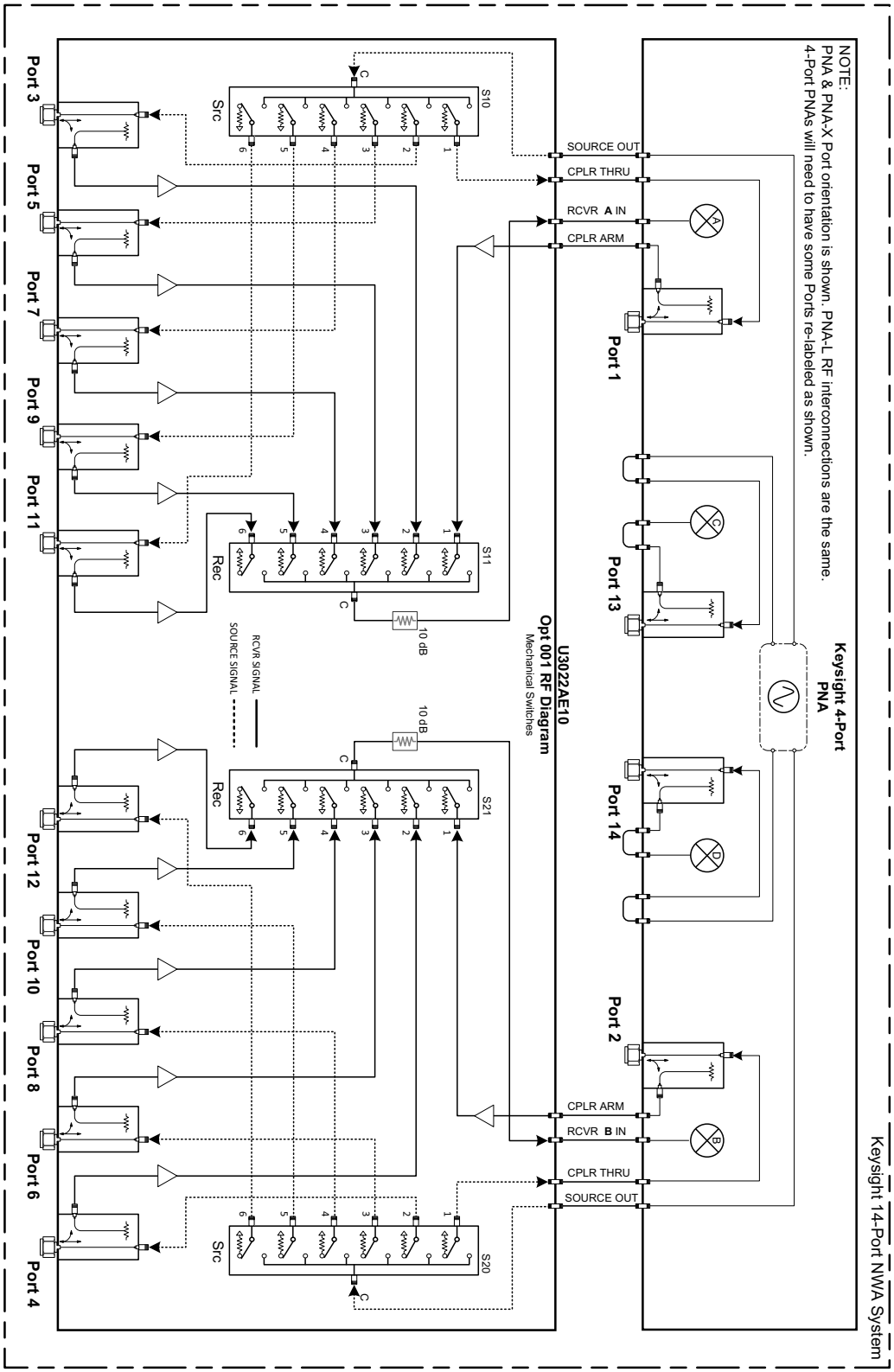


Figure 61 U3022AE10 RF Block Diagram (12-Port, Option 002)

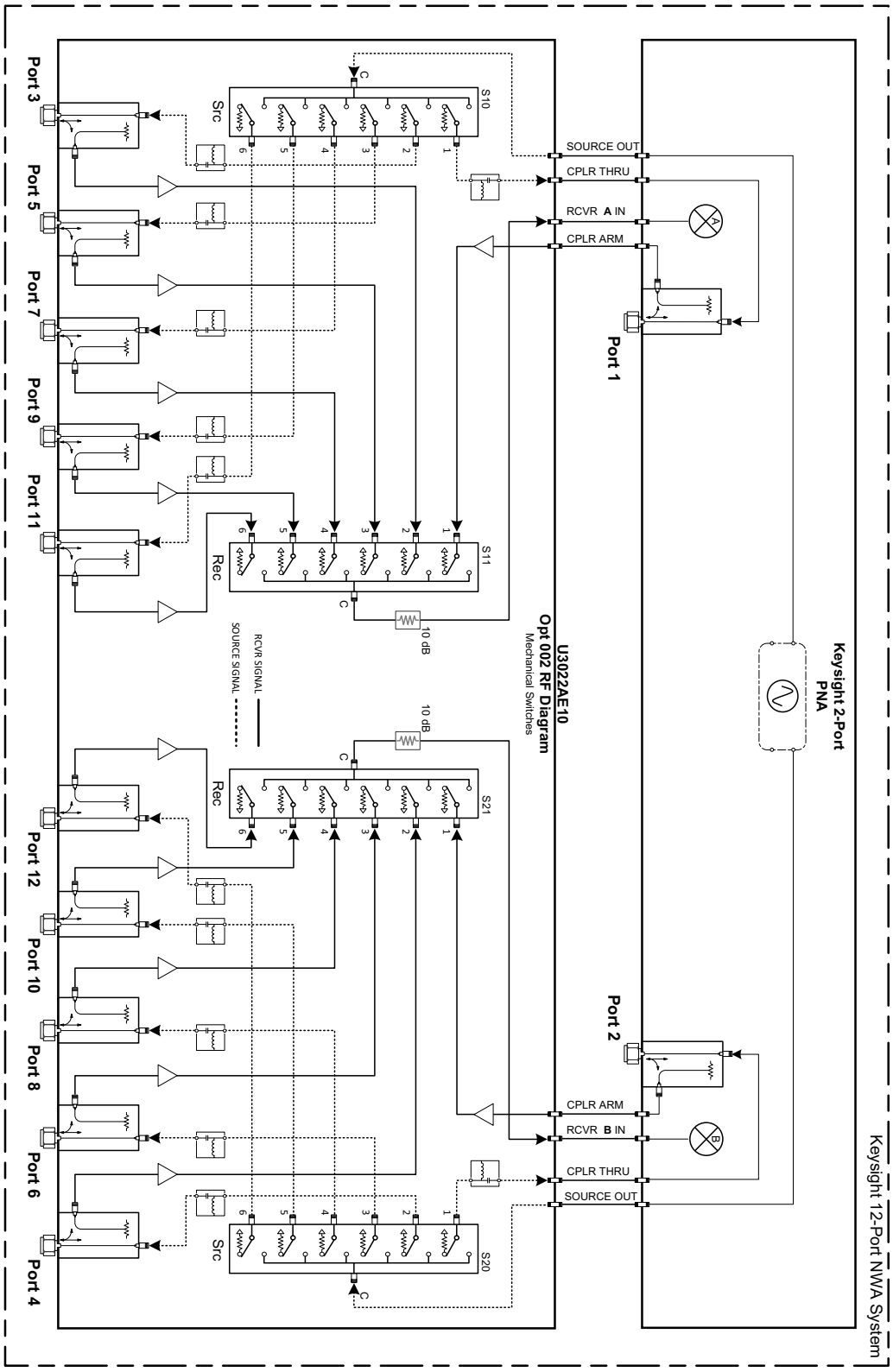
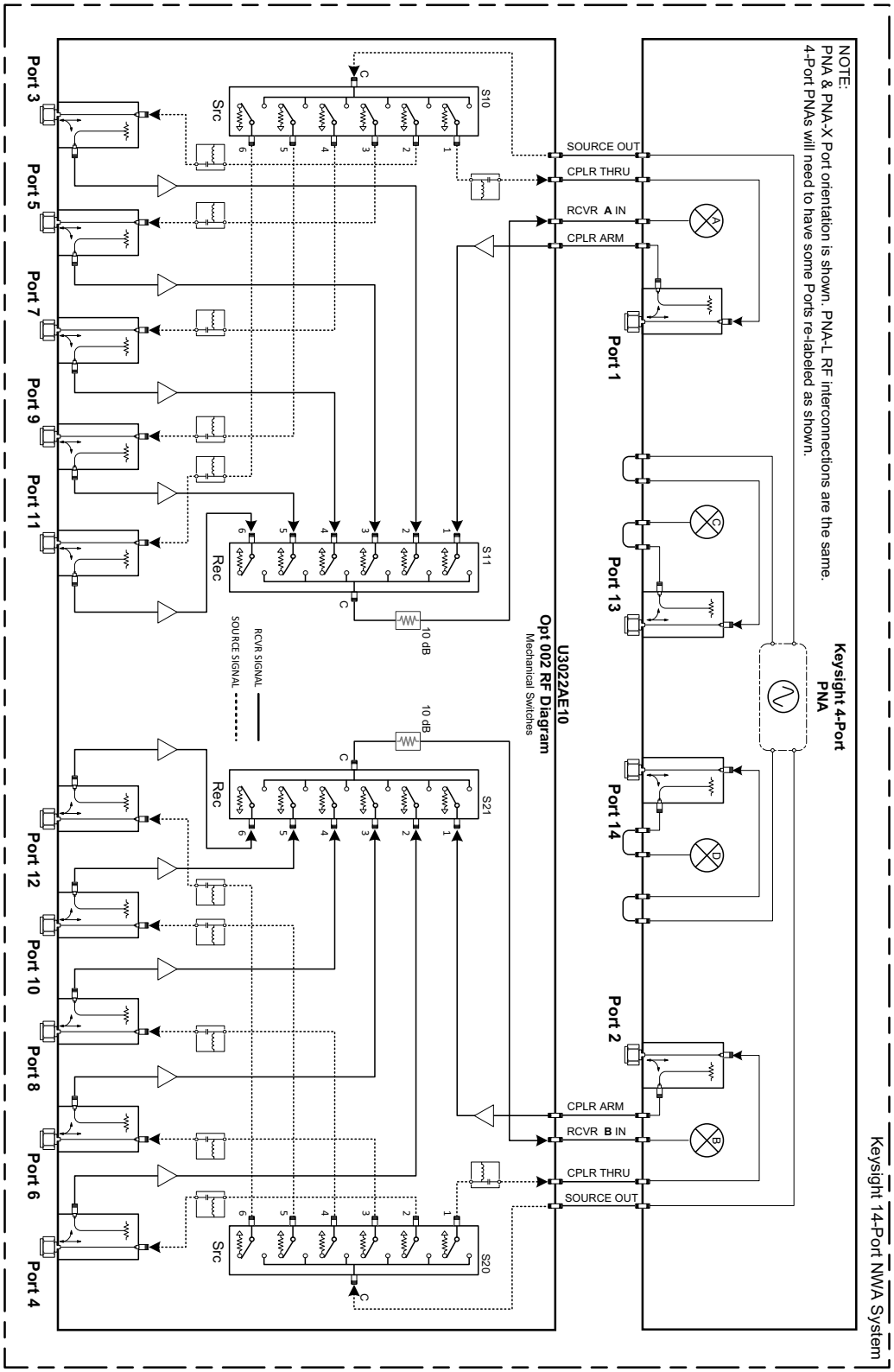


Figure 62 U3022AE10 RF Block Diagram (14-Port, Option 002)



Theory of Operation

The following is a description of the operation of the test set. Reference the test set block diagrams shown in "System Block Diagrams" on page 70. This section assumes the user has a general understanding of couplers, switches, and network analyzers.

RF Coupler/Bridges

The test set uses ten coupler/bridges (5087-7752) on the front panel for RF Test Ports 3 - 12. The coupler/bridges provide the signal separation of the source and receiver paths, using resistor networks. The test set ports can receive from or stimulate a signal to the DUT.

The RF Test Port connectors are male 3.5 mm. The coupling factor is approximately -16 dB for the Coupled Arm (minimum -22 dB and max -12 dB at 26.5 GHz). The insertion loss through the CPLR THRU path is typically < 4 dB at 26.5 GHz. Do not use excessive RF power or DC voltage, or damage may occur to the internal resistors.

RF Switch Components

The test set uses four mechanical switches (87106-60065) that have internal 50 Ohm termination for each path. The switches select the RF paths from the analyzer's source and receiver through interconnect cables to the test set. Network analyzer ports 1 through 2 and test set ports paths 3 through 12.

RF Amplifiers, Option 001 & 002

Twelve RF amplifiers are installed in the receiver signal paths to improve the dynamic range of the system. The amplifiers reduce the operational frequency range of the system to 10 MHz - 20 GHz. A cooling fan (U3022-60005) was added internally to assist in maintaining cooling air flow of the RF amplifiers.

S10 - Source to Odd Ports (1-11) Switch 10 provides control of the Source path to PNA Port 1 and the test set odd ports (3 - 11). In the state shown in the block diagram, switch 102 routes the RF source back to the PNA Port 1 and all unused test set odd ports (3 - 11) source paths are terminated.

S20 - Source to Even Ports (2-12) Switch 20 provides control of the Source path to PNA Port 2 and the test set even ports (4 - 12). In the state shown in the block diagram, switch 202 routes the RF source back to the PNA Port 2 and all unused test set even ports (4 - 12) source paths are terminated.

S11 - Receiver to Odd Ports (1-11) Switch 11 provides control of the A Receiver path to PNA Port 1 and the test set odd ports (3 - 11). In the state shown in the block diagram, switch 302 routes the coupler arm from the PNA Port 1 to the A Receiver and all unused test set odd ports (3 - 11) coupler arm paths are terminated.

S21 - Receiver to Even Ports (2-12) Switch 21 provides control of the B Receiver path to PNA Port 2 and the test set even ports (4 - 12). In the state shown in the block diagram, switch 402 routes the coupler arm from the PNA Port 2 to the B Receiver and all unused test set even ports (4 - 12) coupler arm paths are terminated.

Troubleshooting the Test Set

If the test set is not operating properly, use the following procedures to aid in isolating the problem.

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

To request service, please contact your local service center. In the US, call 800-829-4444. For a listing of service centers worldwide, please visit us at https://service.keysight.com/infoline/public/default.aspx.

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

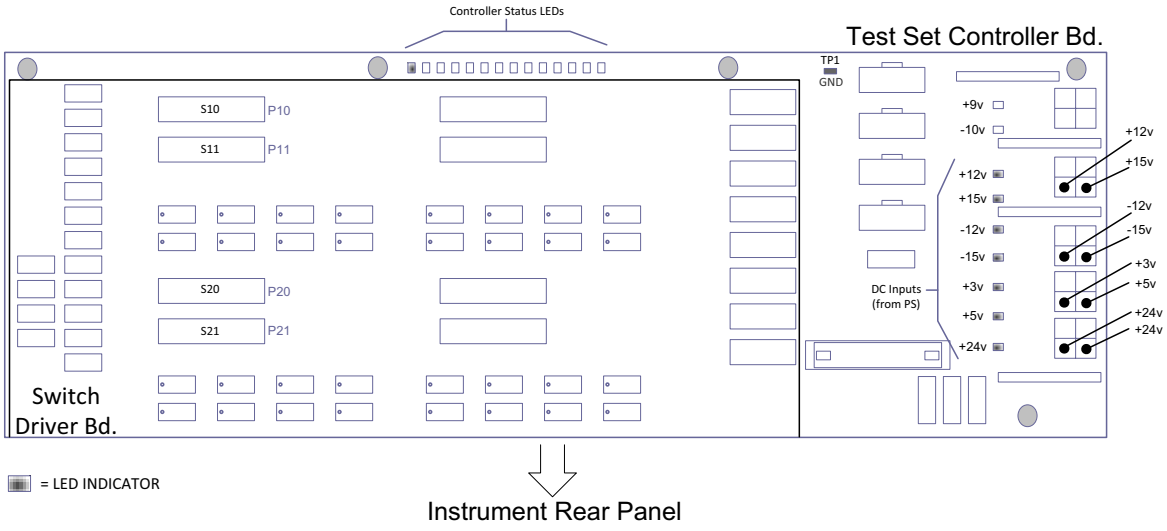
Non-RF Failures

Non RF failures are Power Supply, Fans, Control Lines, Status LEDs or Interface not operating. Refer to Figure 64 on page 78.

1. Verify that the front panel Power Switch is operational.The front panel Active LED will be OFF unless the test set interface cable is connected and the test set is addressed by the network analyzer.
2. Turn on the Standby Switch. The rear panel and internal power supply fans should be operational. If not, continue with step 3.
3. AC Line voltage checks (remove AC power from the instrument).
   a. Ensure the proper AC Line voltage is present at the instrument line cord.
   b. Remove the AC power cord from the instrument. Verify the instrument AC Line Module fuse (2119-0709) and replace if necessary. Refer to Figure 6 on page 20.
   c. Verify the Internal AC lines fuse (2110-0342). Remove the instrument bottom cover. Near the rear panel are two fuse holders, verify the fuses and replace if necessary. See Figure 71 on page 88.
4. Internal DC Power checks.
   a. Set the front panel switch to the Standby position. No fans or indicator lights should be operational
   b. Remove the top cover.
   c. Set the Standby switch to the ON position. Both the rear panel and internal power supply fans should be operational. Verify that the DC indicator LEDs are ON as shown in Figure 63 on page 78.

NOTE The +9 Vdc and -10 Vdc indicator are not used, they will be off.

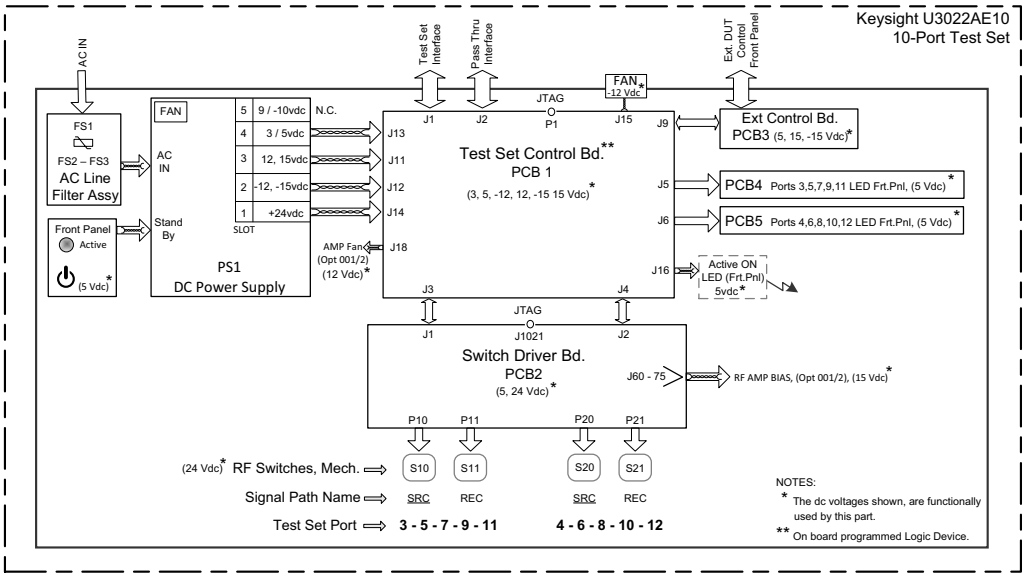
Figure 63 DC Power Status LEDs



d. If the DC Indicator LEDs are not on, suspect the main power supply module or front panel switch. The power supply (0950-4729) terminal connections should also be verified with a DVM. Verify the voltages on the power supply label.

e. If rear panel fan is not operating and the DC Indicator LEDs are on, replace fan.

Figure 64 Test Set Diagram



5. Front Panel R and S indicator LED Check.
   a. Verify the test set Controller board Controller Status LEDs, shown in Figure 63 on page 78.
   b. If none are ON, remove the Switch Driver board and recheck. If still no indication, replace the Controller board.
   c. If the Controller Status LEDs are ON and the front panel Active LED is ON, suspect the front panel LED boards or the ribbon cables. Replace as needed.
6. Control Lines are not working.
   a. Verify that the control voltage pin connections to the DUT control lines are connected properly. Refer to "Control Lines" on page 54.
   b. Verify that the rear panel DC voltage control adjustment can be set to 5 Vdc. Refer to Figure 5 on page 19.

RF Switching Failures

If the test set's RF signal functionality is not operating properly, use the following procedure to aid in isolating the source of problem. The internal RF mechanical switches used in this instrument are biased with the +21 Vdc supply voltage from the Switch Interface board.

1. Follow the "Non-RF Failures" on page 77, if you have not done so.
2. Place the network analyzer and test set side by side (not stacked) and connect the I/O cable (N4011-21002). See Figure 20 on page 31.
3. Ensure that the network analyzer is NOT in Multiport Mode.
4. Using the test set I/O Data command values, confirm the correct address and data values are used, refer to "Address and Data Values" on page 52.

RF Switching Path Test

If you suspect an RF signal path problem with the test set and have verified that the problem in not the front panel RF interface cables, the following procedure will check all of the RF signal paths through the test set.

- Install the Test Set I/O cable from the analyzer to the test set's rear panel.
- Remove the front panel RF interface cables and reinstall the analyzer's front panel semi-rigid "U" shaped jumper cables.

Equipment Required

- PNA, PNA-L or PNA-X Network Analyzer
- Two RF Flex Cables (3.5 mm male/female)
- 3.5 mm Adapters (female to female)
- Test Set I/O Cable

Equipment Setup

1. Turn on the test set and the analyzer.
2. **Preset** the analyzer and set it to **Standalone Mode**. Select **Utility** > **System** > **Configure** > **Multiport Capability**. In the dialog box select **Restart as a standalone PNA** > **OK**.
3. Connect the RF cables to the analyzer's Ports 1 and 2. Connect the cables together using a 3.5 mm adapter.
4. Configure the analyzer to measure S21 and normalize the response trace.
5. Set the analyzer to **Interface Control Mode**: Select **Channel** > **Hardware Setup** > **More** > **Interface Control...** and click **Enable Interface Control box**.

NOTE

The <addrs>.<data> entries noted in the following Test Instructions table will be used to configure the RF switches for this testing. After making your entry select <OK> to execute the command, to return back for further entries, select Interface Control on the PNA display.

Table 19 RF Signal Path Insertion Loss (S21)

RF Path Description	Signal	Insertion Loss (typical)
Source Out to Ports 3-12	Source	Figure 65 on page 82
A/B IN to Ports 3-12	Receiver	Figure 66 on page 83 or Figure 67 on page 84
Source Out to CPLR THRU	Source	Figure 68 on page 85
A/B IN to CPLR ARM	Receiver	Figure 68 on page 85 or Figure 69 on page 86

Source Signal Path Insertion Loss Test

Connect the RF Flex cables to the Test Port and Source Out port indicated in Table 20, the expected results should be similar to Figure 65.

Table 20 Source Signal Path Test Instructions

Path #	RF Path Description	Control Mode <Address>.<Data>	Path Components	Insertion Loss (typical)
1	Source Out to Port 3[a]	0.1	P3 CPLR, S10	
2	Source Out to Port 5	0.2	P5 CPLR, S10	
3	Source Out to Port 7	0.3	P7 CPLR, S10	
4	Source Out to Port 9	0.4	P9 CPLR, S10	
5	Source Out to Port 11	0.5	P11 CPLR, S10	Figure 65
6	Source Out to Port 4	16.1	P4 CPLR, S20	
7	Source Out to Port 6	16.2	P6 CPLR, S20	
8	Source Out to Port 8	16.3	P8 CPLR, S20	
9	Source Out to Port 10	16.4	P10 CPLR, S20	
10	Source Out to Port 12	16.5	P12 CPLR, S20	

a. Use the Source Out port (on the left) associated with the odd test ports.

Figure 65 Source Out to Ports 3-12 Path Response

Connect the RF Flex cables to the Test Port and A/B IN port indicated in Table 21. The expected results should be similar to Figure 66.

Table 21 Source Signal Path Test Instructions

Path #	RF Path Description	Control Mode <Address>.<Data>	Path Components	Insertion Loss (typical)
1	A IN to Port 3	0.16	P3 CPLR, S11	
2	A IN to Port 5	0.32	P5 CPLR, S11	
3	A IN to Port 7	0.48	P7 CPLR, S11	
4	A IN to Port 9	0.64	P9 CPLR, S11	
5	A IN to Port 11	0.80	P11 CPLR, S11	Figure 66
6	B IN to Port 4	16.16	P4 CPLR, S21	
7	B IN to Port 6	16.32	P6 CPLR, S21	
8	B IN to Port 8	16.48	P8 CPLR, S21	
9	B IN to Port 10	16.64	P10 CPLR, S21	
10	B IN to Port 12	16.80	P12 CPLR, S21	

Figure 66 A or B IN to Ports 3-12 Path Response, Standard

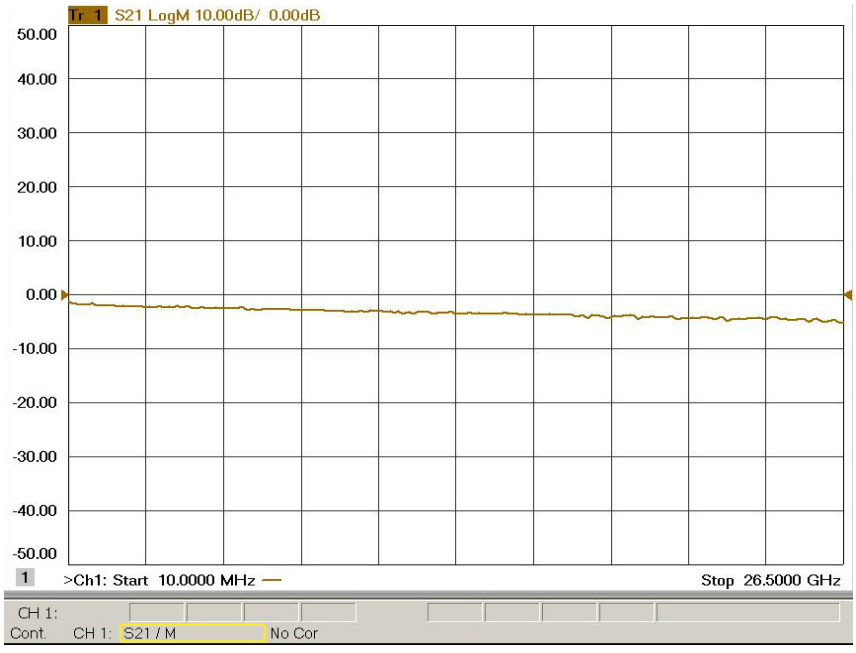
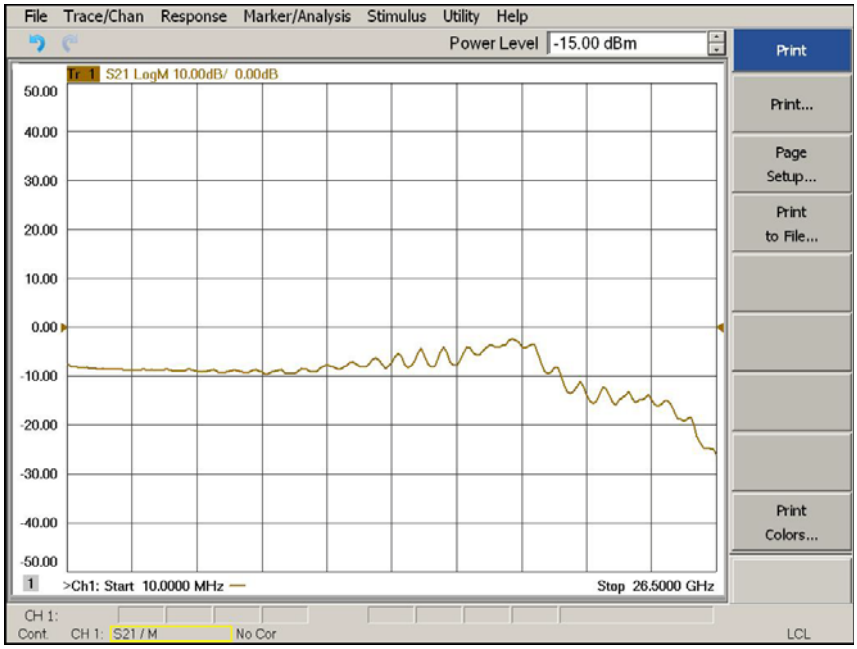


Figure 67 A or B IN to Ports 3-12 Path Response, Option 001



Connect the RF Flex cables to the Source Out and CPLR THRU port indicated in Table 22 and Table 23, the expected results should be similar to Figure 68.

Table 22 Source Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode <Address>.<Data>	Path Components	Insertion Loss (typical)
1	Left Side	Source Out to CPLR THRU	0.0	S10	Figure 68
2	Right side	Source Out to CPLR THRU	16.0	S20	

Table 23 Receiver Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode <Address>.<Data>	Path Components	Insertion Loss (typical)
1	Left Side	A IN to CPLR ARM	0.0	S11	Figure 68
2	Right side	B IN to CPLR ARM	16.0	S21	

Figure 68 Source Out to CPLR THRU or A/B IN to CPLR ARM, Standard

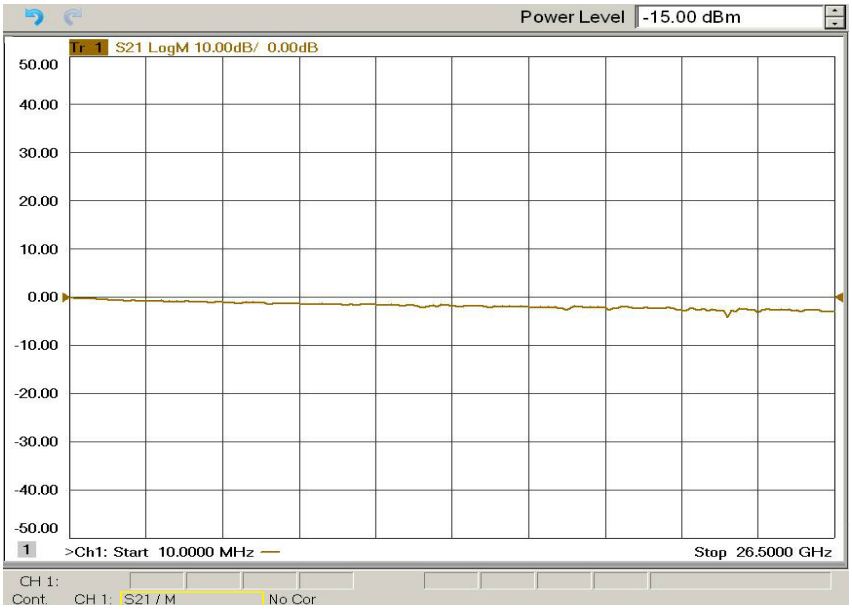


Figure 69 A/B IN to CPLR THRU, Option 001

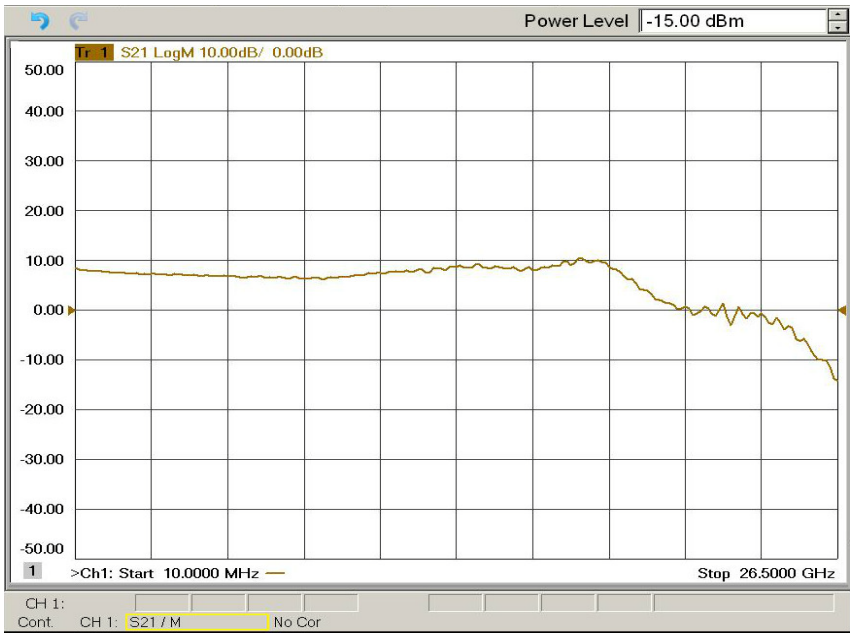


Figure 70 Top View (Option 001)

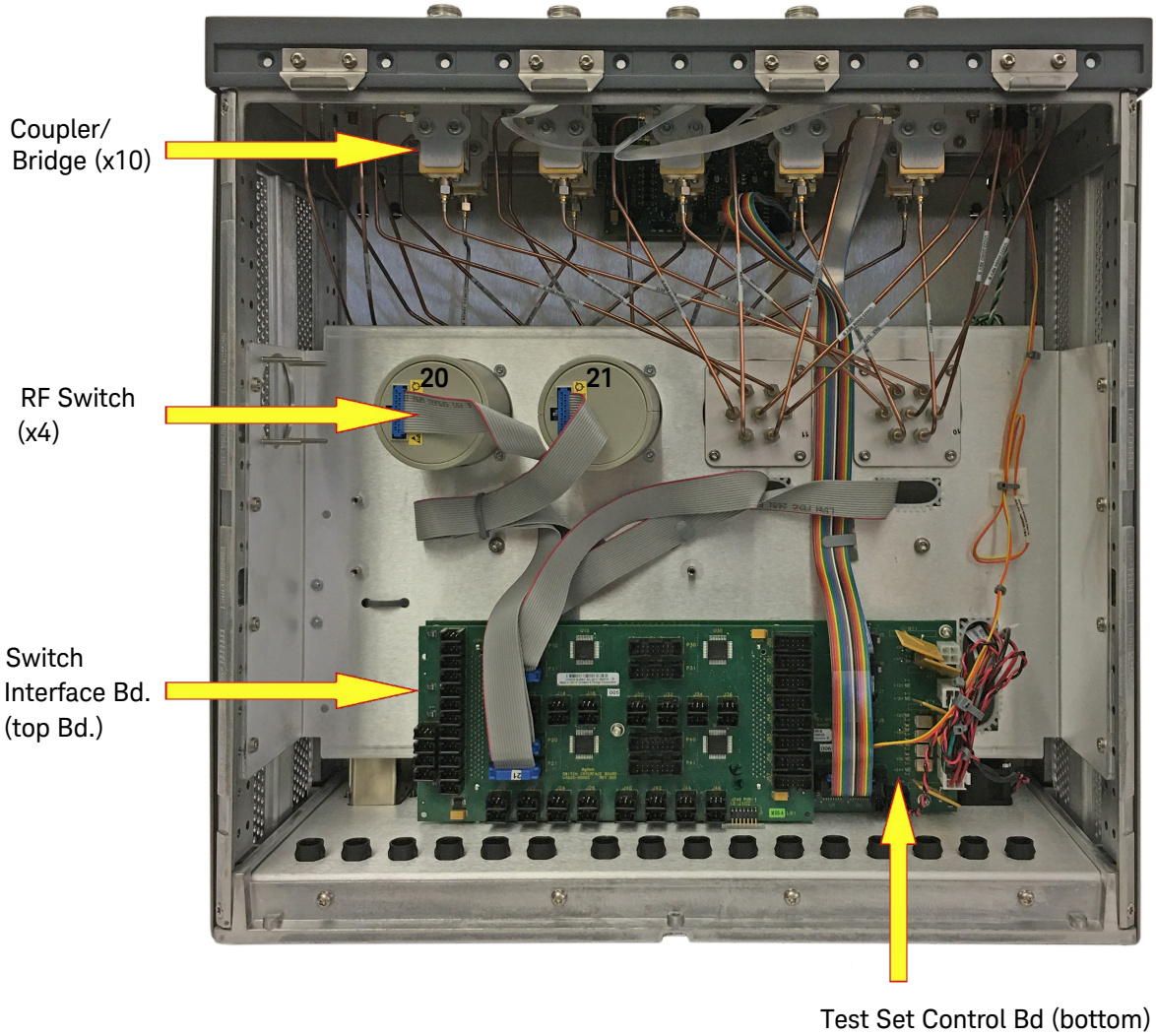
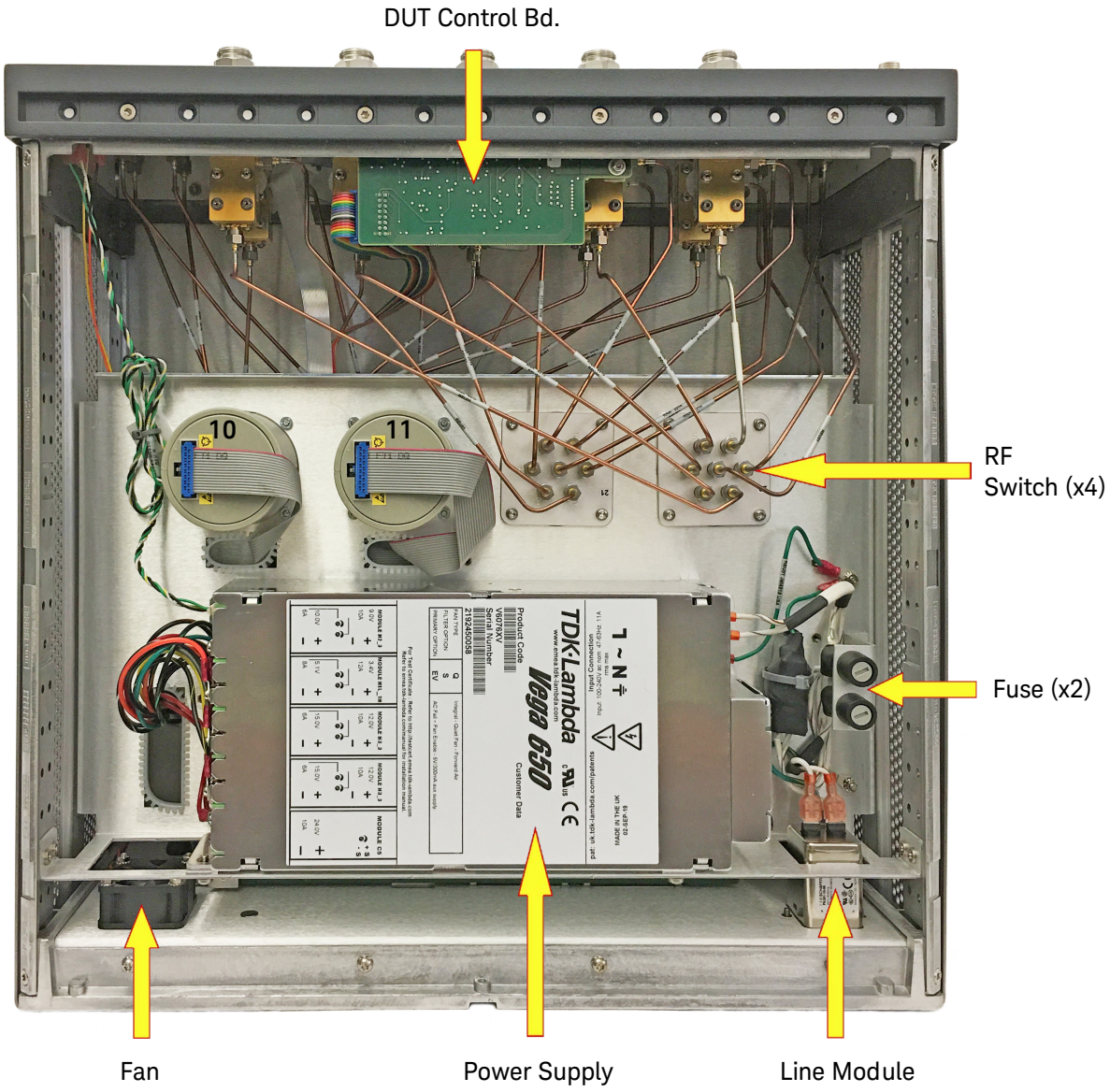


Figure 71 Bottom View



Safety and Regulatory Information

Introduction

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

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

Safety Earth Ground

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

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

Statement of Compliance

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

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 U3022AE10 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.**

Before Applying Power

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

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

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

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

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

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

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

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

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

WARNING **For continued protection against fire hazard replace line fuse only with same type and rating. The use of other fuses or material is prohibited.**

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

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

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

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

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: 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 94 for assistance.

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

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11
- ICES/NMB-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: Complies with the essential requirements of the European Low Voltage Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

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

Acoustic Statement: (European Machinery Directive):

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

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

Keysight Support, Services, and Assistance

Service and Support Options

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

Contacting Keysight

Assistance with test and measurement needs, and information on finding a local Keysight office are available on the Internet at:
http://www.keysight.com/find/assist

You can also purchase accessories or documentation items on the Internet at:
http://www.keysight.com/find

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

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

Shipping Your Product to Keysight for Service or Repair

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

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

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

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U3022-90001

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