Keysight Technologies
U3044AM16

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

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

KEYSIGHT
TECHNOLOGIES

User's and
Service Guide

Safety Notices

CAUTION

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

WARNING

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

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U3044AM16

Introduction

This document describes how to use and service the U3044AM16 Multiport Test Set.

Figure 1   U3044AM16 with connections to N5244/5B PNA-X
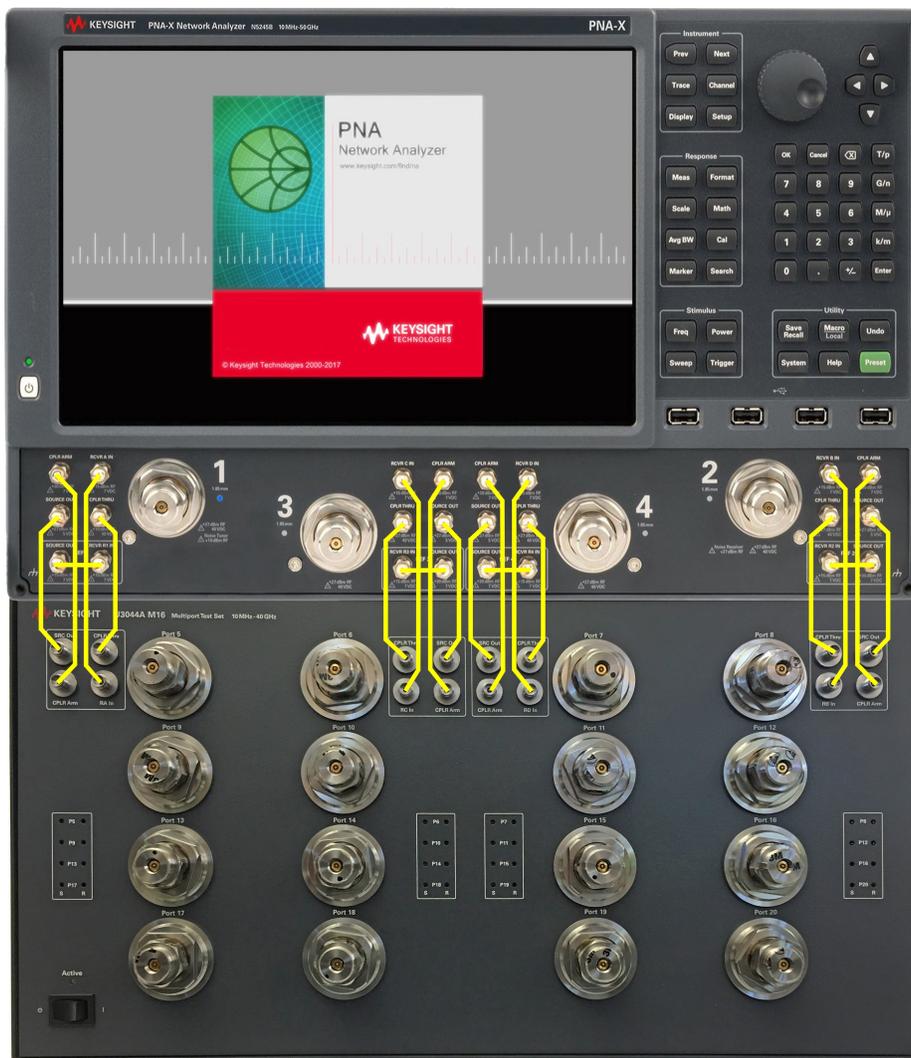
Description   The Keysight U3044AM16 is a Multiport Test Set Extension designed for use
with the Keysight N5244/5A/B 4-Port PNA-X to provide a full 20-Port
measurement solution.

The Keysight U3044AM16 has the following key features:

- 16 Test Ports (2.4mm Male connectors)

- Electro-Mechanical switches

- Frequency Range of Operation: 10 MHz – 40 GHz

- Keysight PNA compatibility with rear panel Test Set I/O interface for
  operational control. The PNA-X Option 400 and 551 are required. An
  external personal computer is not required.

- A standard Keysight System II instrument cabinet (4EIA height x 421.6 mm
  depth)

NOTE   The N5244/5A/B PNA-X network analyzer will be referred to throughout this
document as the Analyzer. The U3044AM16 will be referred to as the Test Set.

Measurement Application Notes

Low Loss DUT Measurements

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

Switch Configuration Command Speed

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

Verifying the Shipment

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

Table 1   U3044AM16 Accessories Supplied

Description	Part Number	Quantity
Short, 2.4 mm (female)	85056-60021	1
User's and Service Guide	U3044-90002	1

Network Analyzer Requirements

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

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

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

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

Table 2   Network Analyzer Configuration Requirements

20-Port System	Options	Test Set File	System Figure
N5244/45A/B PNA-X	400, 551	U3044AM16_pnax_p4.tsx	Figure 1 on page 1

32-Port System	Options	Test Set File	System Figure
N5244/45A/B PNA-X	400, 551	U3044AM16_M12_pnax_p4.tsx	Figure 53 on page 78

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

– Documentation - http://www.keysight.com/find/pna

– Network Analyzer Firmware - http://na.support.keysight.com/pna/firmware

– U3044AM16 Test Set Files - http://na.support.keysight.com/multiport/testsetsupport.html

Available Options

Test Set Options

Refer to "System Block Diagram" on page 60.

— Standard - mechanical switches for low loss.

Rack Mount and Front Handle Kits

Available kits for system cabinet mounting:

— U3044AM16-1CM, Rack Mount Kit without Handles (also 1CM130A)

— U3044AM16-1CN, Front Handle Kit (also 1CN105A)

— U3044AM16-1CP, Rack Mount Kit with Handles (also 1CP126A)

Network Analyzer Interface Kit Options

NOTE   The U3044AM16 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

20-Port System	Interface Kit Option	Hardware Lock-link	Cable Kit, Connector Type
N5244/5A/B PNA-X	U3021PX2-444	U3021-60003[1]	U3021-60105, 2.4 mm m/m[2]
32-Port System	**Interface Kit Option**	**Hardware Lock-link**	**Cable Kit, Connector Type**
N5244/5A/B PNA-X	U3044AM16-044	U3021-60003[3]	U3021-60103, 2.4 mm m/m[3]

1. "Hardware Lock-link Installation (U3021-60003)" on page 17.
2. "20-Port System Interface Cable Connections (U3021-60105)" on page 20.
3. "Supplemental System Configuration, 32-Port" on page 78.

General Specifications

Specifications for the test set are characteristic for the system performance of the network analyzer and the test set. Before using the network analyzer and test set a calibration is recommended for best measurement performance. 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.

When connected to a network analyzer, this test set will degrade the performance at the test ports. The internal switch paths reduce test port power and power to the receivers. This affects the test port power of the network analyzer and also reduces dynamic range. The reflection tracking values measured in the "Operational Check" on page 50 can be subtracted from the analyzers dynamic range to determine the approximate performance of the system.

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

— 87106D (Qty 8, 87106-60069)

Power Requirements

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

— 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 network analyzer.

— N5244/5A/B maximum power is 450 W.

— U3044AM16 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 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.

Environmental Requirements

Refer to the PNA series standard documentation for environmental requirements.

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 Measurement

Accuracy–enhanced (error–corrected) measurements require the ambient temperature of the network 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
U3044AM16	16.3 kg (35.94 lb)	23.3 cm (9.2 in)	42.5 cm (16.7 in)	43.2 cm (17.0 in)

Maximum Power Levels

CAUTION   It is recommended that you do not operate components near damage levels (+28 dBm). Do not apply any DC voltage to any front panel ports. The power levels must be 3 dB below maximum level to ensure no damage, see Table 5.

Table 5   Maximum Power Levels

Maximum Power Levels	
U3044AM16 Test Port RF Power Levels:	
PORT 5-16	+25 dBm
U3044AM16 Access Ports:	
SOURCE OUT	+15 dBm
CPLR ARM	+15 dBm
CPLR THRU	+15 dBm
RCVR OUT	+15 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 reflection tracking are typical and are intended as non-warranted information.

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

Table 6   Typical Reflection Tracking

Frequency	Port 5-20	Port 1-4
10 MHz to 500 MHz	−2.5 dB	−3.0 dB
500 MHz to 3.2 GHz	−3.5 dB	−4.0 dB
3.2 GHz to 10 GHz	−4.0 dB	−6.0 dB
10 GHz to 16 GHz	−4.5 dB	−7.0 dB
16 GHz to 20 GHz	−5.0 dB	−8.0 dB
20 GHz to 26.5 GHz	−5.5 dB	−9.0 dB
26.5 GHz to 40 GHz	−7.0 dB	−11.0 dB

Table 7   Typical Reflection Tracking (32-Port System)

Frequency	Port 5-32	Port 1-4
10 MHz to 500 MHz	−3.0 dB	−4.0 dB
500 MHz to 3.2 GHz	−5.0 dB	−7.0 dB
3.2 GHz to 10 GHz	−6.0 dB	−11.0 dB
10 GHz to 16 GHz	−7.5 dB	−13.0 dB
16 GHz to 20 GHz	−8.0 dB	−15.5 dB
20 GHz to 26.5 GHz	−10.0 dB	−18.0 dB
26.5 GHz to 40 GHz	−13.0 dB	−23.0 dB

Front and Rear Panel Features

Figure 2　　　　　　　U3044AM16 Front Panel
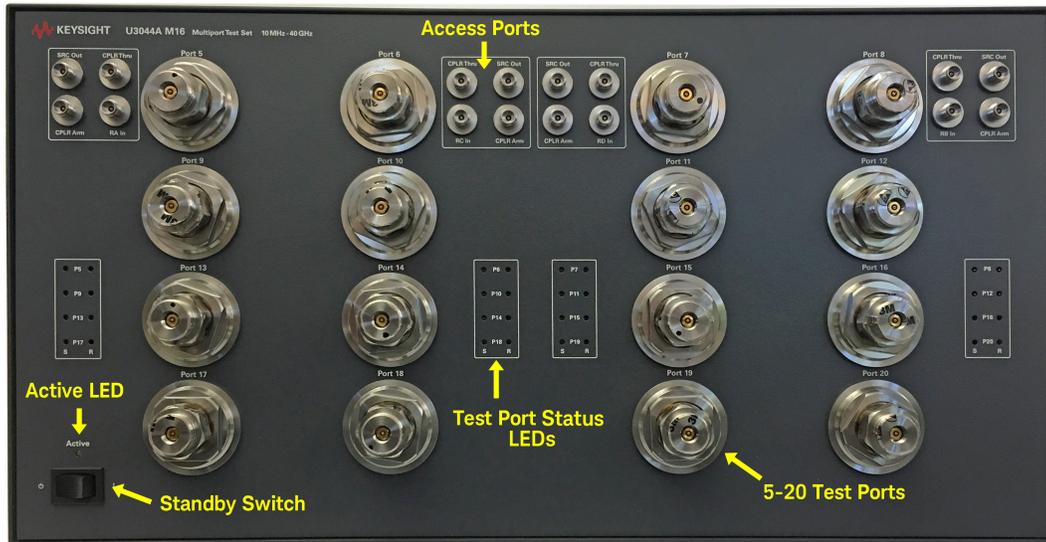
Test Ports – 2.4 mm Bulkhead (male)
- – 　Ports 5 to 20

Access Ports – 2.4 mm (female)
- – RCVR OUT
- – CPLR ARM
- – CPRL THRU
- – SOURCE IN

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.

Standby Switch

Note that this switch is Standby only, not a line 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 3   U3044AM16 Rear Panel
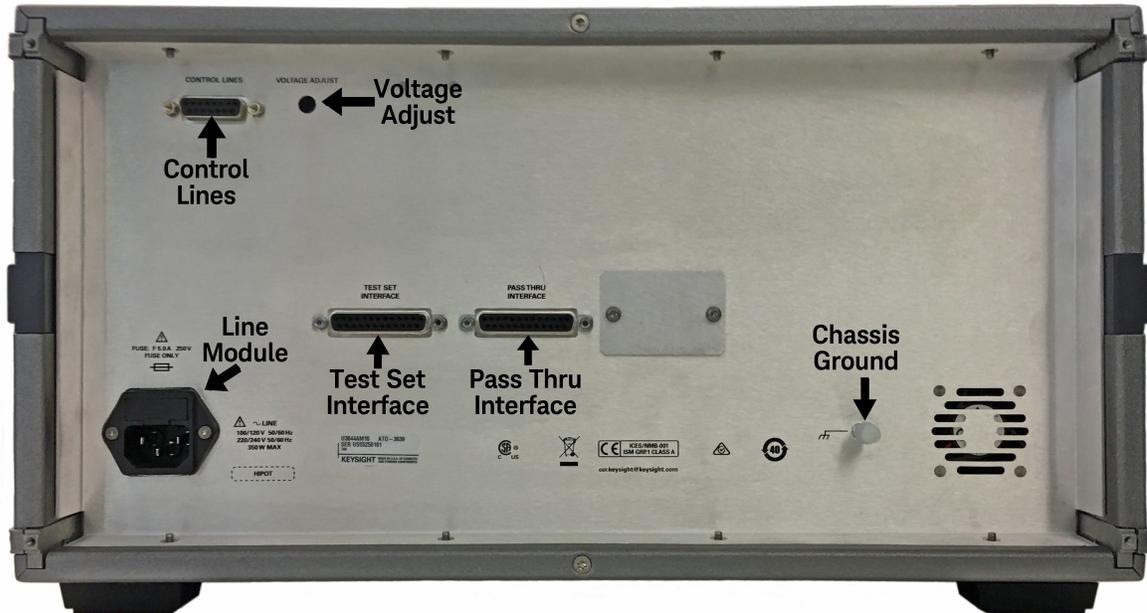
Control Lines and Voltage Adjust

For further information pertaining to control lines and voltage adjustments. Refer to "Control Lines" on page 44.

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

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

Test Set Interface

The test set Interface connector is used to send address and data to the test set from the network analyzer.

Line Module

The line fuse, as well as a spare, reside within the line module. Figure 4 illustrates where the fuses are located and how to access them.

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is

only a standby switch and is not a LINE switch. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

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

Power Cords

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

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

Available Fuses

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

— Fuse (F 8 A/250V, 2110-0342) UL listed and CSA certified.

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

Figure 4   Line Fuse

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

Hardware Lock-link Installation (U3021-60003)

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

WARNING   Opening covers or removing parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

Locking the Test Set to the Network Analyzer

1. The lock-link kit (U3021-60002) includes the following:

   – 5023-0132 – Lock-links kit (left, right pair and screws), analyzer

   – 0515-2317 – Screw T15 M3.5 x 0.6 12 mm

   – N5242-20138 – Right Lock-link, Test Set

   – N5242-20139 – Left Lock-link, Test Set

2. Remove the feet from the bottom of the analyzer.

3. Remove the 2 lower standoffs from the rear panel on the analyzer using a T20 torx driver.

Figure 5   Rear Bottom Feet

Standoffs (x2)

Feet (x4)
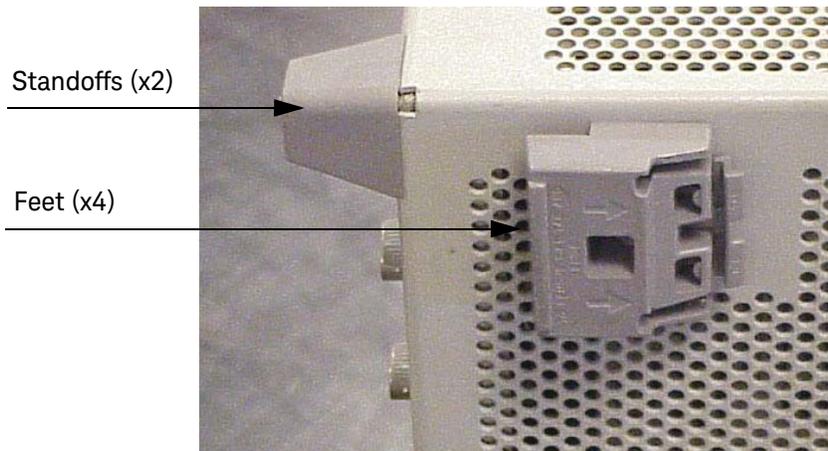
4. Install the lower left and right lock-links (left not shown) onto the analyzer, as shown in Figure 6.

Figure 6   Install Lock-Links on the Network Analyzer

Screws (0515-1619)

T20 M4X0.7 25 mm

Right Lock-link
5023-0132 (pair)
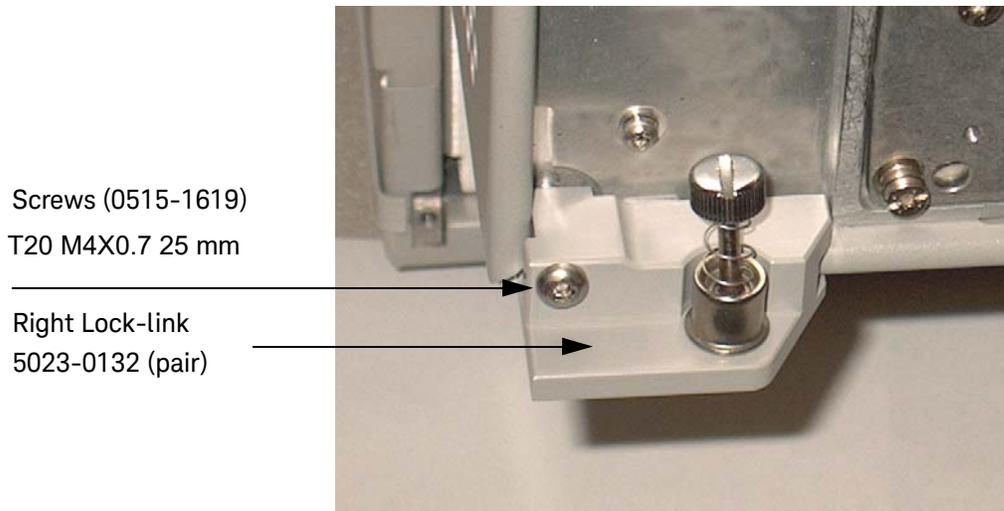
5. Remove the two upper standoffs from the rear panel of the test set using a T20 torx driver.

6. Install the left and right lock-links onto the test set, as shown in Figure 7.

Figure 7   Install Locking Feet on the Test Set

Right lock-link
N5242-20138

Left Lock-link
N5242-20139

Screw 0515-2317 (x2)
T15 M3.5X0.6 12 mm

7. Place the analyzer 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 8   Locking the Analyzer

Network Analyzer Front Frame

Lock Link

screw

Test Set Front Frame

Slide the network analyzer back to engage the lock link in the back of the network analyzer's front frame,
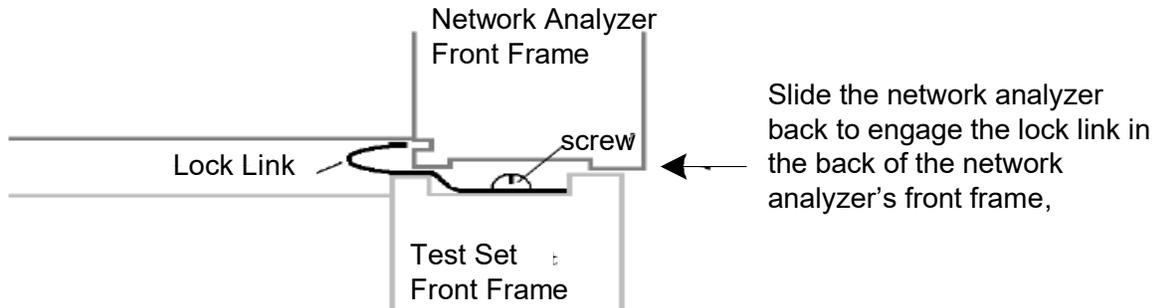
8. Secure the analyzer's lower lock-links to the test set's upper lock-link using the spring–loaded screws. If the analyzer's lock-links are not aligned with the screw holes, loosen the screws securing the feet to the instrument slightly to align and tighten.

Figure 9   Locked

20-Port System Interface Cable Connections (U3021–60105)

Figure 10 illustrates the cable configuration of the test set to the network analyzer. The cables have been supplied with Cable Kit (U3021-60105).

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x8) on the network analyzer. The RCVR R1 to SOURCE OUT reference loop jumpers (x4) remain on the front panel. Keep the jumpers for future use.

2. Connect the RF interconnect cables from the network analyzer to the test set in the order listed. As you are connecting each cable, torque to 8 in-lb. Refer to Table 8 and Figure 10.

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

Table 8   RF Interface Cable Connection (U3021–60105)

Numeric Order	RF Cables	From: Network Analyzer	To: Test Set
1	U3044-20018	CPLR ARM	CPLR ARM
2	U3044-20018	RCVR IN	RCVR OUT
3	U3044-20019	CPLR THRU	CPLR THRU
4	U3044-20019	SOURCE OUT	SOURCE IN

Figure 10 illustrates the connection of the cables by their part number. The cables must be connected in the numeric order listed in Table 8.

Figure 10   RF Interface Cable Connections
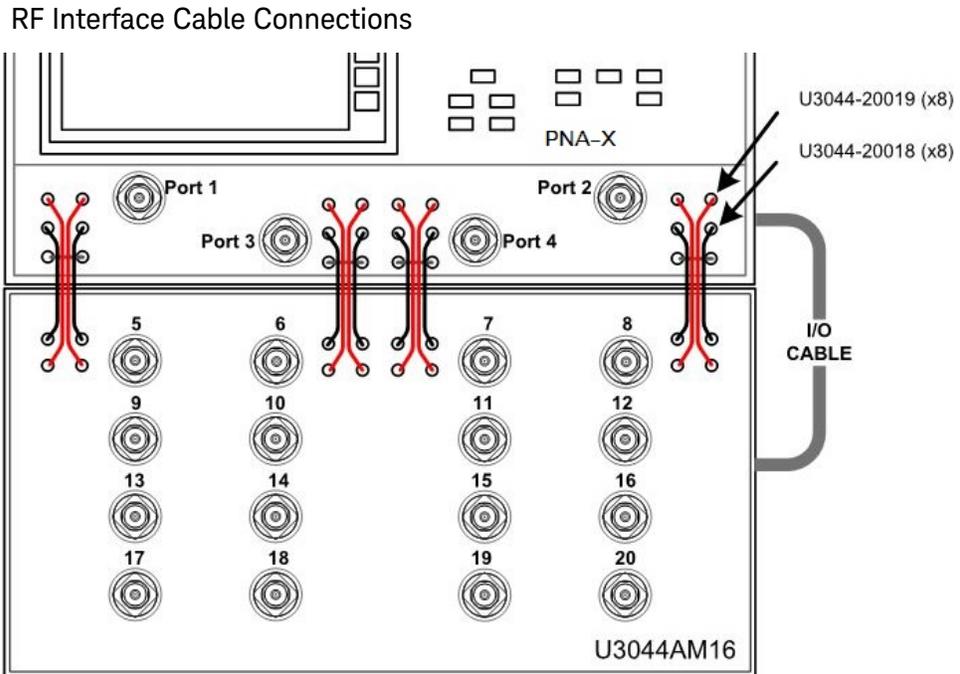
Test Set I/O Cable Installation

1. Connect the test set I/O cable (N4011-21002) to the test set Interface connector on the rear panel, similar to Figure 11.

Figure 11   Test Set I/O Cable Connection

Test Set I/O Cable (N4011-21002)
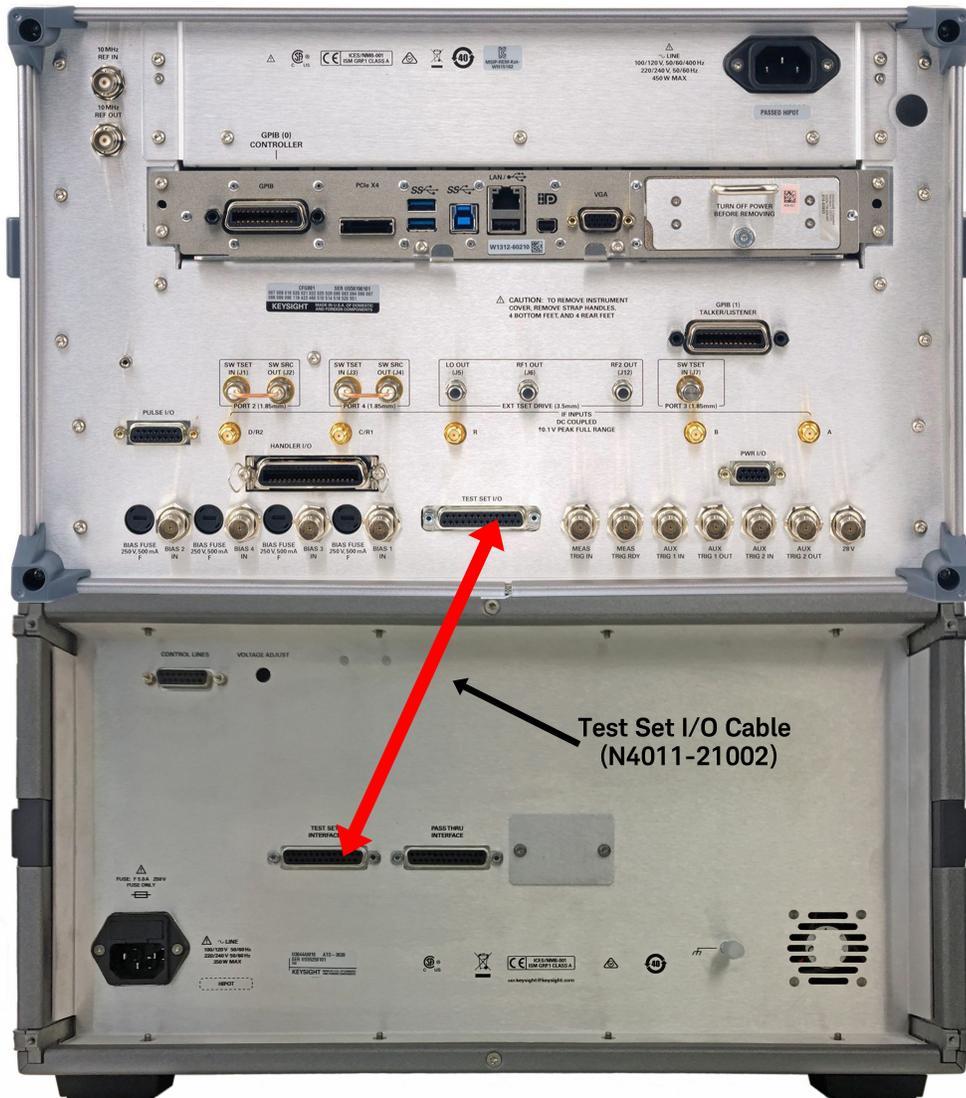
Interconnect Cable Verification

1. Perform the "System Operational Checks" on page 22.

2. If the problem still exists, perform the "RF Switching Failures" on page 67.

3. If a power hole or other failure still exists, refer to "Contacting Keysight" on page 91.

System Operational Checks

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

Before beginning this procedure complete the following steps:

— Stack the network 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 2.4 mm short (85056-60021) to network analyzer Port 1.

Equipment Setup

— Turn on the test set and network analyzer.

— Preset the network analyzer and make the following settings:

— Set to Multi-Port Mode

— Frequency range: 10 MHz to 40 GHz

— IFBW: 1kHz

— Scale: 10 dB/Div

— Set the network analyzer to measure S11

Verify Results

The 2.4 mm short will be relocated to each Test Port and an uncorrected reflection response trace should be displayed that resembles the following plots indicated in the 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 9   Reflection Response Results

Reflection Port	Response Trace	Cable Path Diagram
Port 1 to 4	Figure 12 on page 23	Figure 13 on page 23
Ports 5 to 20	Figure 14 on page 24	Figure 15 on page 24

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 .

Figure 12   Typical Reflection Response Ports 1 to 4
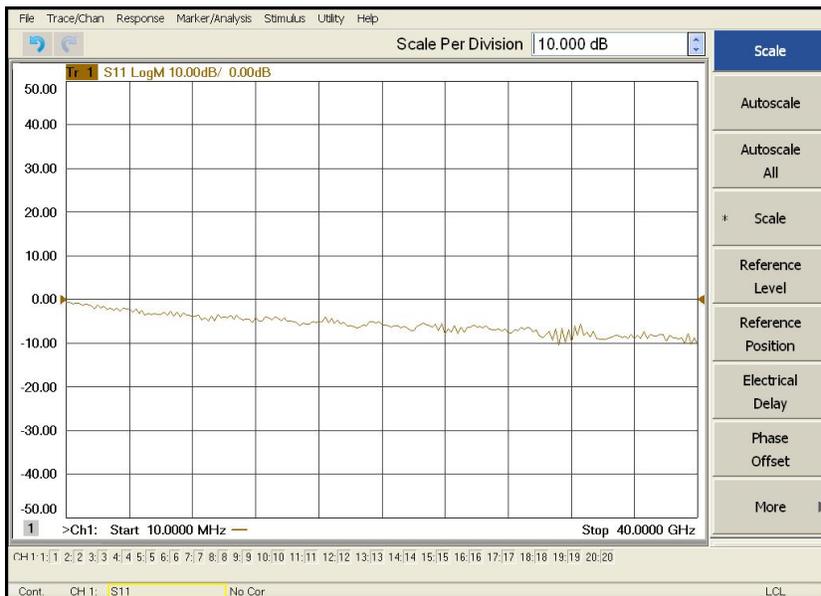
Figure 13   Reflection Response Signal Path Diagram Ports 1 to 4
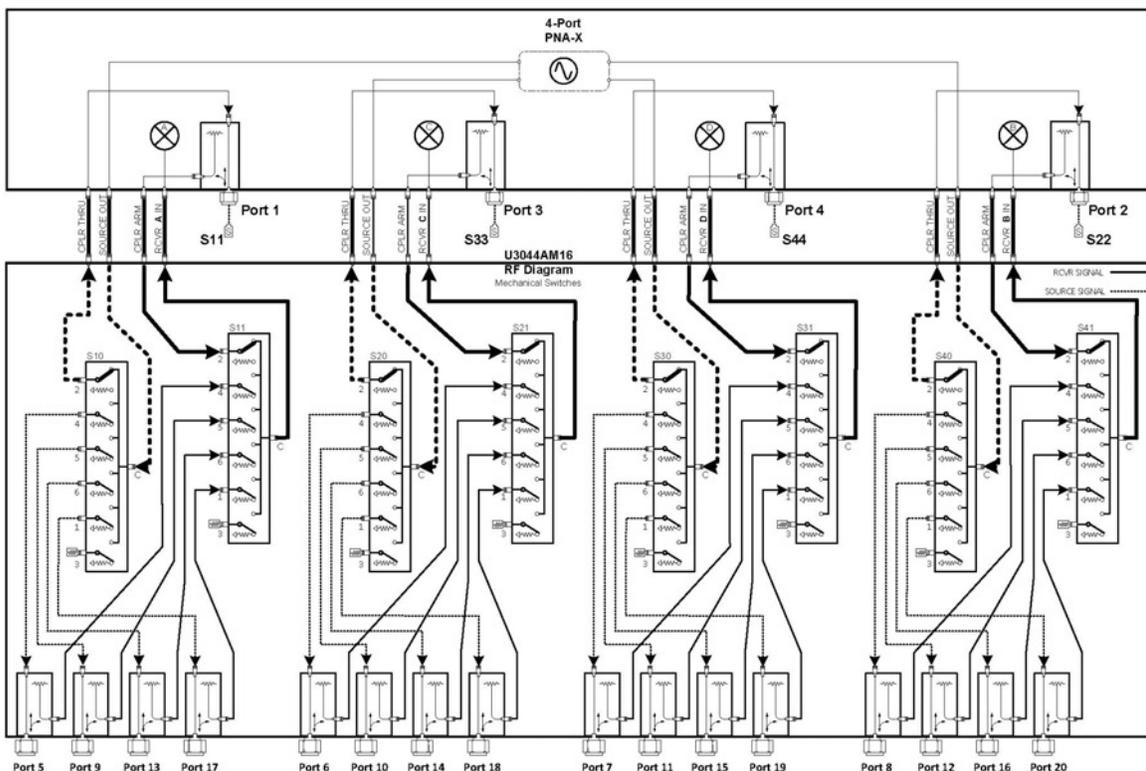
Figure 14   Typical Reflection Response Ports 5 to 20
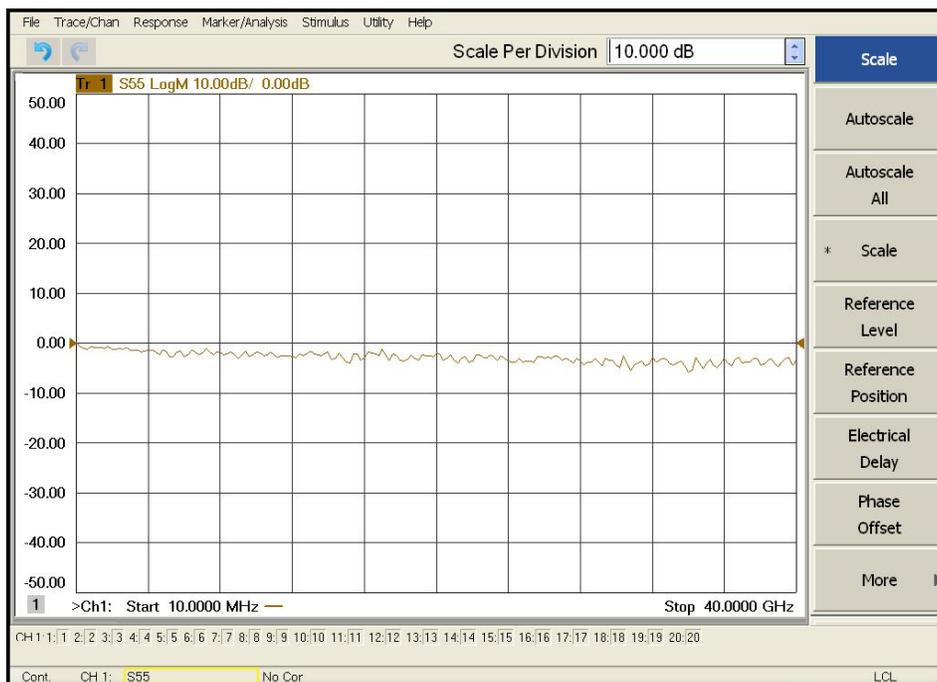
Figure 15   Reflection Response Signal Path – Ports 5 and 20 (remaining ports are similar)
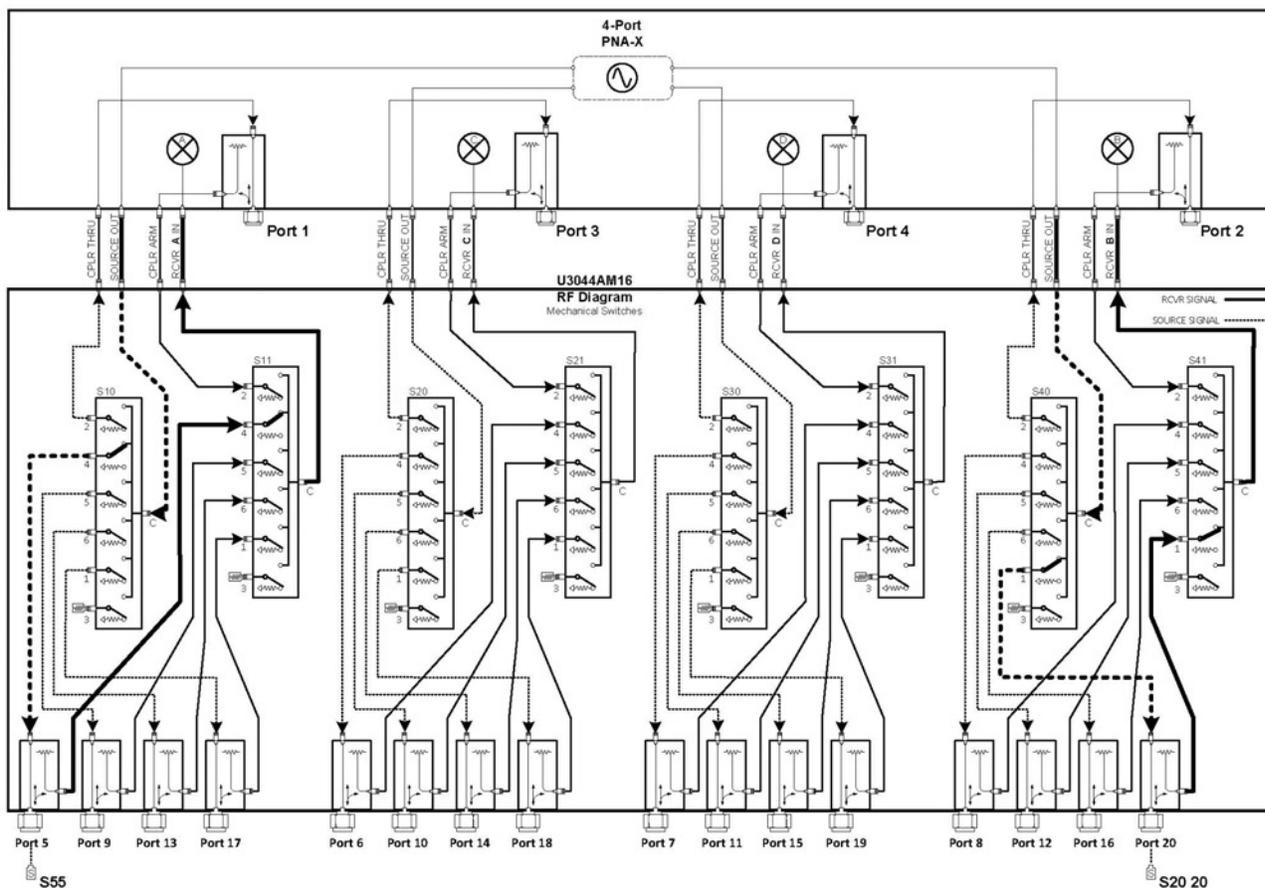
Controlling the Test Set

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

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

– "Multiport Mode" on page 28.

– "Interface Control Mode" on page 34.

– "SCPI Control Mode" on page 38.

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.

Sweep Setup for Multiport and Standalone Modes

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

1. On the PNA select STIMULUS > Sweep > Sweep Setup.

2. Select Stepped Sweep.

3. Set the Dwell Time to 5 μs > OK.

Figure 16   Sweep Setup
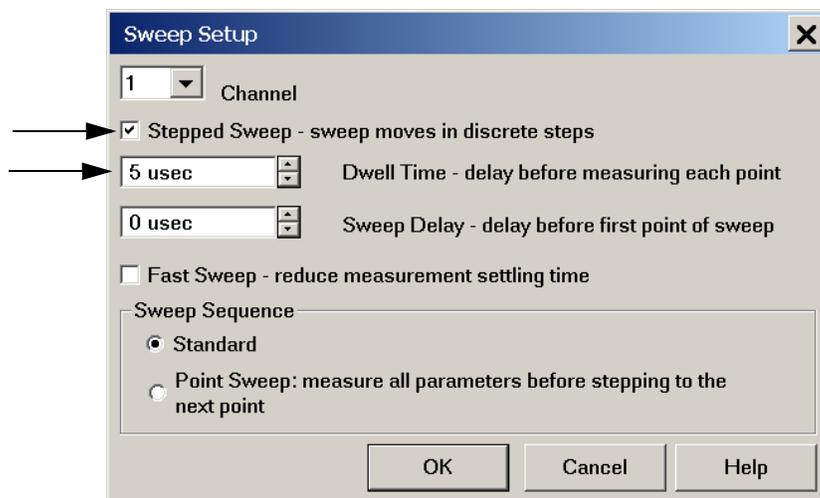
Sweep Setup for PNA-X N52xxB Models

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 17   Sweep Setup, N52xxB
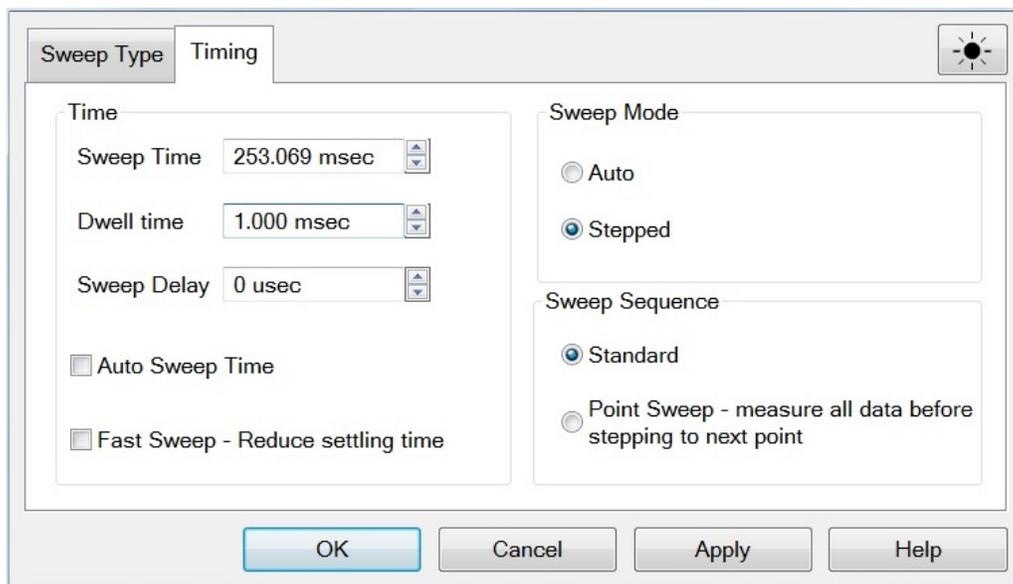
RF Path Configuration

NOTE

If the analyzer has Option 029 or H29 (noise figure capability), verify that the path configuration is set to Default. If the network analyzer is not in Default configuration, ports 5 and 9 will not operate correctly. Select **Trace/Chan > Channel > Hardware 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 18   RF Path Configuration
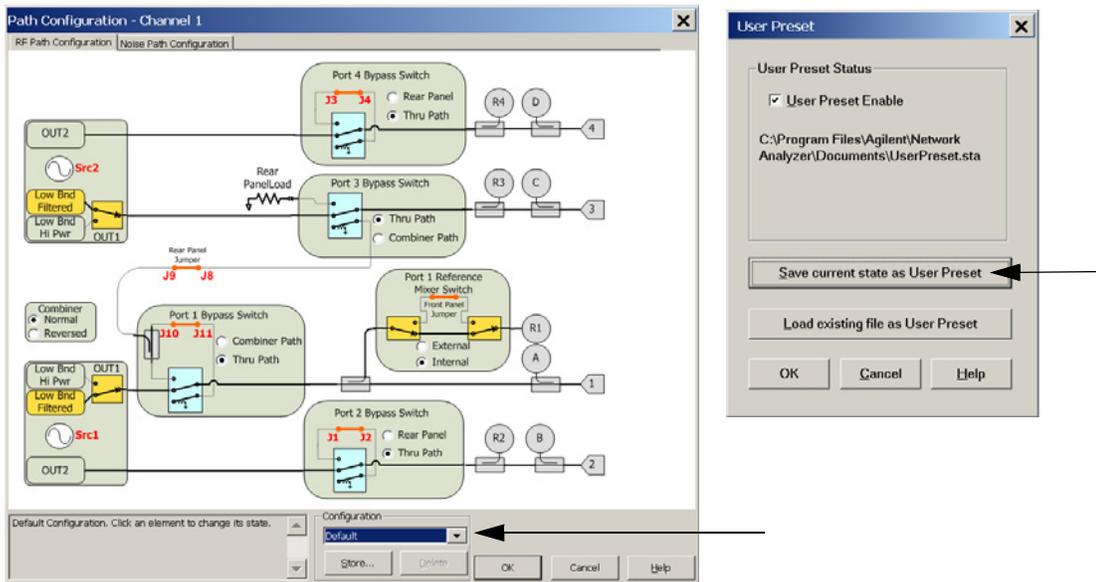
Multiport Mode

The 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.

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 **U304xAM16_PNAX_p4 (20-Port System)** from the drop-down menu and select **Restart as a multiport PNA with this testset > OK**.

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. Copy the appropriate file to **c:\program files\Keysight\Network Analyzer\testsets** directory.

Figure 19   Test Set Selection
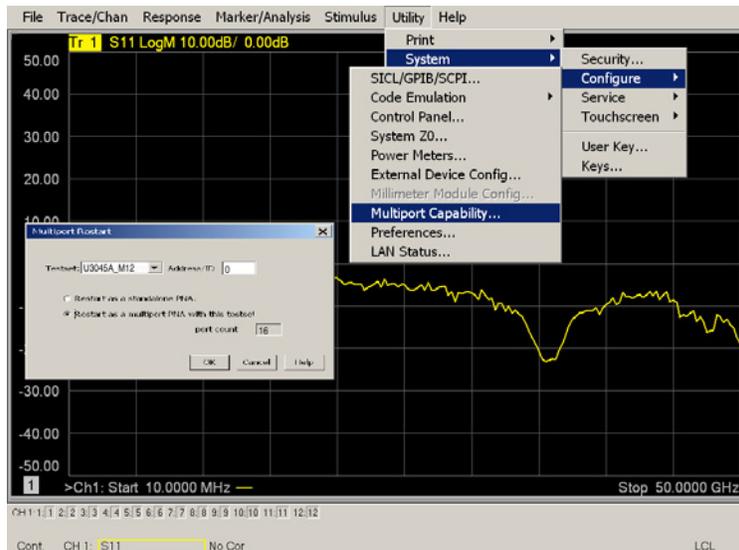
External Test Set Control Operation

To verify that the network application has the test set interface features, select **Trace/Chan > Channel > Hardware Setup > External Test Set > Other** -OR- *(Instrument > Setup > External hardware > External Device... > Multiport > Other Test Set Setup...)*. The test set will be displayed as **External Test Set Control-U3044AM16**.

Figure 20   External Test Set Control
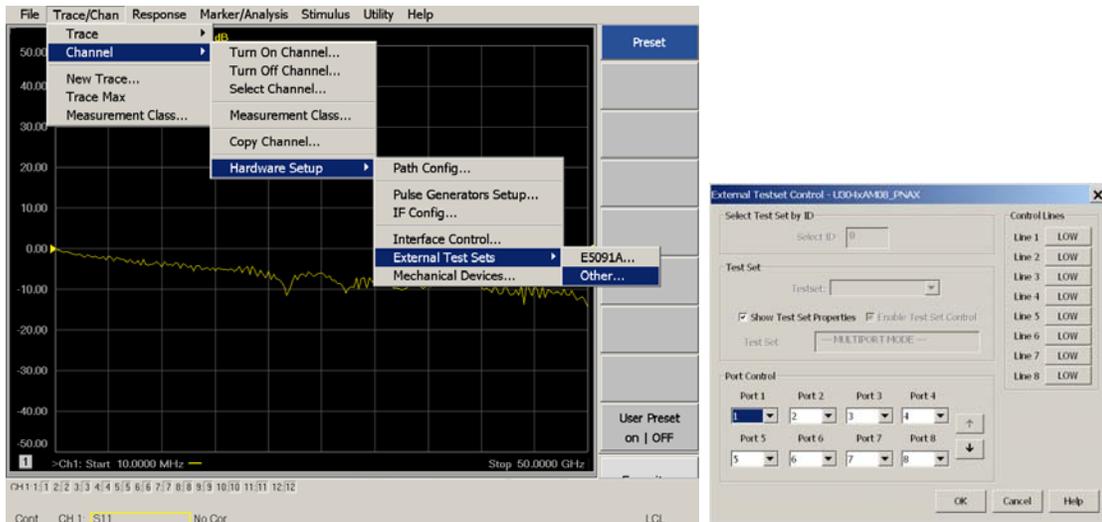
This menu will allow the physical Ports 1 through 20 to be identified as any port for your convenience. Select the Port Control down arrow for Ports 9 through 20. For example, Port 5 can be re-named Port 2.

The **External Test Set Control-U3044AM16** also allows control of the DUT control lines, refer to "Control Lines" on page 44. To change the state from LOW to HIGH, select the graphical user interface (GUI) for the specific control (LINE 1 thru 8), click **OK**. Each line can be controlled separately.

Selecting S-Parameter Measurement

S-Parameter selection can be accomplished using **Response** > **Measure**. Use the drop-down menu to select available S-Parameters for the 16-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.

The 'B' Model analyzer provides an S-Parameter selection using the keypad. For example, to select S20: **MEAS [MEAS]** > **Enter S-Parameters** >**[2][.][0] [Enter]**.

Figure 21   S-Parameter Measurement ('A' Model Analyzers Only)
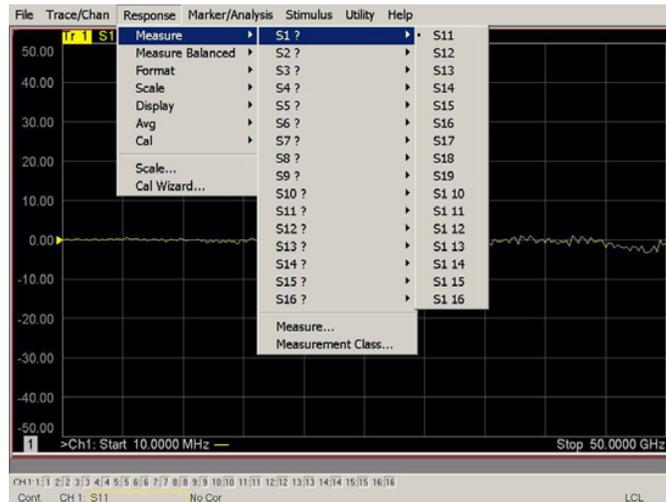
Selecting New S-Parameter Measurement

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 available S-Parameters.

Figure 22   New S-Parameter Measurement
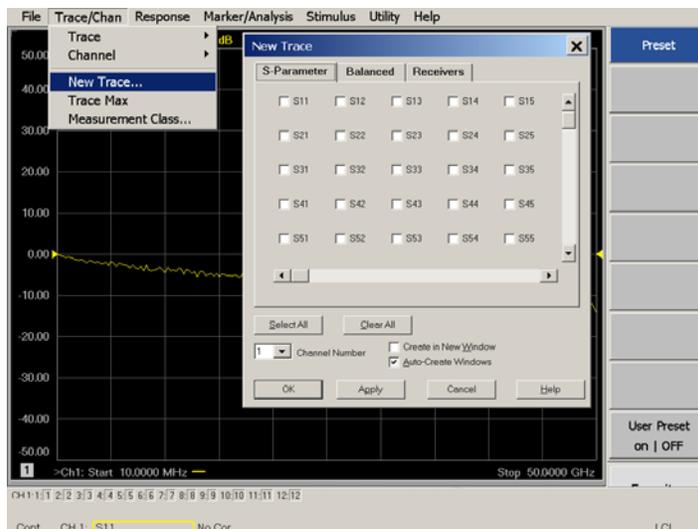
Balanced Tab:

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 23   Selecting Balanced Measurements
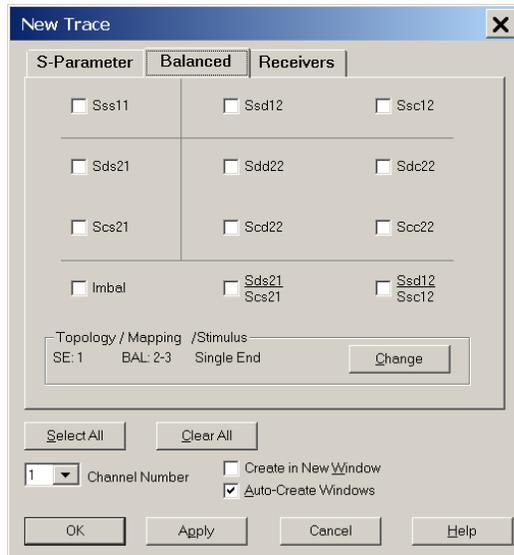
Receivers Tab:

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

Figure 24   Receiver Measurements
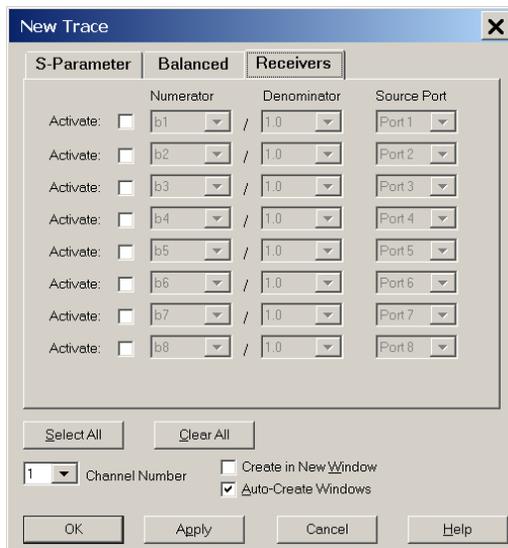
N-Port Calibration

It is recommended that you perform an ECal characterization to minimize the connections required for multiple port calibration. The N4693AB Option M0F is recommended with cable (85133F) if you are calibrating at the network 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 Option 551 firmware revisions and history. http://na.support.keysight.com/pna/firmware/

Figure 25   ECal Characterization and Cal Wizard
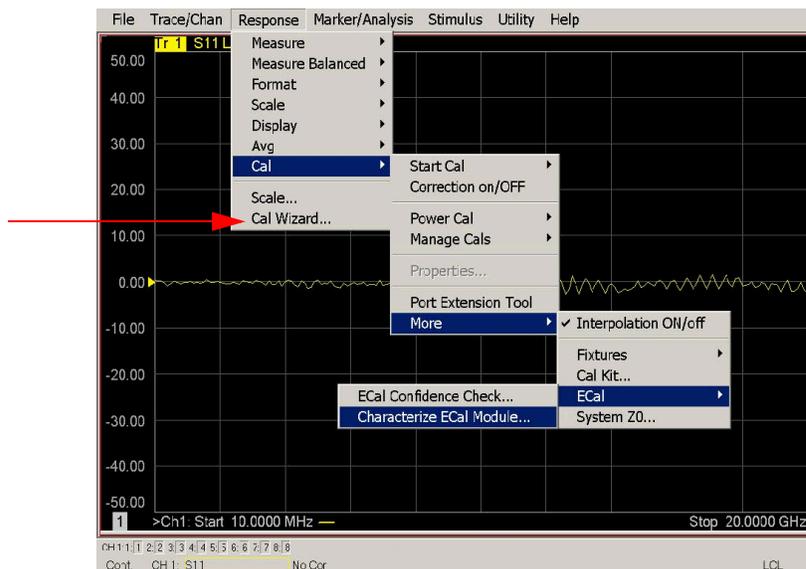
1. On the network analyzer select **Response > Cal Wizard** –OR– *(Response > Cal > Other Cals...)*.

   a. If using a mechanical cal kit, select **SmartCal (Guided Calibration) > Next**.

   b. If using an ECal module, connect the ECal to an available network analyzer USB port and select **Use Electronic Calibration (ECal) > Next** –OR– *(Response > Cal > Other Cals > ECal...)*.

Figure 26   Begin Calibration
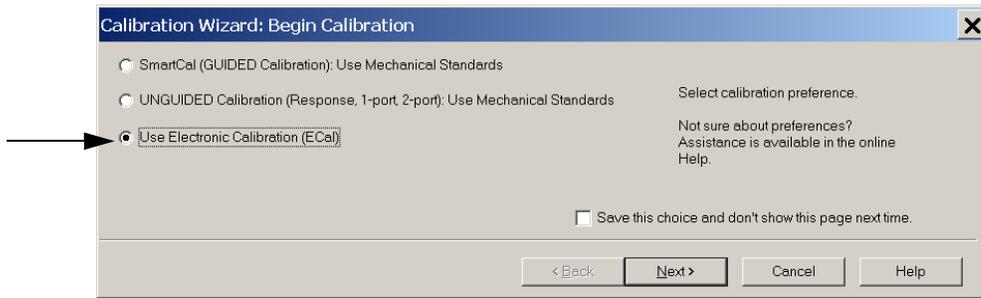
2. Continue following the Cal Wizard prompts. In the Select Calibration Ports and ECal Module dialog box click the **Select All**, check box, or select the ports you are calibrating and click **Next**. If an ECal characterization has been done, select **View/Select ECal Module** and select the previously saved user file from Step 1.

Figure 27   16-Port Calibration
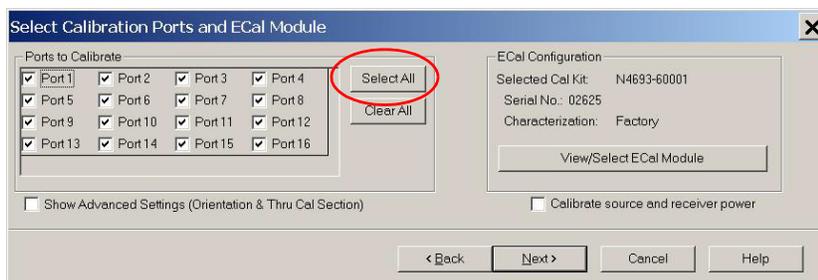
3. Connect the ECal or the mechanical cal kit to the ports you are calibrating following the Cal Wizard prompts and click **Measure** after each connection. The electrical delay value may be shown in the dialog box after the last measurement, click OK.

4. At the Calibration Completed prompt, select **Save As User Calset**, type the name and **Save**. See Figure 39 on page 54.

5. After calibrating test set ports, use a quality load and short to verify the calibration on each port or end of the test cable. Measure reflection and confirm the return loss is as expected. If the result is not as expected, repeat the calibration without the test set and ensure that the network analyzer is in standard (non-multiport) mode.

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 Option 551 firmware revisions and history. http://na.support.keysight.com/pna/firmware/.

Interface Control Mode

The Interface Control feature allows you to send data and remote commands to control external equipment using the GPIB, Material Handler I/O, test set I/O, and Auxiliary I/O without the need of an external computer. Refer to analyzer's Help menu, "Rear Panel Tour" and "Interface Control."

This section includes:

— How to Access Interface Control Settings

— Interface Control dialog box

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

— 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

5. Aux I/O Output Voltage

How to Access Interface Control Mode

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

NOTE   The PNA or PNA-X Series Network 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 network analyzer Help
menu, Interface Control. The application is shown below.

Figure 28   Accessing Interface Control Mode
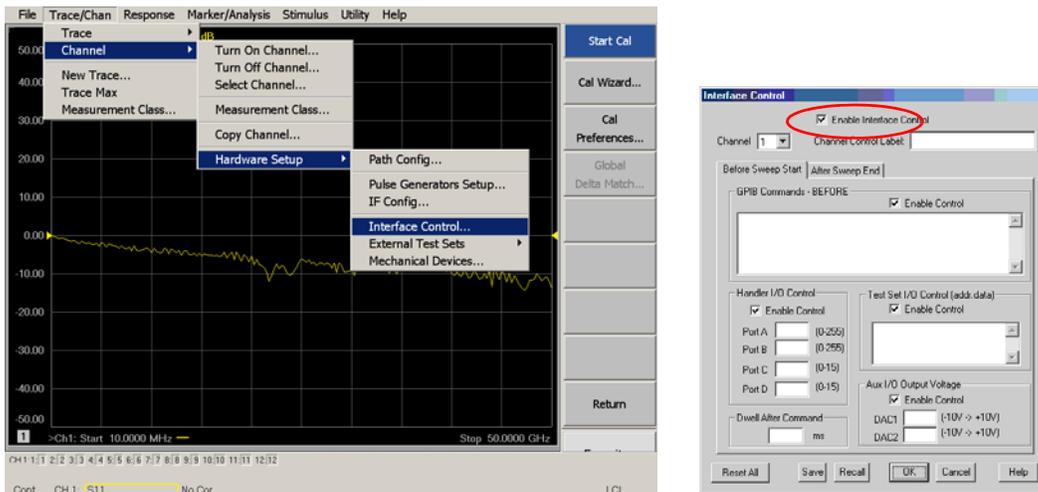
Using Interface Control Mode

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 network analyzer 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 29   Interface Control
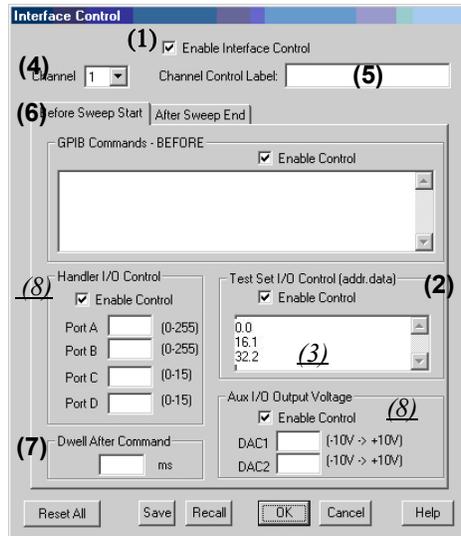
Enable Interface Control: (1)

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 network 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 42.

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 network analyzer. Refer to the Address and Data example below.

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 network analyzer 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 network analyzer 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 network analyzer. Refer to the analyzer's 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 network analyzer 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 network analyzer rear-panel GPIB connector and test set I/O connector. More information regarding the Command Processor can be found in the analyzer's Help menu.

Overview of the SCPI Control

The Command Processor allows you to send address and data to control an external test set, without needing to create a remote program. The user is required to manually input address and data using the Command Processor Console in the analyzer's 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 > System Setup > Remote Interface > SCPI Monitor Input >
   Show SCPI Parser Console)*.

2. Check the **SCPI Command Processor Console** box.

Figure 30   Command Console for 'A' Model Analyzers
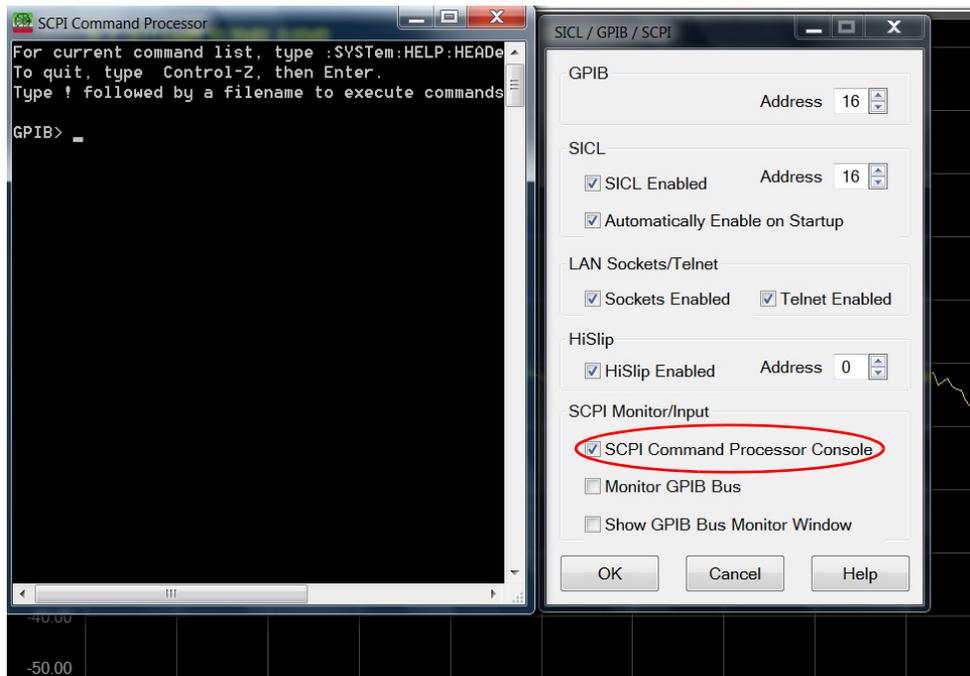
Figure 31   Command Console for 'B' Model Analyzers
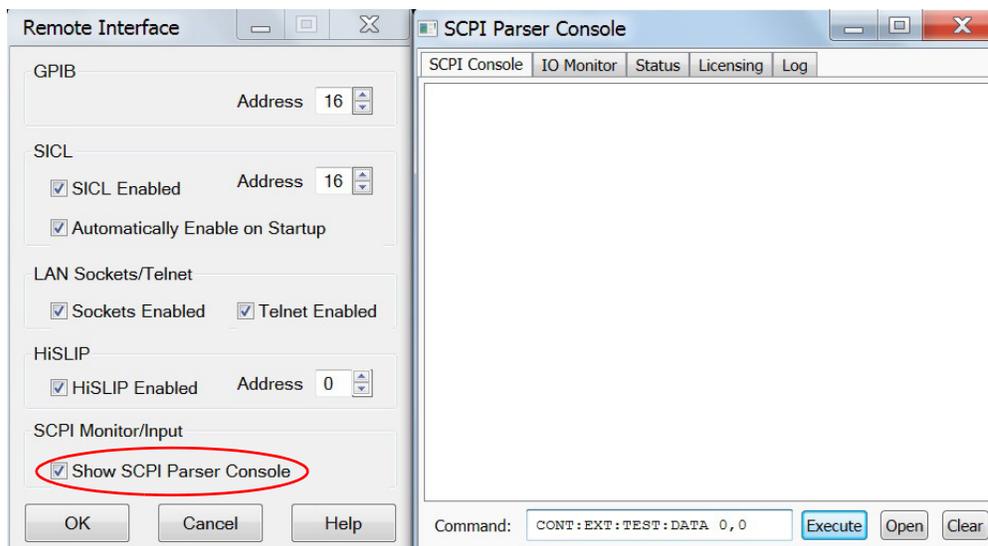
SCPI Command Processor Console

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.

When the Command Processor Console is opened as instructed in the previous page, examples of the two control methods will be provided.

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 32   Method 1 - Using GPIB/SCPI Command Values
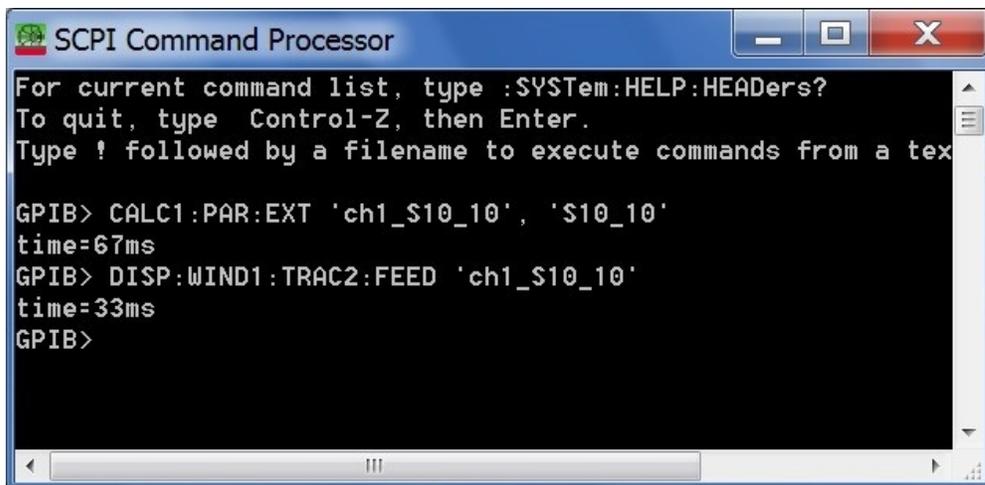
This first command creates a new S10_10 measurement on channel 1 of the PNA-X, named "ch1_S10_10," and configures the internal Test Set RF switches.

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 42.

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 33   Method 2 - Using Test Set Address and Data Values
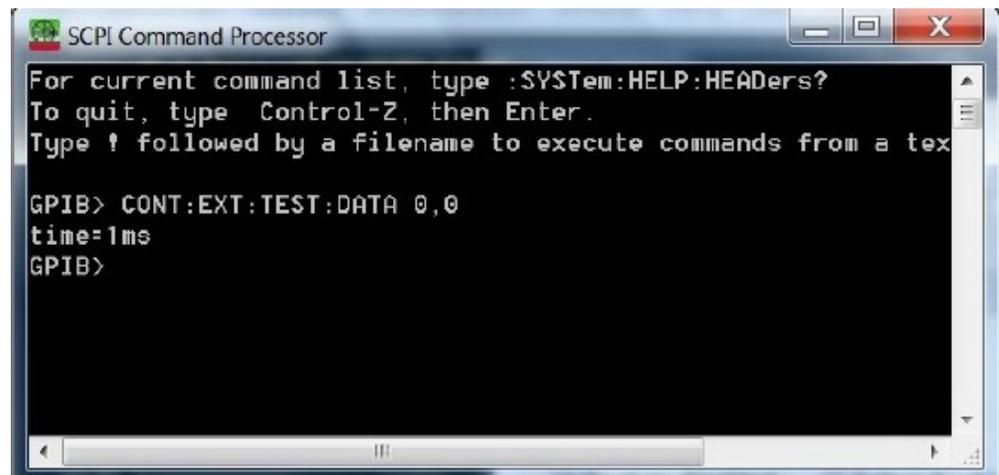
Address and Data Values

Setting the Test Port Paths with Address and Data

Refer to Table 10 below and Figure 34 on page 43 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, the Internal RF switches must be set to complete the source and receiver paths. Table 10 provides the Address and Data codes needed to configure the RF switch configurations.

Example 1: Refer to Figure 34 on page 43.

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

Port 5 is the Source and Port 6 is the Receiver.

Source Port 5 = address 0, data 1 and Receiver Port 6 = address 16, data 16. Two separate commands must to be sent, you may use the same dialog box. Send address 0 and data 1 in one command line, and address 16 and data 16 in the second line. Refer to "Interface Control Mode" on page 34 and in "SCPI Control Mode" on page 38.

For further information refer to "How to Access Interface Control Mode" on page 35 and "How to Access the Command Processor" on page 39.

Example 2:

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

Port 5 is the Source and Ports 9 is the Receiver.

Source Port 5 = address 0, data 1 and Receiver Port 9 = address 0, data 32. The data values are added together, the entry will be 0.33.

Table 10   Test Port Address and Data Values

Address	Source Path						Receiver Path				
	Data	0	1	2	3	4	0	16	32	48	64
0	Ports	1	5	9	13	17	1	5	9	13	17
16	Ports	3	6	10	14	18	3	6	10	14	18
32	Ports	4	7	11	15	19	4	7	11	15	19
64	Ports	2	8	12	16	20	2	8	12	16	20

Refer to Figure 47, "U3044AM16 RF Block Diagram," on page 62 for in-depth RF path information.

Figure 34   Address and Data Example 1 (Port 5 and 6)
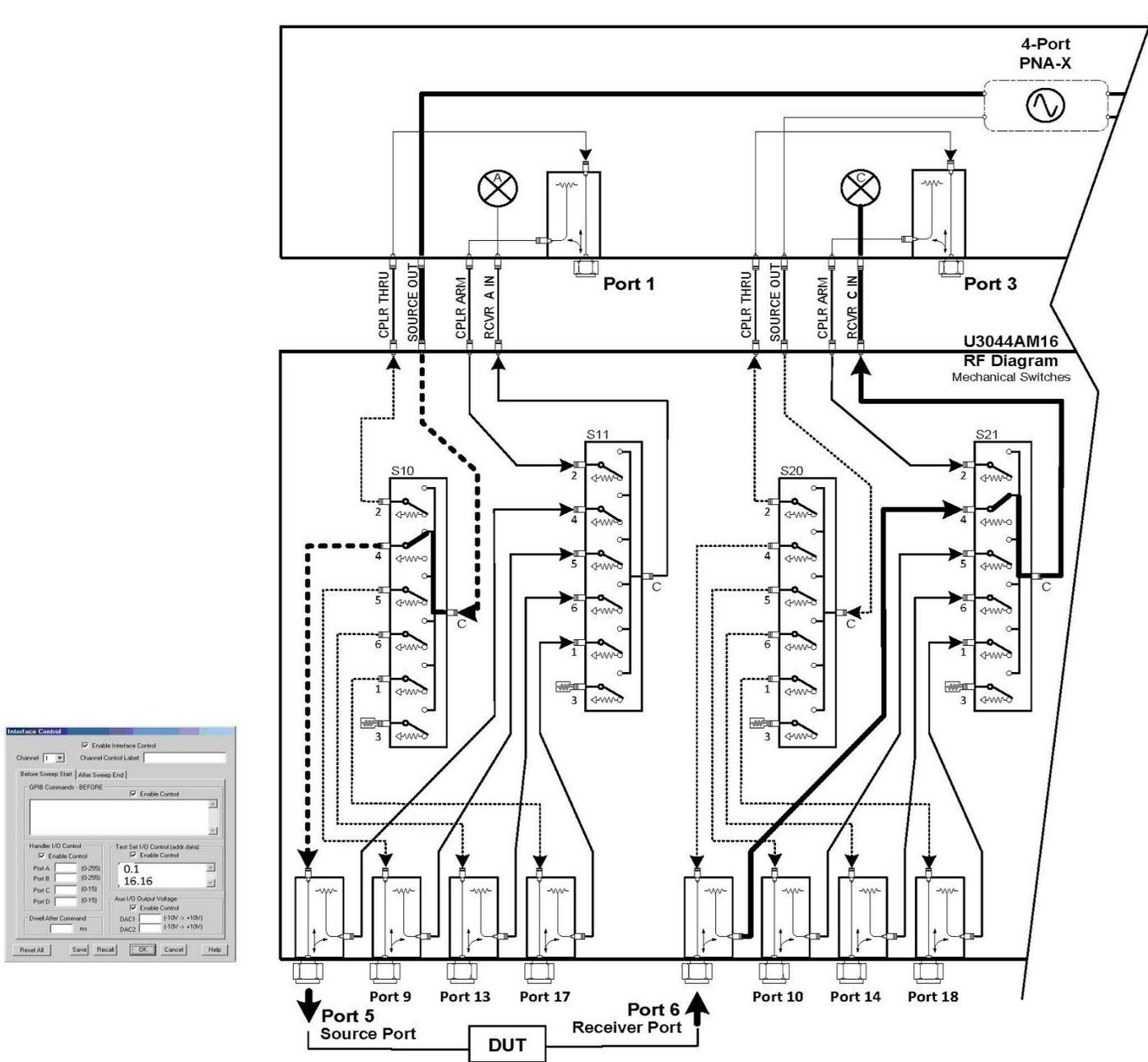
Control Lines

The 15 pin female D-Sub connector on the rear panel provides 8 latched data lines that can be used to control your device under test (DUT). The lines can be controlled with the multiport external test set control, or test set I/O commands. Refer to "External Test Set Control Operation" on page 29 and "Setting the Control Lines with Address and Data Values" on page 48. See Table 11 for DUT control line specification.

The output voltage of the lines can be from the internal adjustable voltage source (+2 to +5 Vdc), or an external DC power supply depending on how the connection to the control line is configured. When using an external power supply a positive or negative voltage can be used. Refer to Figure 35 and Table 12 on page 45 for control line pin location and description. Refer to "Internal Voltage Supply Configuration" on page 46 and "External Voltage Supply Configuration" on page 47 for configurations.

Table 11   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 W (each line)
Voltage Range:	
Positive Input	0 to +5 V
Negative Input	–5 to 0 V
Internal Variable Voltage	+2 to +5 V

Figure 35   DUT Control Line Pin Assignment (rear panel view)
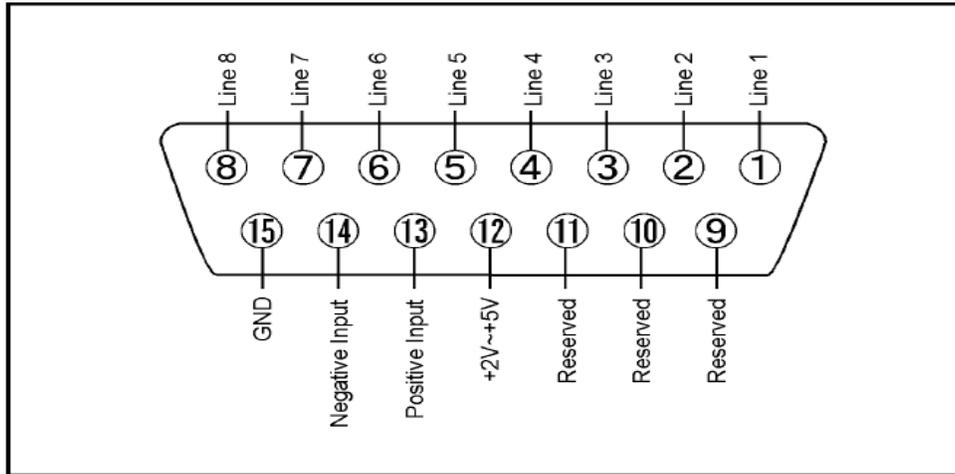
Table 12   DUT Control Line Interface Connector Pin Assignment

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

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

Figure 36   Internal DC Power Configuration (rear panel view)
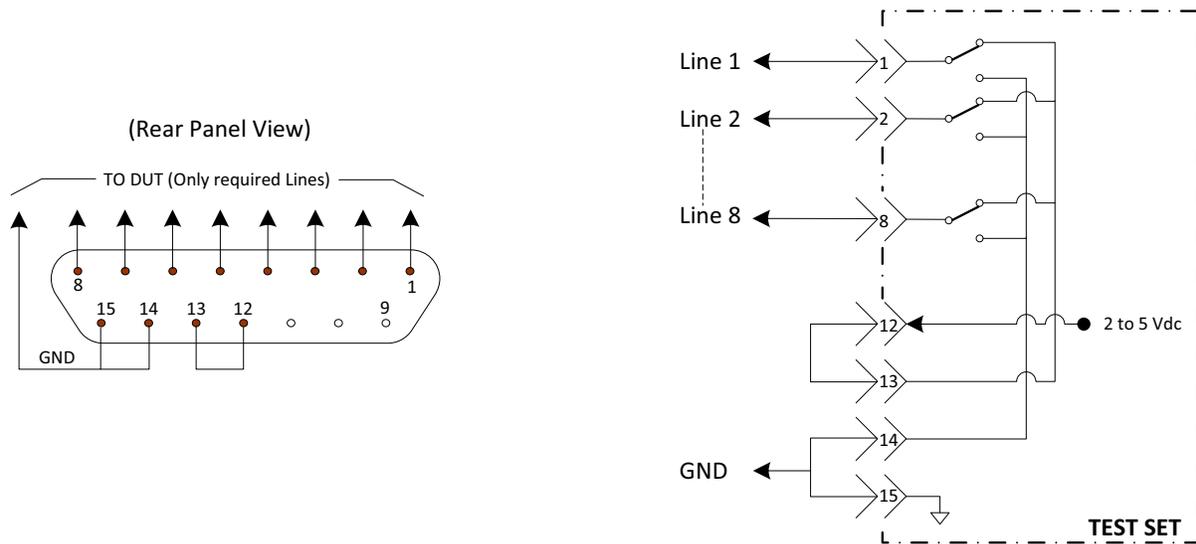
External Voltage Supply Configuration

Figure 37 below illustrates an example of the connection with an external DC power supply. Connect the positive and negative voltage supply from the external power supply to the positive input (pin 13) and the negative input (pin 14). Connect the power supply DC ground to pin 15.

Turning On the Test Set using an External Power Supply

1. Turn on the test set.

2. Connect the DUT.

3. Turn on the external power supply.

Turning Off the Test Set using an External Power Supply

1. Turn off the Power Supply.

2. Turn off the test set.

3. Disconnect the DUT.

Figure 37   Test Set to the DUT and External DC Power Supply
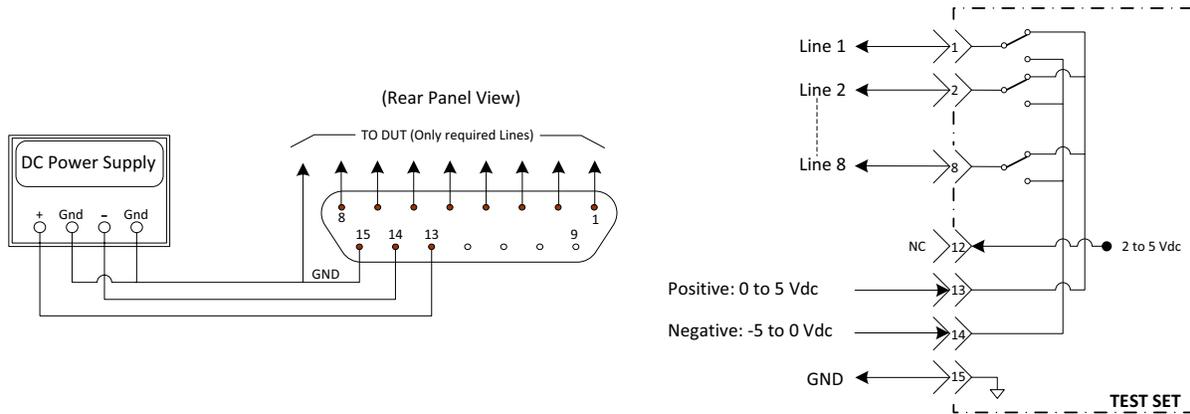
Setting the Control Lines with Address and Data Values

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

NOTE   The following control feature will function only while the network analyzer 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 42, the ‹address›.‹data› values are determined in a similar manner, with the following exceptions:

— Table 13 will be used.

— The ‹address› value is always = 112

Table 13   Test Set DUT Control Address and Data Logic Table

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

After a power reset all DUT control lines are initially configured to a logic high state or connected to Pin 13, refer to Figure 36 on page 46. To reset all control lines to logic high, without having to reset the power switch on the test set, make the following network analyzer entry:

Front panel network analyzer 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 37, shown with all lines = logic high.

Example 1: To change lines 1 & 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 network analyzer Interface Control Mode line entry = 112.129 > OK.

Example 2: From Example 1 to only change Lines 2 & 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 network 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. |

Operational Check

The following procedure can be used to confirm the 1-Port Cal operation of an ECal module or Mechanical Cal Kit with the test set. The operation verification limits provided ensure that your test set and analyzer are operating properly. Refer to "Verifying Cal Kit Operational Check Failure" on page 56 to ensure the RF interface cables are installed and working correctly before returning the test set for repairs.

Verification Limits

Specifications for the test set are typical. System performance for the 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 analyzer performance exceed the operational verification limits.

A periodic calibration is not required. The Operators Check should be performed after System Setup, or if performance is in question. An N-Port calibration should be performed before making a measurement. Refer to Table 6 and Table 7 on page 12.

| NOTE | If you suspect that your 16-Port configuration is not operating properly, ensure that all front RF jumper interconnect cables are correctly attached. |

Equipment Required

The U3044AM16 requires that the user be familiar with the equipment listed.

Table 14   Equipment List

Description	Qty
N4693A 2.4 mm ECal Module 10 MHz - 50 GHz (Option 00F or M0F) or 85057B Verification Kit.	1
N524xA/B Option 400 and 551	1
Set of interconnect cables (network analyzer and test set), see "20-Port System Interface Cable Connections (U3021-60105)" on page 20.	1

Operational Check Procedure

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

Preparing the Network Analyzer

1. Connect the test set to the 4-Port network analyzer using the interconnect cables as shown in Figure 10 on page 20 and Table 8 on page 20.

2. Turn on the test set.

3. Select **Response > Cal > Manage Cals > Cal Set**. Delete or Rename any Cal Sets titled "999.1" thru "999.20" (20-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.

    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 **U3044AM16** (20-Port) from the drop-down menu > **OK**. Refer to Figure 19 on page 28.

5. Press [**Preset**].

6. Verify that the [**Start Frequency**] is set to [**10 MHz**].

7. Set the [**Stop Frequency**] is set to [**40 GHz**] for the N5244/5 PNA-X.

8. Select [**Power**] > **Power Level** and enter [**-15 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 network analyzer USB port on the front or rear panel. Refer to Figure 10 on page 20. This procedure assumes you are using a ECal. If you are not, see "1-Port Calibration and Verification Procedure" on page 53, step 2 "Perform a 1-Port Calibration on Port 1..." on page 53.

12. Allow the ECal module, test set and network 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, see Figure 38.

2. Perform a 1-Port Calibration on Port 1. On the network 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 a network analyzer 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**.

Figure 38   1-Port Calibration
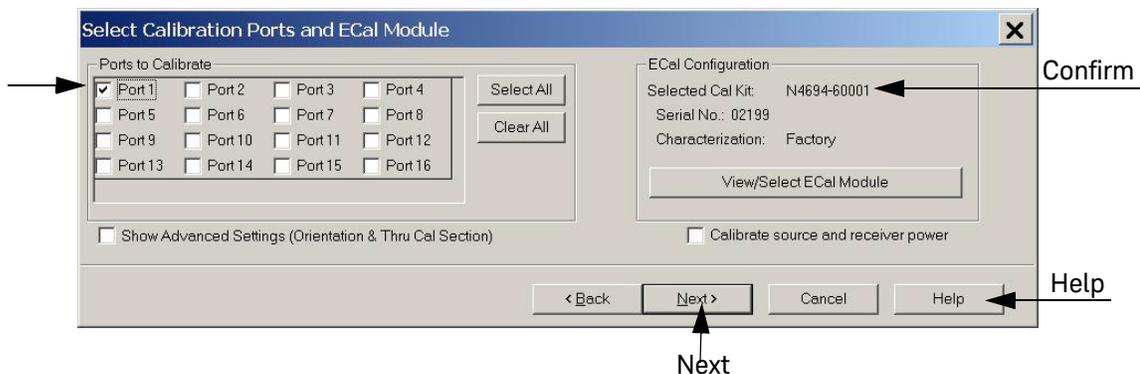
4. Continue to follow the prompts until the Calibration Completed dialog box appears.

5. At the Calibration Completed prompt, select **Save As User Calset**, type the name **999.1**. Overwrite the 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 network analyzer front panel to enter "999.1."

Figure 39   Calibration Complete

6. Repeat steps 1 thru 5 for Ports 2 thru 16. When finished, there should be 16 Cal Sets saved with the titles "999.1" thru "999.12" (12-Port).

7. If you are using an ECal module you can verify the individual port calibration by selecting **Response > CAL > More > ECAL > ECAL Confidence Check** -OR- **(Response > Cal > Cal Sets & Cal Kits > ECal Confidence Check)**.
Select Change Measurement and select the test port
S-Parameter > Apply > OK > Read Module Data. For further information refer to the Help menu.

8. Select **Trace/Chan > Trace > Delete Trace**. There should be no traces on the network analyzer screen.

9. To launch the Cal Set Viewer toolbar, select **Response > Cal > Manage Cals > Cal Set Viewer**.

Figure 40   Calibration, Cal Set Viewer
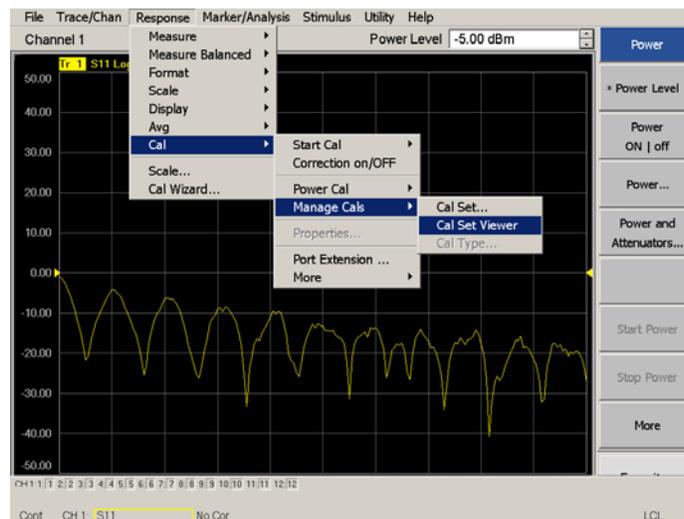
9. From the Cal Sets drop-down menu, select **999.1** and select **Enable**.
Select the **Reflection Tracking(x,x)**, where x,x is the port being tested, term in the center drop-down menu and ensure that the **Enable** and **Error Terms** check boxes are selected.

10. Compare the Reflection Tracking (1,1) trace to the appropriate limits shown in the tables on page 12. The trace should be above the limit.

11. Repeat steps 9 and 10 for Cal Sets "999.1" thru "999.20" (20-Port).

Figure 41   Typical Reflection Tracking Trace (Ports 1 to 4)
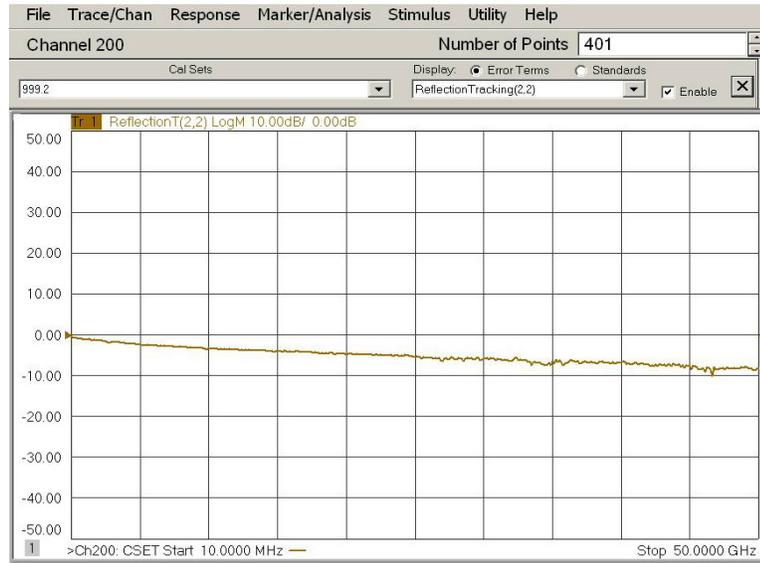
Figure 42   Typical Reflection Tracking Trace (Ports 5 to 20)

If you are using an ECal module you can verify the individual port calibration.

1. Select Response > Cal > More > ECal > ECal Confidence Check.

2. Click Change Measurement and select the test port S-Parameter > Apply > OK.

3. Click Read Module Data.

For further information refer to the Help menu.

Verifying Cal Kit Operational Check Failure

If your test results fail the Cal Kit Operational Check limits, see Table 6 on page 12. Verify the following verify following:

1. Ensure that the test set is turned on and connected properly to the network analyzer.

2. Check all appropriate network analyzer and test set connectors for damage, cleanliness, and proper torque.

3. Repeat the relevant 1-Port calibrations using another ECal or mechanical standard.

4. Verify that the network analyzer is operating properly and meeting its published specifications. If the network analyzer is connected to the test set it will fail the Operational Check. Refer to "Network Analyzer Requirements" on page 7.

ECal Confidence Check

The following ECal Confidence Check is a method to check the accuracy of a 1-Port calibration performed with mechanical standards or an ECal module. In order 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 calibration on 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 tested. 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. ECal Confidence Check dialog box: Click **Change Measurement** and select the test port **S-Parameter** > **Apply** > **OK**. Click **Read Module Data**.

Figure 43   ECal Confidence Check
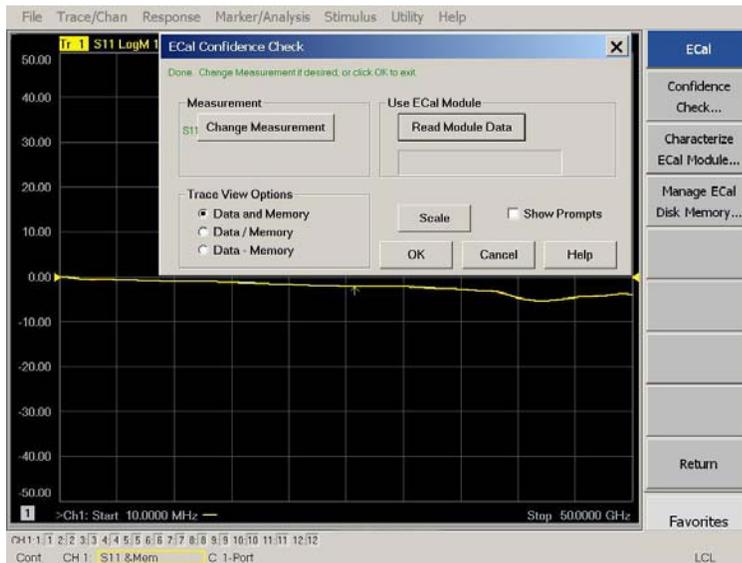
6. Select ECal Module dialog box: Select the ECal Module you are using, and
   select the **ECal Module Memory** and **Factory ID > OK**.

Figure 44   ECal Confidence Check Trace
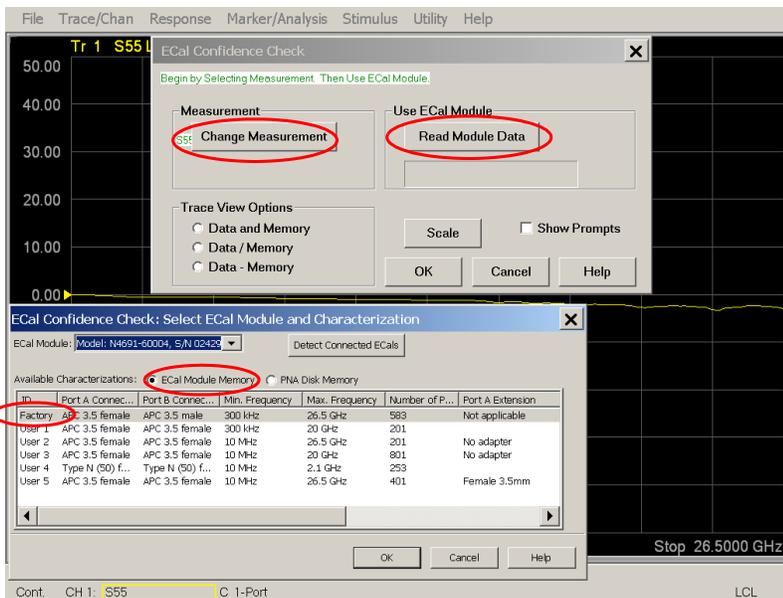
Service Information

This section provides information to troubleshoot and repair the U3044AM16 Test Set. Refer to "Keysight Support, Services, and Assistance" on page 91 for information on returning your test set to Keysight Technologies.

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

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

Replaceable Parts

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

Table 15   Available Replacement Parts (SPO)

Description	Keysight Part Number
PWR Supply (AC/DC SWG 650W 9- Output)	0950-4729
Fuse (8 A 250 V non-time delay 0.0146 Ohm)	2110-0342
Fuse (5 A 250 V non-time delay Socket)	2110-0709
Network Analyzer Locking Feet	5023-0132
Couplers, 50 GHz (Pb Free)	5087-7793
Fan (rear panel)	87050-60027
Test Set I/O Cable	N4011-21002

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 16   Replaceable Parts (M16)

Description	Keysight Part Number
Screw-Pan Head Machine with thread patch, Torx-T15 M3.5 with 0.6 thread, 12 mm-LG	0515-2317
2.4 mm Short (female)	85056-60021
RF Switch, SP6T, 24 V, 40 GHz	87106-60069
Test Set Rear Lock Feet (right)	N5245-20130
Test Set Rear Lock Feet (left)	N5245-20131
Front Panel LED Board	N5261-60005
Test Set Control Board (programmed)	N5261-60006
DUT Control Board	U3020-63223
Switch Interface Board, programmed	U3025-60062
U3044AM16 User's and Service Guide	U3044-90002
RF Cable, Semi-rigid	U3044-20018
RF Cable, Semi-rigid	U3044-20019

System Block Diagram

Figure 45   U3044AM16 RF Block Diagram
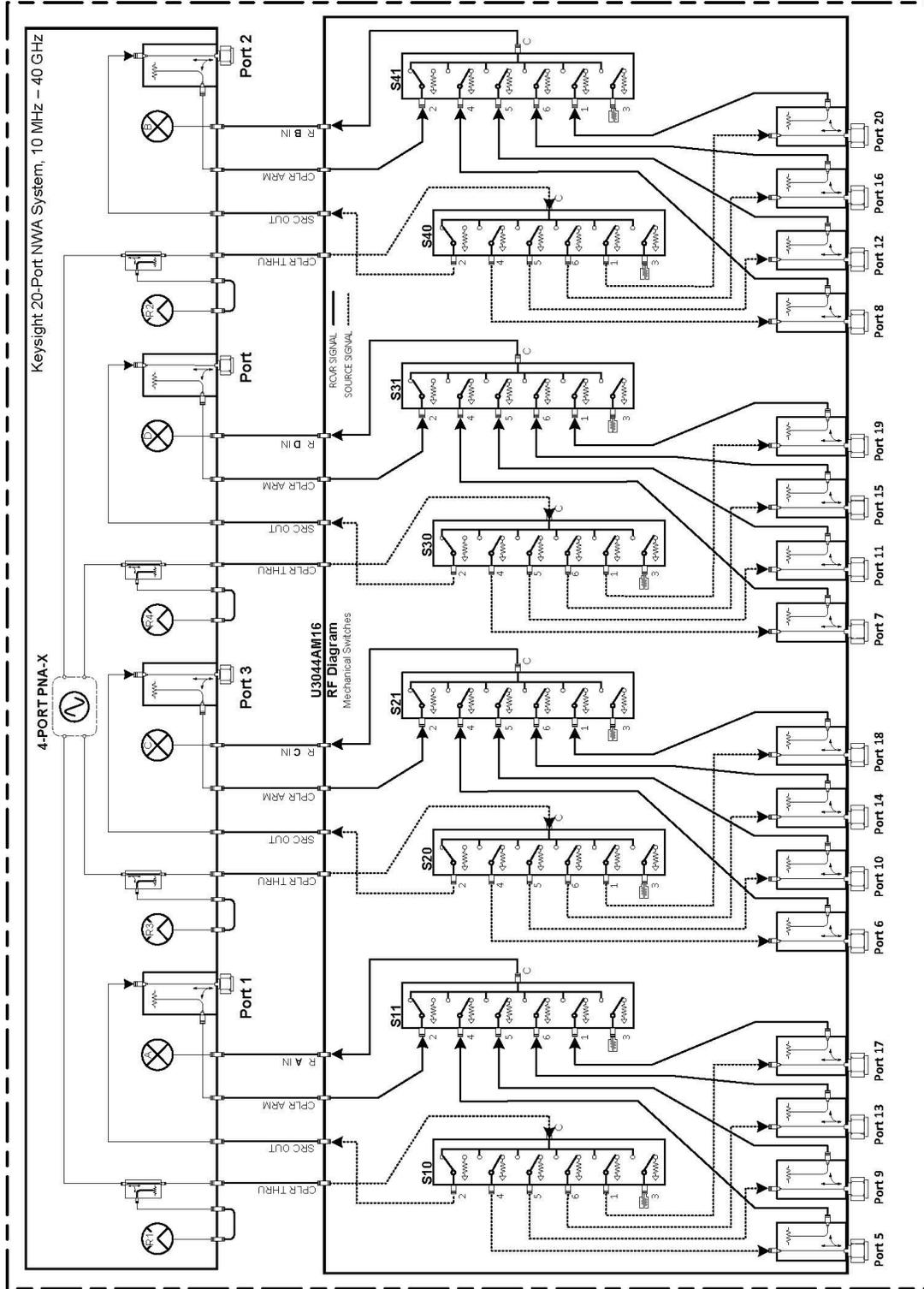
Figure 46   Electrical Block Diagram
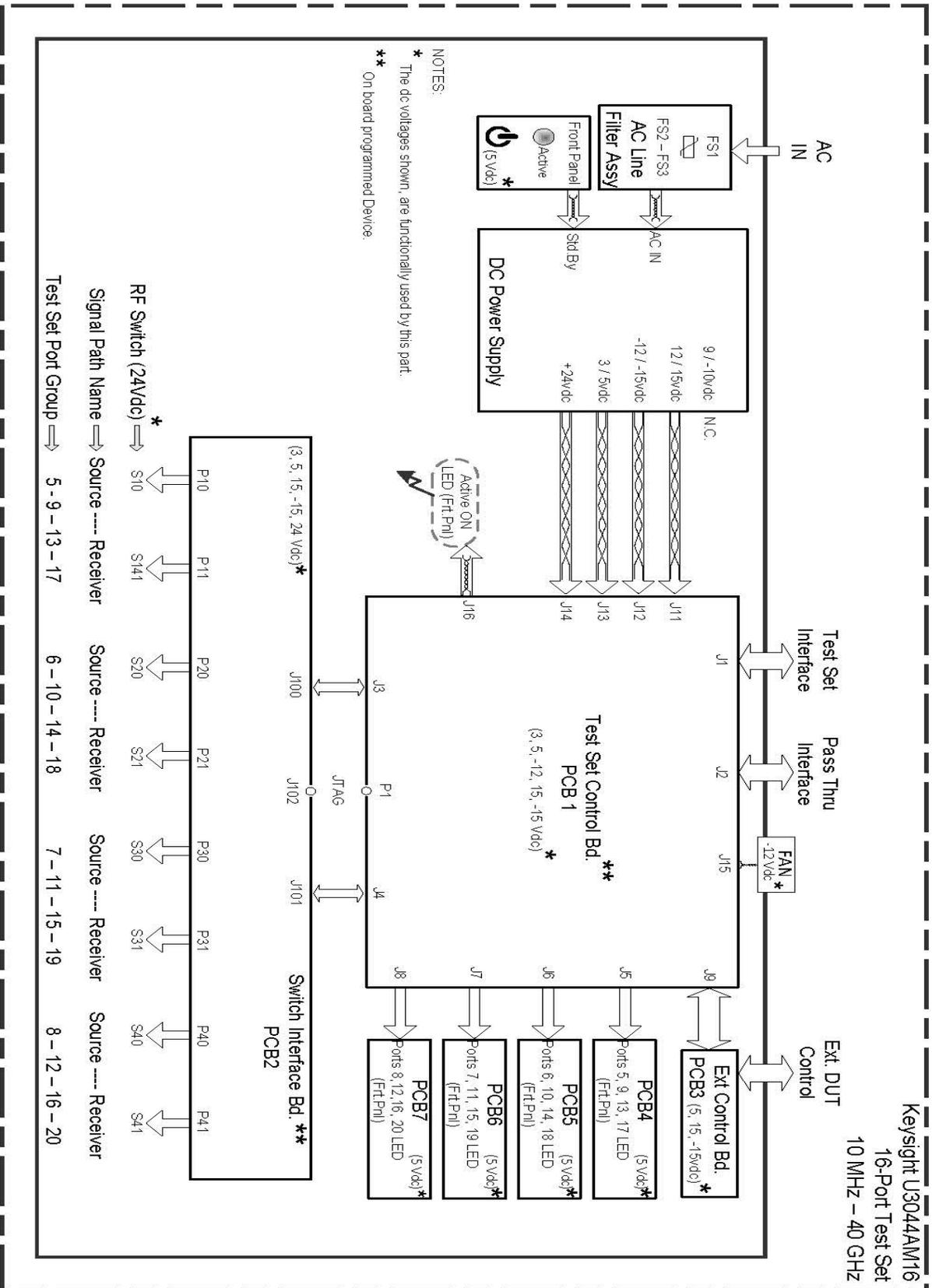
Theory of Operation

The following is a description of the operation of the test set. Reference the test set block diagrams shown in Figure 47 on page 62. This section assumes the user has a general understanding of couplers, switches, and network analyzers.

The test set adds 16 test ports to a 4-Port network analyzer. The internal RF switches direct the source and receiver signals of the analyzer to the selected measurement test port.

The switches and couplers are arranged in four groups to control the source and receiver paths of the network analyzer port to the couplers in the column under the analyzer port.

Test Set Control Board

The test set Control Board (N5261-63006) is a surface mount, printed circuit assembly (PCA). It provides a connection to the power supply, and the network analyzer's test set I/O for control of the RF switch paths (through the Switch Interface board (U3025-60062). The front panel "Active" and port LEDs are on only when the network analyzer has addressed the U3044AM16 test set. The rear panel fan is on when the controller board supplies are operational.

Switch Interface Board

The Switch Interface board (U3025-63062) is installed on top of the test set Controller Board and provides connections to the RF switches. This board regulates the DC voltage supply (24 volts), and routes logic signals to the switches through harness cables connected to the RF switches.

Front Panel LED Boards

Four LED board assemblies (N5261-63005) are mounted to the front panel. The LEDs indicate the Source Path (amber/yellow color), or Receiver Path (green colored) shown as "S" and "R" on the front panel. The LED board assemblies are connected to the test set controller board by ribbon cables to J5, J6, J7 and J8.

DUT Control Board

The DUT Control Board (U3020-63223) provides eight control lines for controlling an external device. The DUT Control Board installed on the rear panel and is connected to the test set Control Board through a ribbon cable to J9.

Power Supply

The switching power supply (0950-4729) coverts the AC line voltages to DC. This is an automatic line voltage selecting power supply. The DC supplies are connected to the test set control board through four wire harness to J11, J12,

J13 and J14. The 9/10 Vdc section of the power supply is not used in this instrument. The AC line voltage (100 to 240 V @ 50/60 Hz) is provided from the line module on the rear panel.

RF Coupler

The test set uses 12 couplers (5087-7793) on the front panel for RF Test Ports 5-20. The couplers provide the signal separation of the source and receiver paths. The test set ports can receive from or stimulate a signal to the DUT.

The RF Test Port connectors are male 2.4 mm. The coupling factor is approximately -18 dB for the Coupled Arm for frequencies > 1 GHz to 40 GHz.

RF Switch Components

The test set uses 8 mechanical switches that have an internal 50 Ω termination. The switches select the RF paths from the analyzer's source and receiver through interconnect cables to the test set.

Source and Receiver Switch Paths

Refer to the U3044AM16 RF Block Diagram on .

Troubleshooting the Test Set

If the U3044AM16 is not operating properly, use the following procedures to isolate and repair the type of failure encountered. It is recommended that a qualified service technician perform the following procedures.

Refer to the Keysight PNA Series: Firmware, Upgrades, and Support Home Page at: http://na.support.keysight.com/pna for further information.

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

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

Non-RF Failures

Typical malfunctions may be the rear panel fan, control lines or front panel indicator lights.

1. Verify that the front panel Power Switch is operational.

  a. The rear panel fan and front panel Active LED should operate when the Standby Switch is in the On position.

2. AC line voltage checks (remove AC power from the instrument).

  a. Ensure the proper AC line voltage is present at the instrument line cord.

  b. Remove the AC power cord from the instrument. Confirm the instrument AC line module fuse is operational. Refer to Figure 4 on page 16.

  c. Internal AC line fuses - Remove the bottom cover of the instrument. Near the rear panel are two fuse holders, remove the fuses and verify that they are operational. Refer to Figure 52 on page 77.

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.

3. Internal DC Power - During this check you will apply AC power to the instrument with the top cover removed. Connect the AC power cord to the test set.

  a. Set the front panel switch to the Standby position. The fans and indicator lights should be Off.

b. Set the standby switch to the On position. The rear panel and internal power supply fans should be operational. The Active LED will be On when test set is connected to an active network analyzer and is addressed by the network analyzer.

c. Verify that the DC LEDs indicators are On.
Note: The LEDs only indicate the presence of a DC voltage, not the DC voltage level. Use the indicated wire locations for voltage measurements, TP1 is your common. Refer to Figure 47 below.

d. If there is no DC power, suspect the power supply module. The actual power supply terminal connection should also be confirmed with a DVM by removing the bottom cover and using the power supply label to identify the terminal voltage values.

e. If all of the DC Input LEDs are On and the fan is not working, replace fan.

NOTE	The +9 and −10 Vdc indicators are not used in this instrument (Off is normal).

Figure 47   DC Power Status LEDs
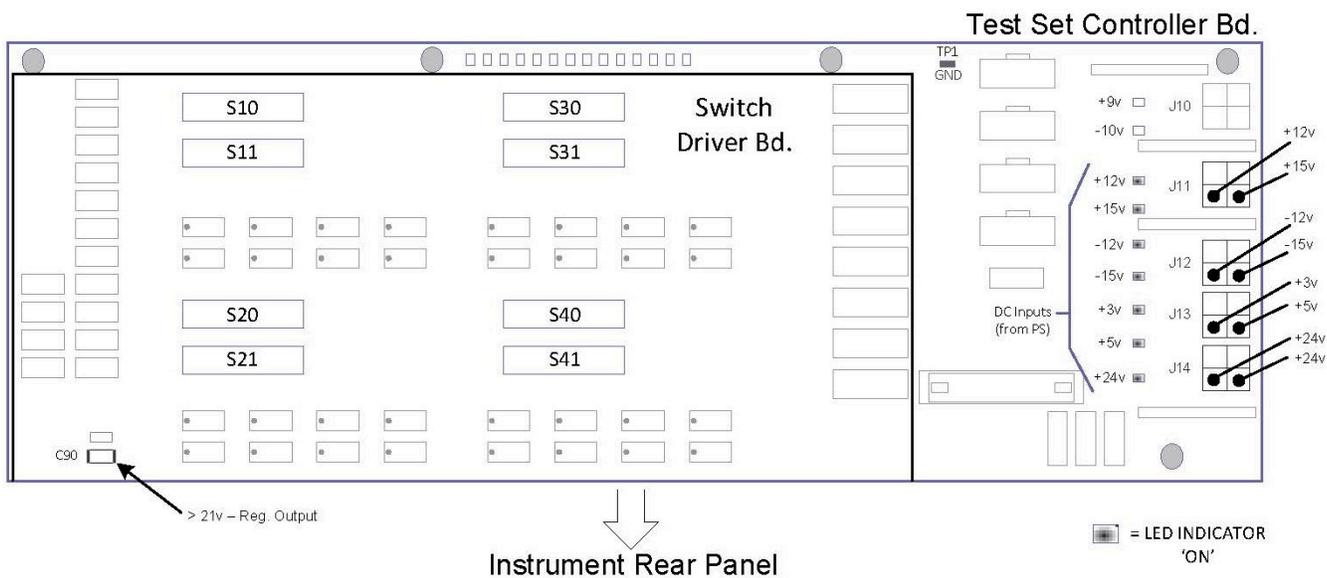
4. Front panel R and S indicator LED check.

a. If the indicators are not operating, continue to "RF Switching Failures" step 1 and step 2.

5. 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 44.

b. Verify that the rear panel DC voltage control adjustment can be set to 5 Vdc. Refer to Figure 3 on page 14.

RF Performance Failures

If the U3044AM16 operates correctly, but RF performance fails the operational test. The following procedures can be used to isolate the failed component. Suspect the RF switches, RF cables, or coupler (5087-7793).

NOTE	The RF performance of the U3044AM16 depends on the performance of the network analyzer. Ensure the network analyzer is meeting specification before continuing.

1. Verify that the test set and network analyzer SOURCE, RCVR, CPLR THRU, and CPLR ARM connectors are clean and that the center pins are not damaged.

2. Verify the interface and internal RF cables are cleaned and not damaged. "Verifying Cal Kit Operational Check Failure" on page 56.

3. Review the "Operational Check" on page 50 and verify the results.

4. If isolation is poor between ports, inspect the RF connections. If it continues to fail, replace the RF switch. The RF cables require proper torque (10 in-lb) and can be damaged by over tightening.

RF Switching Failures

Typical failures may be the loss of RF switch control failure or a non RF failure as outlined in the prior section. The internal RF switches used in this instrument are controlled by the +21 Vdc from the Switch Driver board.

1. Confirm that the network analyzer and test set are properly connected using the test set I/O cable (N4011-21002). Refer to Figure 11 on page 21.

2. Using Multiport Mode (Option 551), verify that the network analyzer firmware is correct, and that the test set file is loaded into the network analyzer. Refer to "Network Analyzer Requirements" on page 7.

3. Follow the "Non-RF Failures" on page 64 procedure (if not already done so).

4. Front Panel R and S indicator LED Check.

   a. Confirm that the test set Controller Board Status LEDs are On. Refer to Figure 47 on page 65. If the LEDs are Off, remove the Switch Driver board; if the LEDs are remain Off, replace the Controller board.

   b. If the Status LEDs are On and the front panel Active LED is On, suspect the front panel LED board or the ribbon cable (replace as needed).

Test Set and RF Switching Path

If you suspect an RF signal path problem with the test set and have verified that the problem is not the front panel RF interface cables, the following procedure will check all of the RF signal paths through the test set. A network analyzer will be used to make S21 measurements.

— Install the test set I/O Interface cable from the network analyzer to the test set rear panel.

— Remove the front panel test set to network analyzer RF interface cables and reinstall the network analyzer front panel jumper cables.

Equipment Required

— N5245A/B PNA-X or equivalent network analyzer
— Two 40 GHz, 2.4 mm RF Flex Cables
— 2.4 mm Adapters (female to female)
— Test Set Interface Cable

Equipment Setup

1. Turn on the test set and the analyzer's.

2. Preset the network analyzer and set it to Standalone Mode. 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.

3. Confirm the frequency range is set to 10 MHz to 40 GHz.

4. Connect the RF flexible cables to network analyzer Ports 1 and 2. Connect the cables together using a 2.4 mm adapter.

5. Configure the network analyzer to measure S21 and normalize the response trace.

6. Set the network analyzer to Interface Control Mode: Select **Channel > Hardware Setup > More > Interface Control...** -OR- *(Instrument > Setup > Internal Hardware > 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 network analyzer display.

Cable Connections

The RF flex cables will be connect to the designated test set front panel ports and an uncorrected response trace should resemble the figures indicated in Table 17.

Table 17   RF Signal Path Insertion Loss (S21)

RF Path Description	Signal	Insertion Loss (typical)
SRC Out to Ports 5-20	Source	Figure 48 on page 71
Rx In to Ports 5-20	Receiver	Figure 49 on page 73
SRC Out to CPLR Thru	Source	Figure 50 on page 74
Rx In to CPLR Arm	Receiver	Figure 50 on page 74

Source Signal Path Insertion Loss Test

Connect the RF Flex cables to the Test Port and Source IN port indicated in Table 18, the expected results should be similar to Figure 48 on page 71.

Table 18   Source Signal Path Test Instructions

Path #	RF Path Description	Control Mode <Address>.<Data>	Path Components	Insertion Loss (typical)
1	SRC Out to Port 5[1]	0.1	P5 CPLR, S10	
2	SRC Out to Port 9	0.2	P9 CPLR, S10	
3	SRC Out to Port 13	0.3	P13 CPLR, S10	
4	SRC Out to Port 17	0.4	P17 CPLR, S10	
5	SRC Out to Port 6	16.1	P6 CPLR, S20	
6	SRC Out to Port 10	16.2	P10 CPLR, S20	
7	SRC Out to Port 14	16.3	P14 CPLR, S20	
8	SRC Out to Port 18	16.4	P18 CPLR, S20	Figure 48 on page 71
9	SRC Out to Port 7	32.1	P7 CPLR, S30	
10	SRC Out to Port 11	32.2	P11 CPLR, S30	
11	SRC Out to Port 15	32.3	P15 CPLR, S30	
12	SRC Out to Port 19	32.4	P19 CPLR, S30	
13	SRC Out to Port 8	64.1	P8 CPLR, S40	
14	SRC Out to Port 12	64.2	P12 CPLR, S40	
15	SRC Out to Port 16	64.3	P16 CPLR, S40	
16	SRC Out to Port 20	64.4	P20 CPLR, S40	

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

Figure 48   SRC Out to Ports 5-20 Path Response

Connect the RF Flex cables to Rx In Port

Connect the RF Flex cables to the Test Port and Rx In port indicated in Table 19, the expected results should be similar to Figure 49 on page 73.

Table 19   Receiver Signal Path Test Instructions

Path #	RF Path Description	Control Mode <Address>.<Data>	Path Components	Insertion Loss (typical)
1	RA In to Port 5[1]	0.16	P5 CPLR, S11	
2	RA In to Port 9	0.32	P9 CPLR, S11	
3	RA In to Port 13	0.48	P13 CPLR, S11	
4	RA In to Port 17	0.64	P17 CPLR, S11	
5	RC In to Port 6	16.16	P6 CPLR, S21	
6	RC In to Port 10	16.32	P10 CPLR, S21	
7	RC In to Port 14	16.48	P14 CPLR, S21	
8	RC In to Port 18	16.64	P18 CPLR, S21	
9	RD In to Port 7	32.16	P7 CPLR, S31	Figure 49 on page 73
10	RD In to Port 11	32.32	P11 CPLR, S31	
11	RD In to Port 15	32.48	P15 CPLR, S31	
12	RD In to Port 19	32.64	P19 CPLR, S31	
13	RB In to Port 8	64.16	P8 CPLR, S41	
14	RB In to Port 12	64.32	P12 CPLR, S41	
15	RB In to Port 16	64.48	P16 CPLR, S41	
16	RB In to Port 20	64.64	P20 CPLR, S41	

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

Figure 49   Rx In to Ports 5-20 Path Response

Connect the RF Flex cables to the SRC Out and CPLR Thru Port

Connect the RF Flex cables to the SRC Out and CPLR Thru port indicated in Table 20, the expected results should be similar to Figure 50.

Table 20   Source Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode <Address>.<Data>	Path Components
1	Port 5, 9, 13, 17	SRC Out to CPLR Thru	0.0	S10
2	Port 6, 10, 14, 18	SRC Out to CPLR Thru	16.0	S20
3	Port 7, 11, 15, 19	SRC Out to CPLR Thru	32.0	S30
4	Port 8, 12, 16, 20	SRC Out to CPLR Thru	64.0	S40

Figure 50   SRC Out to CPLR Thru and Rx In to CPLR Arm Path Response
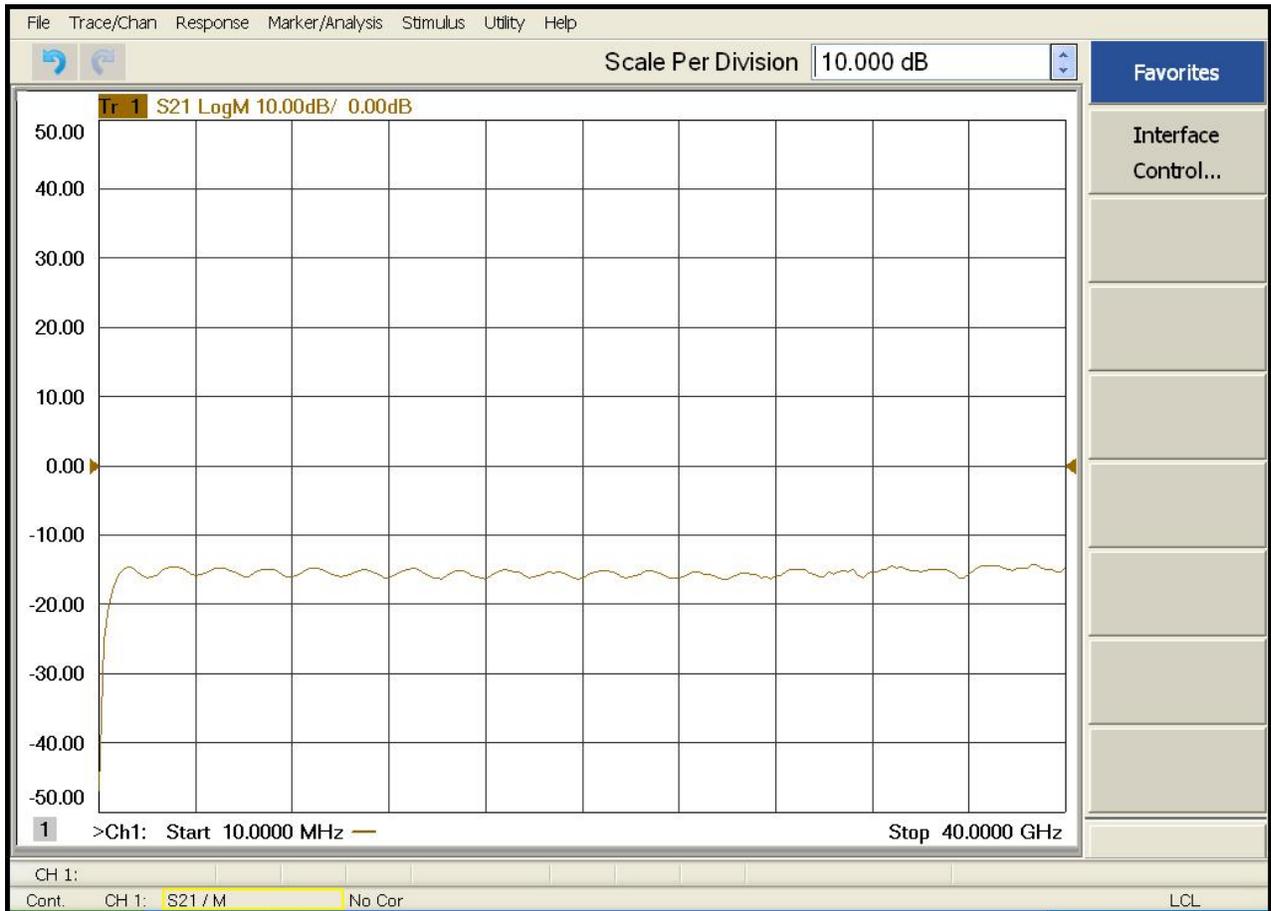
Connect the RF Flex cables to the Rx In and CPLR Arm Port

Connect the RF Flex cables to the Rx In and CPLR Arm port indicated in Table 21, the expected results should be similar to Figure 50 on page 74.

Table 21   Receiver Bypass Signal Path Test Instructions

Path #	Test Port Group	RF Path Description	Control Mode <Address>.<Data>	Path Components
1	Port 5, 9, 13, 17	RA In to CPLR Arm	0.0	S11
2	Port 6, 10, 14, 18	RC In to CPLR Arm	16.0	S21
3	Port 7, 11, 15, 19	RD In to CPLR Arm	32.0	S31
4	Port 8, 12, 16, 20	RA In to CPLR Arm	64.0	S41

Figure 51   Test Set Top View
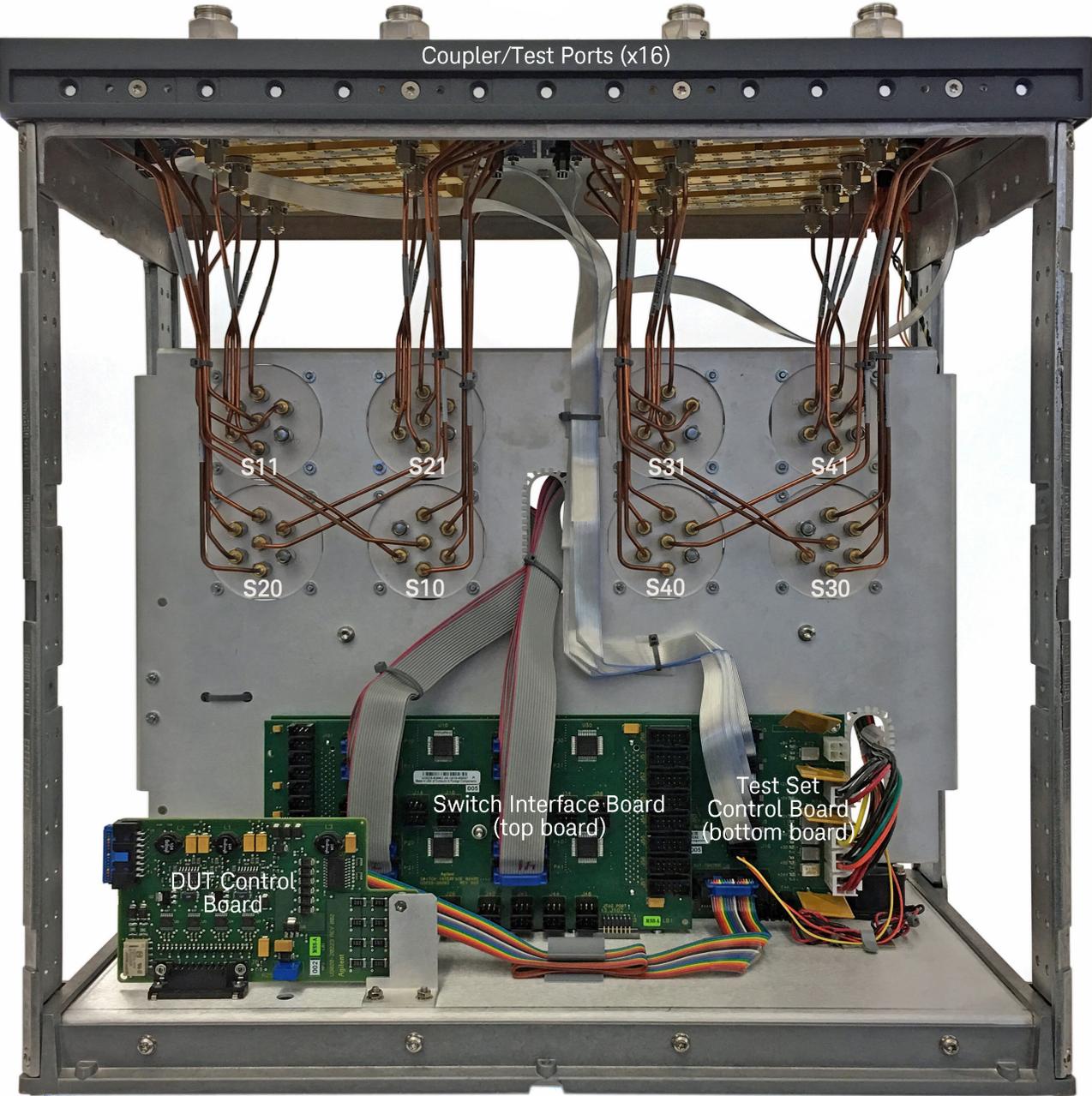
Figure 52   Test Set Bottom View

Supplemental System Configuration, 32-Port

This section provides information related to a custom 32-Port Network Analyzer Measurement System that requires the use of both the U3044AM12 and M16 Test Sets. This system configuration requires interface kit options that must be ordered separately and are listed in Table 22 below. If the equipment for this system is to be installed in a racked system cabinet, and not on a table top, only the interface cable kit listed will be needed.

Table 22 shows the Interface Kit option required for the 32-Port PNA-X System. The Interface Kit includes both the hardware Lock-link and the RF Interface cables needed for a table top setup. Individual Lock-link and Cable Kit numbers are shown for reference.

Table 22   Interface Kit Option

System	Interface Kit Option	Hardware Lock-link	Cable Kit, Connector Type
32-Port System	U3044AM16-044	U3021-60003[1]	U3021-60103, 2.4 mm m/m[2]

1. Installation instructions are provided in the Interface Kit.
2. Refer to "N5244/45A RF Interface Cable Connections (32-Port System)" on page 79.

Figure 53   32-Port Measurement System
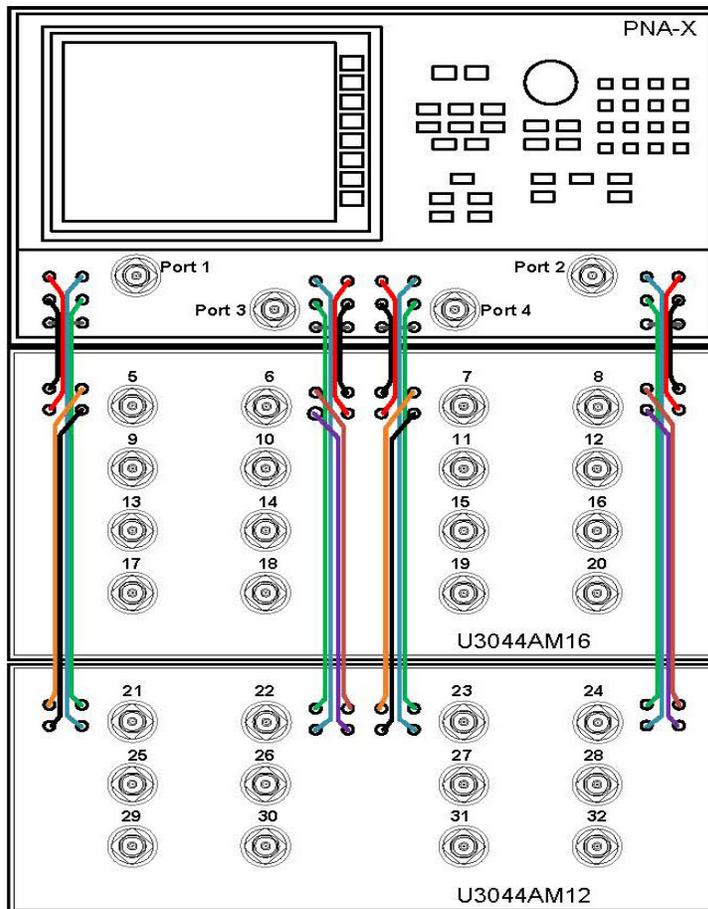
N5244/45A RF Interface Cable Connections (32-Port System)

The semi-rigid cable assemblies are precision 2.4 mm male and should be handled with care. Inspect the protruding center pins of each cable before installation to ensure that the pin is straight. If the pin is deformed slightly, you can re-form it to achieve a perpendicular position.

1. On the PNA-X, remove the SOURCE OUT to CPLR and RCVR IN to CPLR ARM front panel jumpers (x8). Keep the jumpers for future use when the PNA-X is serviced or used without the Multiport Test Set.

2. Connect the RF semi-rigid cables from the PNA-X to the Multiport Test Set as listed in the order shown in the following cable connections tables.

3. During installation of the cable connector, it may be necessary to re-form the cable slightly by hand at the bend points to seat the connector barrel squarely into the mating PNA-X access port.

4. Once the connector barrel is fully seated into the mating port, slide the connector nut onto the PNA-X access port and thread it into place by hand. Tighten the nut to a torque of 8 in-lbs.

NOTE   Overtorque will cause damage to the cable and/or connector parts

Cable Kit Installation for a 32-Port System, U3021-60103

The U3044AM12 Multiport Test Set will need to have its Test Port numbers changed as shown in Figure 54, using the provided port number label sheet in the kit.

Table 23 below provides the cable installation order and Figure 54 provides an illustration of a configured 32-port measurement system.

Table 23   RF Interface Cable Connections (U3021-60103)

	Cable Part Number	PNA-X	to	Test Set (M16)
1	U3044-20018	P1-Source Out		SRC Out
2	U3044-20018	P3-Source Out		SRC Out
3	U3044-20018	P4-Source Out		SRC Out
4	U3044-20018	P2-Source Out		SRC Out
5	U3044-20019	P1-CPLR Arm		CPLR ARM
6	U3044-20019	P3-CPLR Arm		CPLR ARM
7	U3044-20019	P4-CPLR Arm		CPLR ARM
8	U3044-20019	P2-CPLR Arm		CPLR ARM
		PNA-X	to	Test Set (M12)
9	U3044-20044	P1-CPLR Thru		CPLR Thru
10	U3044-20044	P3-CPLR Thru		CPLR Thru
11	U3044-20044	P4-CPLR Thru		CPLR Thru
12	U3044-20044	P2-CPLR Thru		CPLR Thru
13	U3044-20045	P1-RCVR A IN		RA In
14	U3044-20045	P3-RCVR C IN		RC In
15	U3044-20045	P4-RCVR D IN		RD In
16	U3044-20045	P2-RCVR B IN		RB In
		Test Set (M16)	to	Test Set (M12)
17	U3044-20021	P5-CPLR Thru		P21-SRC Out
18	U3044-20021	P7-CPLR Thru		P23-SRC Out
19	U3044-20020	P5-RA In		P21-CPLR Arm
20	U3044-20020	P7-RD In		P23-CPLR Arm
21	U3044-20043	P6-CPLR Thru		P22-SRC Out
22	U3044-20043	P8-CPLR Thru		P24-SRC Out
23	U3044-20042	P6-RC IN		P22-CPLR Arm
24	U3044-20042	P8-RB IN		P24-CPLR Arm

Figure 54   RF Interface Cable Connections, 32-Port System
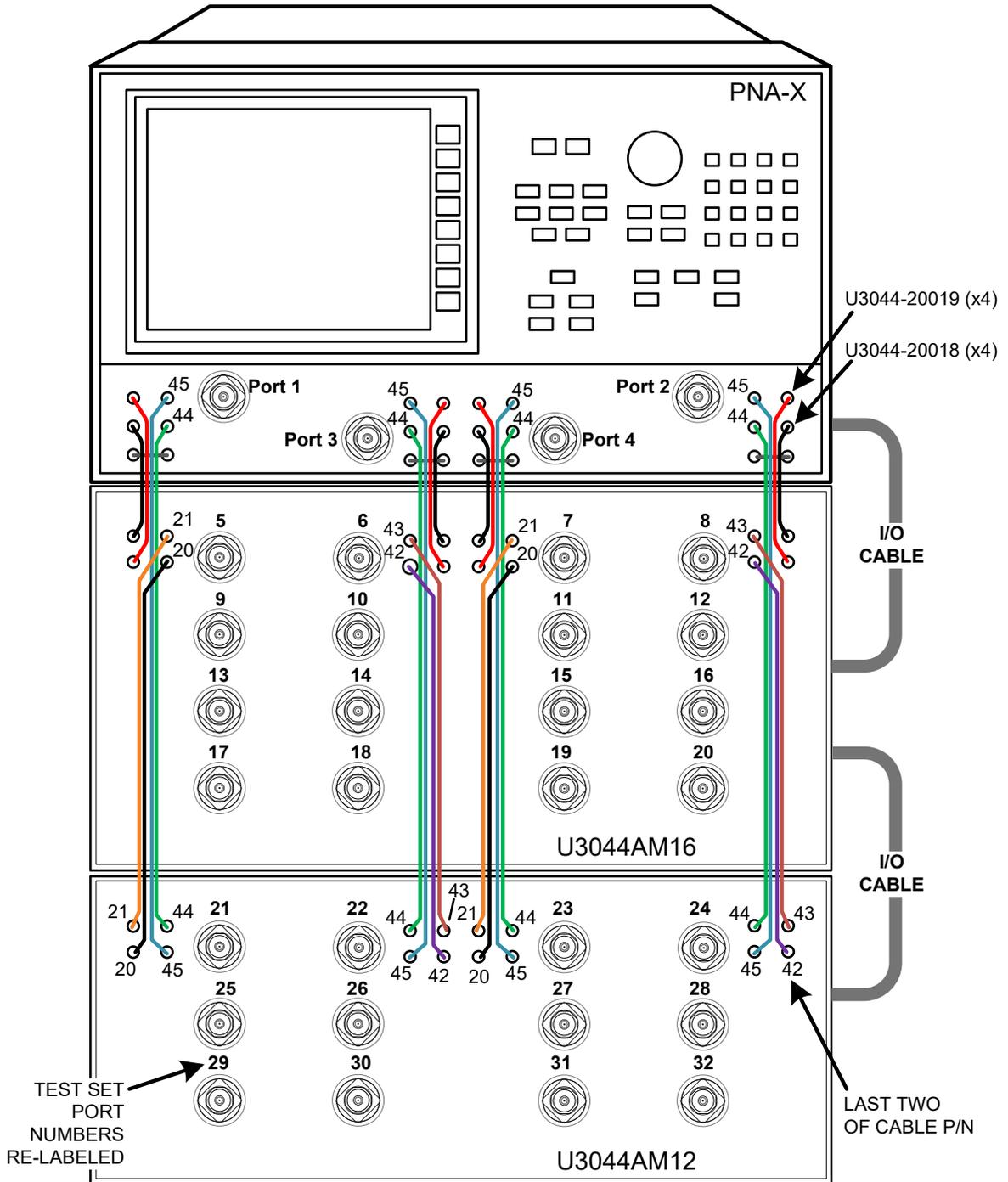
Address and Data Values

Setting the Test Port Switch Paths for the 32–Port System

Refer to Table 24, "32-Port System, Address and Data Values" for information on how to set the internal switch paths of this dual Test Set system. Unlike the single Test Set system, in which two ‹address›.‹data› strings are needed for your Source and Receiver selections, two sets of values will now be needed for the Source and Receiver selections.

Example 1:   Port 5 is the Source and Port 6 is the Receiver.
Port 5 Receiver Port Address and Data Value is ‹0›.‹16› & ‹1›.‹0›
Port 6 Source Port Address and Data Value is ‹16›.‹1› & ‹17›.‹x›[1]

Your three Control Code entries will be: **0.16**
                                                                1.0
                                                                16.1

Example 2:   Port 22 is the Source and Port 10 is the Receiver.
Port 22 Receiver Port Address and Data Value is ‹16›.‹0› & ‹17›.‹1›
Port 10 Source Port Address and Data Value is ‹16›.‹32› & ‹17›.‹0›

Your two Control Code entries will be
(after adding the pairs with an equal Address value):   16.0 + 16.21 = **16.32**
                                                                            17.1 + 17.0   = **17.1**

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1. "x" indicates a "Don't Care" value.

Figure 55   32-Port System RF Block Diagram
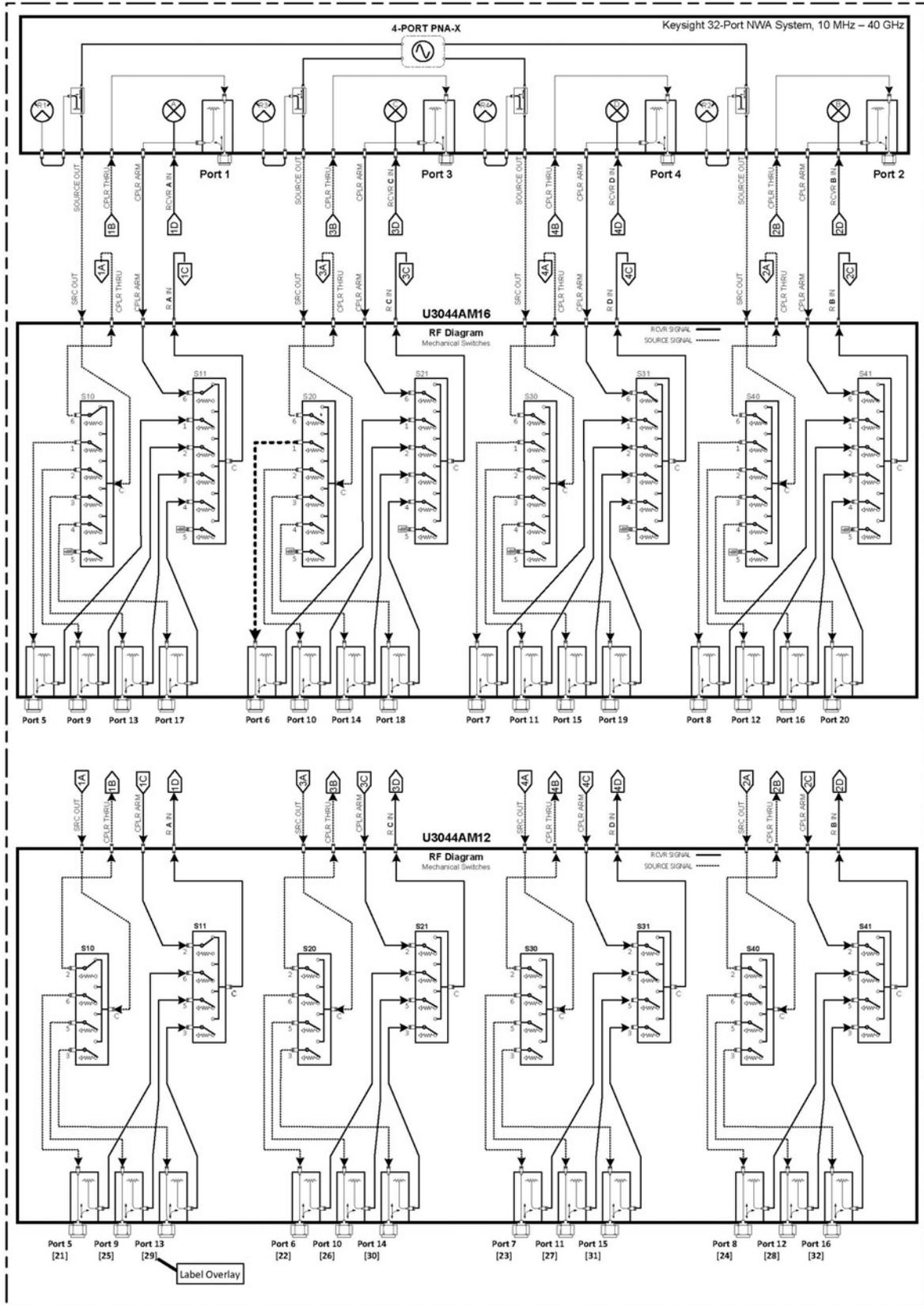
Table 24 32-Port System, Address and Data Values

M16 Test Set (Upper)

Address	Data →	Source Port										Receiver Port									
		0	0	1	x^1	2	x^1	3	x^1	4	x^1	0	0	16	0	32	0	48	0	64	0
0 / 1	Ports	1		5		9		13		17		1		5		9		13		17	
16 / 17	Ports	3		6		10		14		18		3		6		10		14		18	
32 / 33	Ports	4		7		11		15		19		4		7		11		15		19	
64 / 65	Ports	5		8		12		16		20		5		8		12		16		20	

M12 Test Set (Lower)

Address	Data →	Source Port							Receiver Port						
			0	1	0	2	0	3			x^1	16	x^1	32	x^1	48	
0 / 1	Ports		21		25		29				21		25		29	
16 / 17	Ports		22		26		30				22		26		30	
32 / 33	Ports		23		27		31				23		27		31	
64 / 65	Ports		24		28		32				24		28		32	

---

1. "x" indicates a "Don't Care" value.

Safety and Regulatory Information

Introduction

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

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

Safety Earth Ground

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

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

Declaration of Conformity

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

Statement of Compliance

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

Before Applying Power

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

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

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

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

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

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

CAUTION   This instrument has auto-ranging line voltage input, be sure the supply voltage is within the specified range and voltage fluctuations do not to exceed 10 percent of the nominal supply voltage.

Servicing

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

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

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

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

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

WARNING The power cord is connected to internal capacitors that may remain live for 5 seconds after disconnecting the plug from its power supply.

Connector Care and Cleaning Precautions

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

WARNING To prevent electrical shock, disconnect the Keysight Technologies U3044AM16 from mains electrical supply before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.
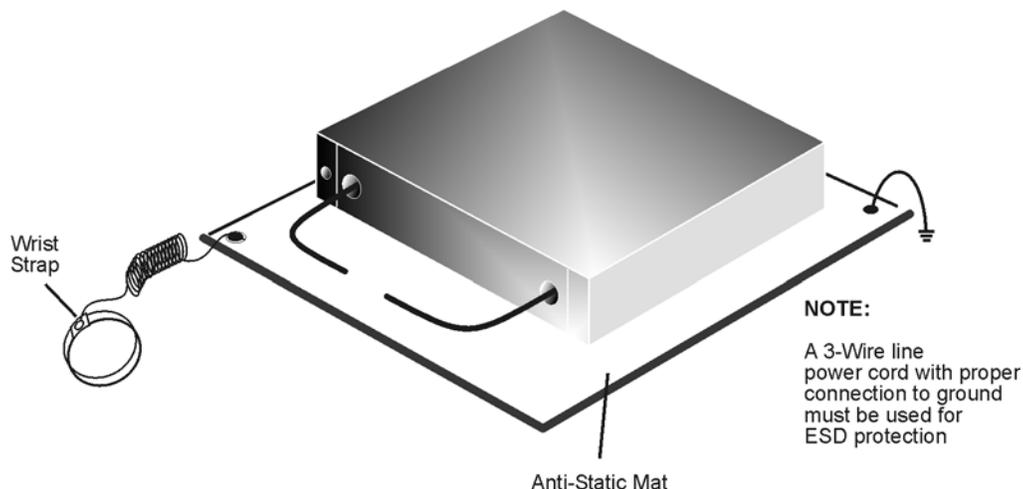
WARNING If flammable cleaning materials are used, the material shall not be stored, or left open in the area of the equipment. Adequate ventilation shall be assured to prevent the combustion of fumes, or vapors.

Electrostatic Discharge Protection

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

— **always** have a grounded, conductive table mat in front of your test equipment.

— **always** wear a grounded wrist strap with grounding cord, connected to a grounded conductive table mat, having a 1 MΩ resistor in series with it, when handling components and assemblies or when making connections.

— **always** wear a heel strap (9300-1126) when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.

— **always** ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port or cable connector briefly.

— **always** ground the center conductor of a test cable before making a connection to the analyzer test port or other static-sensitive device. This can be done as follows:

 1. Connect a short to one end of the cable to short the center conductor to the outer conductor.

 2. While wearing a grounded wrist strap, grasp the outer shell of the cable connector.

 3. Connect the other end of the cable to the test port and remove the short from the cable.

Figure 56   ESD Protection Setup

Wrist Strap

NOTE:

A 3-Wire line power cord with proper connection to ground must be used for ESD protection

Anti-Static Mat

Instrument Markings

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

⚠	The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.
∼	The AC symbol indicates the required nature of the line module input power.
♲	This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive).
I	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.
CE	The CE mark is a registered trademark of the European Community.
ccr.keysight@keysight.com	The Keysight email address is required by EU directives applicable to our product.
CSA ® C US	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.
RCM	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
40	Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.
♻	This symbol on all primary and secondary packaging indicates compliance to China standard GB 18455-2001.
KC	South Korean Certification (KC) mark; includes the marking's identifier code which follows the format: MSIP-REM-YYY-ZZZZZZZZZZZZZZ.

Battery: Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Keysight Technologies for disposal. Refer to "Contacting Keysight" on page 91 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.

사용자 안내문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.
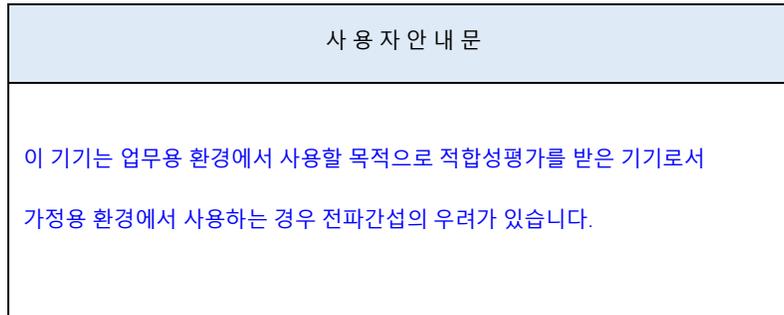
※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

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):

- Acoustical 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: https://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 measurements needs and information or finding a local Keysight office are available on the Web at:
http://www.keysight.com/find/assist

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

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

Shipping Your Product to Keysight for Service or Repair

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

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

— To improve turn-around time, return your test set along with your network analyzer and cables to Keysight so that we may verify the operation of the complete system.

— Include a complete description of the service requested or of the failure and a description of any failed test and any error message.

— Remove and retain the front handles and all rack mount hardware. The analyzer should be sent to Keysight in the same configuration as it was originally shipped.

— Ship the analyzer using the original or comparable antistatic packaging materials.

— Contact Keysight for instructions on where to ship your analyzer.

U3044-90002

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