

Keysight Technologies U3047AE04 Multiport Test Set Extension

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

Notices

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Manual Part Number

U3047-90002

Edition

Edition 2, August 2026

Supersedes: November 2016

Printed in USA/Malaysia

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

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

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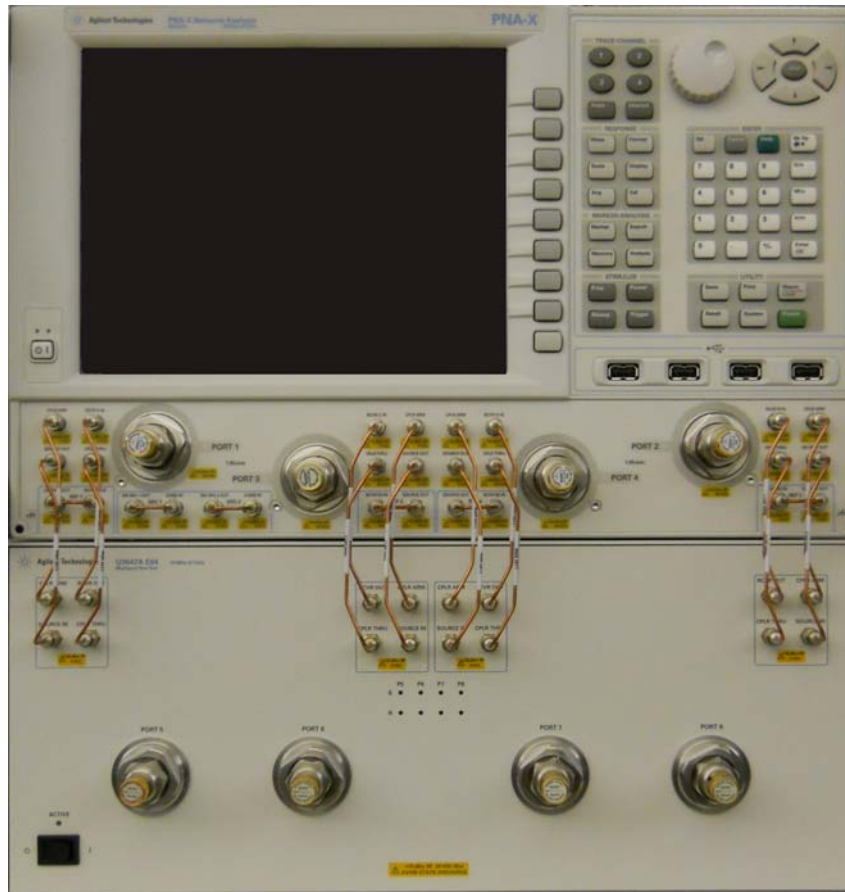
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U3047AE04

Introduction

This document describes how to use and service the U3047AE04 Multiport Extension Test Set with the Keysight N5247A 4-Port PNA-X for a 8-Port network analyzer solution.

Figure 1 Front Panel N5247A with U3047AE04



Description

The Keysight U3047AE04 is a Multiport Test Set extension designed for use with the N5247A 4-Port PNA-X (10 MHz to 70 GHz) to provide a full 8-Port measurement solution. The U3047AE04 has the following key features:

- 4 Test Ports (1.85 mm male connectors)
- Solid-State switching
- 10 MHz to 70 GHz frequency range of operation
- Keysight PNA compatibility with rear panel Test Set I/O interface for operational control. An external personal computer is not required. The N5247A Option 400 and 551 are required.
- A standard Keysight System II instrument cabinet (4EIA high by 497.8 mm deep).

NOTE

The N5247A PNA-X will be referred to throughout this document as the PNA-X. The U3047AE04 will be referred to as the Test Set.

Verifying the Shipment

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

Inspect the shipping container. If the container or packing material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is physical damage refer to **“Contacting Keysight” on page 74**. Keep the damaged shipping materials (if any) for inspection by the carrier and an Keysight Technologies representative.

Network Analyzer Requirements

All network analyzers require Option 551 for multiport operation (N-Port error correction and measurement capability). **Table 1** below provides a listing of other network analyzer option requirements. The analyzer's frequency range must be equal to or exceed that of the test set so that the measurement system covers the full frequency range of the test set.

The test set files indicated in **Table 1** must be installed into the analyzer's file directory:
c:\Program Files\Agilent\Network Analyzer\testsets

Table 1 Network Analyzer Configuration Requirements

4-Port Network Analyzer	Options	Test Set File	System Figure
N5247A PNA-X or N5227A PNA	400, 551	u3047ae04_pnax_p4.tsx	Figure 1 on Page 2

- Documentation - <http://www.keysight.com/find/pna>
- Network Analyzer Firmware - <http://na.support.keysight.com/pna/firmware>
- U3047AE04 Test Set Files - <http://na.support.keysight.com/multiport> (see test set files)

Available Options

Test Set Option

Refer to “System Block Diagram” on page 52.

- Standard – mechanical switches for low loss.

Rack Mounting Kits

Available options for system cabinet mounting:

- U3047AE04-1CM Rack Mount Kit without Handles (5063-9215)
- U3047AE04-1CN Front Handle Kit (5063-9228)
- U3047AE04-1CP Rack Mount Kit with Handles (5063-9222)

Network Analyzer Interface Kit Options

NOTE

The U3047AE04 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 the cable kit listed in Table 2 below.

Table 2 Interface Kit Options

16-Port Network Analyzer System	Interface Kit Option	Hardware Lock-Link	Cable Kit, Connector Type
N5247A PNA-X or N5227A PNA	U3021PX1 Opt 447	U3021-60002 ¹	U3021-60101 ² , 1.85 mm M/M

1. "Hardware Lock-Link Installation (U3021-60002)" on page 12.
2. "RF Interface Cable Connections (U3021-60101)" on page 15.

General Specifications

Specifications for the Test Set are characteristic for the system performance of the PNA-X and the Test Set. Before using the PNA-X and Test Set a calibration is recommended for best measurement performance. Actual performance of the system is based on the customer's PNA-X and options that are used with the Test Set. A functional certificate is only offered for the Test Set.

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

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

When connected to a PNA-X, 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 PNA-X and also reduces dynamic range. The reflection tracking values measured in **Table 6** in the “**Cal Kit Operational Check**” on page 43 can be subtracted from the analyzers dynamic range to determine the approximate performance of the system.

Power Requirements

Verify that the required ac power is available before installing the Test Set to the PNA-X.

- 100/120/220/240 VAC (50/60Hz)
- The instruments can operate with mains supply voltage fluctuations up to $\pm 10\%$ of the nominal voltage.
- Air conditioning equipment (or other motor-operated equipment) should not be placed on the same AC line that powers the Test Set and PNA-X.
- **Table 3** below contains the maximum wattage for all instruments. This table can be used to determine the electrical and cooling requirements.

Table 3 Power Requirements

Instrument	Maximum Wattage
N5247A	450
U3047AE04	350

WARNING

This is a Safety Class I Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall be 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.

Environmental Tests

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

- Operating Temperature 0 - 50 °C
- Altitude (Operation)
3,000 meters (~10,000 feet)
- The instrument can safely operate in a relative humidity of 80% for temperatures to 31 degrees C, decreasing linearly to 50% relative humidity at 40 degrees C.

Equipment Heating and Cooling

If necessary, install air conditioning and heating to maintain the ambient temperature within the appropriate range. Air conditioning capacity must be consistent with the BTU ratings given in **Table 3**.

CAUTION

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

Required Conditions for Accuracy Enhanced Measurement

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

Dimensions and Space Requirements

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

Table 4 Instrument Dimensions

Model	Weight	Height	Width	Depth
U3047AE04	10 kg (22 lb)	17.7 cm (7 in)	42.9 cm (16.9 in)	49.8 cm (20 in)

Maximum Power Levels

CAUTION

It is recommended that you do not operate components near damage levels (+25 dBm). The power levels must be 3 dB below maximum level to ensure no damage, see [Table 5](#).

Table 5 Power Levels

Maximum U3047AE04 Test Port RF Power Levels:	
PORT 5-8	+15 dBm 20 Vdc
Maximum U3047AE04 Access Ports:	
SOURCE OUT	+15 dBm 0 Vdc
CPLR ARM	+15 dBm 0 Vdc
CPLR THRU	+15 dBm 0 Vdc
RCVR OUT	+15 dBm 0 Vdc

NOTE

Refer to your PNA-X 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.

Reflection Tracking Performance

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.

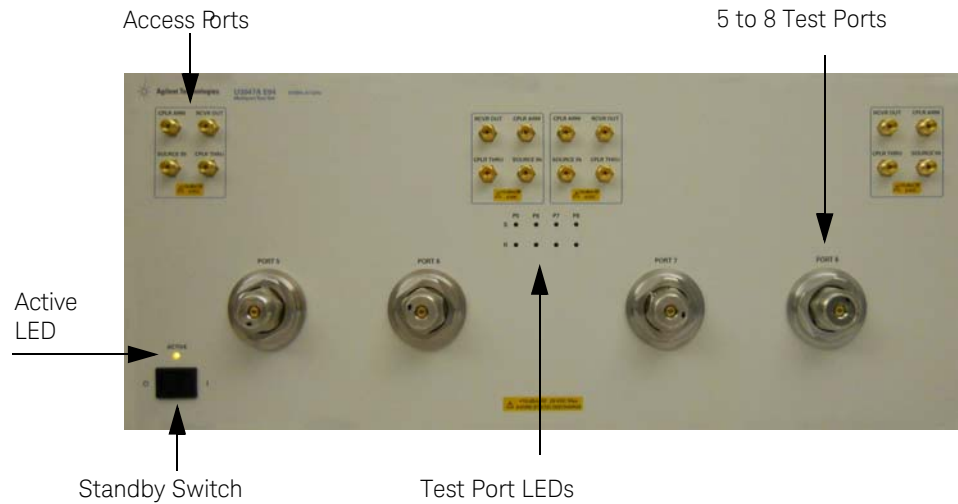
Table 6 Typical Reflection Tracking PNA-X¹

Frequency	Ports 1 to 8
10 MHz to 45 MHz	-11
45 MHz to 2 GHz	-13
2 GHz to 10 GHz	-17
10 GHz to 20 GHz	-21
20 GHz to 30 GHz	-22
30 GHz to 40 GHz	-27
40 GHz to 50 GHz	-38
50 GHz to 60 GHz	-38
60 GHz to 67 GHz	-40
67 GHz to 70 GHz	-40

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

Front and Rear Panel Features

Figure 2 U3047AE04 Front Panel



Test Ports – 1.85 mm (male)

- Port 5 – 8

Access Ports – 1.85 mm (female)

- RCVR OUT
- CPLR ARM
- CPLR THRU
- SOURCE IN

Test Port 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.

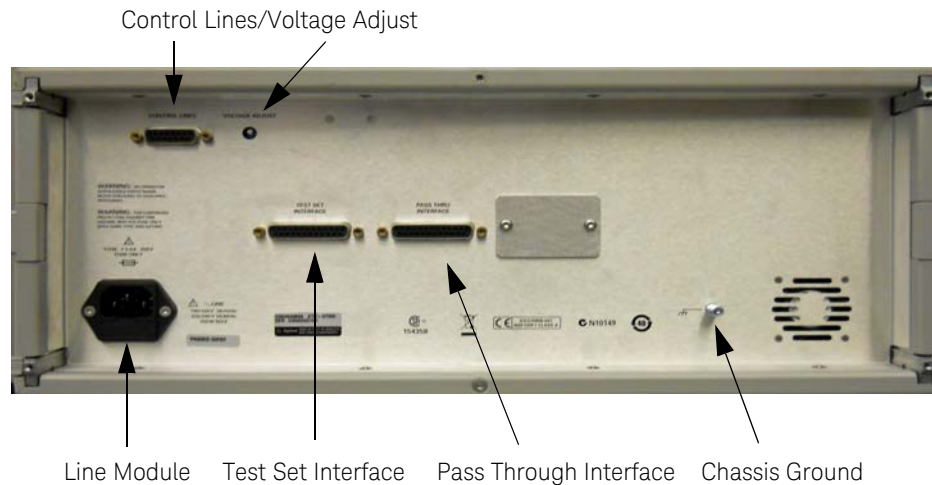
Standby Switch

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.

Figure 3 U3047AE04 Rear Panel



Control Lines and Voltage Adjust

For further information pertaining to control lines and voltage adjustments see. Refer to **“Control Lines” on page 37**.

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 connection 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 PNA-X.

Line Module

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

CAUTION

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

Power Cords

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

WARNING

The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The standby 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, and or circuit breakers only with same type and ratings. The use of other fuses, circuit breakers or materials is prohibited.

Figure 4 Line Fuse



CAUTION

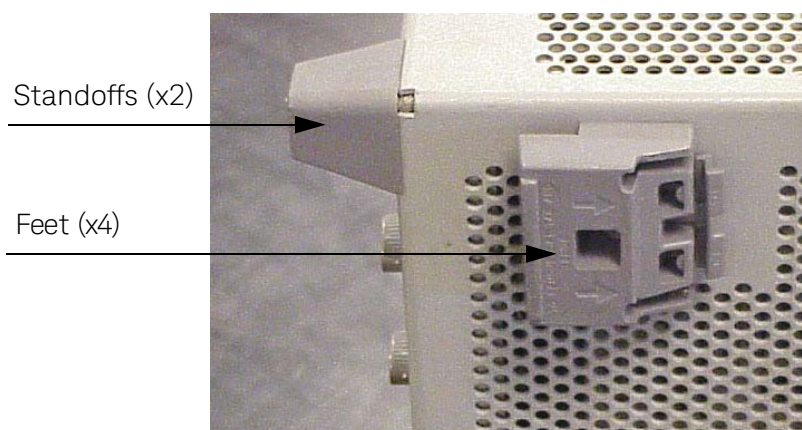
Verify that the premise electrical voltage supply is within the range specified on the instrument.

Hardware Lock-Link Installation (U3021-60002)

Preparing the PNA-X

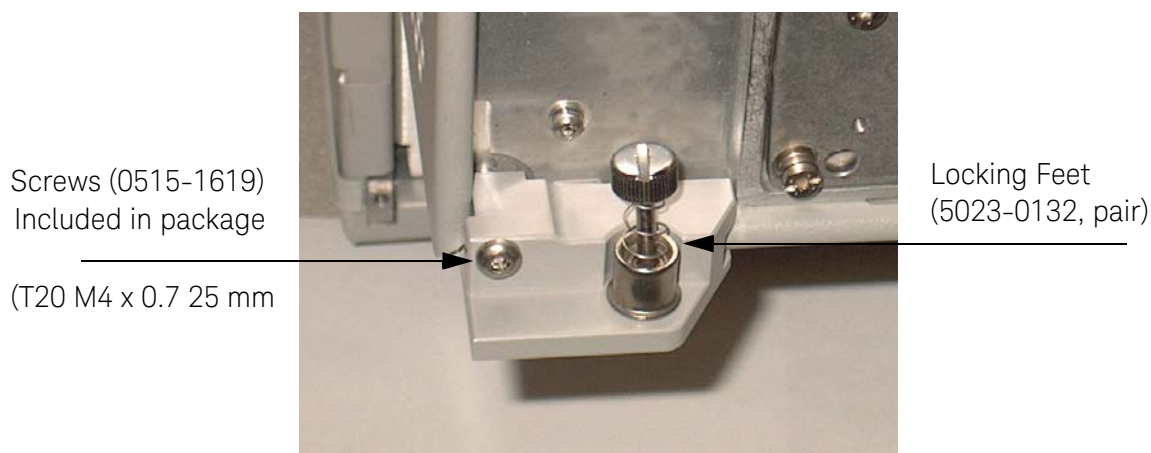
1. The Lock-Link Kit (U3021-60002) includes:
 - 5023-0132 - Lock-Links Kit (left, right pair and screws), analyzer
 - 0515-2317 - Screw T15 M3.5 x 0.6 12 mm
 - N5242-20138 - Right Lock-Link, test set
 - N5242-20139 - Left Lock-Link, test set
2. Remove the feet from the bottom of the PNA-X.
3. Remove the two lower standoffs and screws (0515-1619) from the rear panel on the PNA-X using a T20 Torx driver.

Figure 5 Rear Bottom Feet



4. Install the two rear locking feet (5023-0132) onto the PNA-X, using the included screws (0515-1619), where the standoffs were removed.

Figure 6 Install Locking Feet on PNA-X



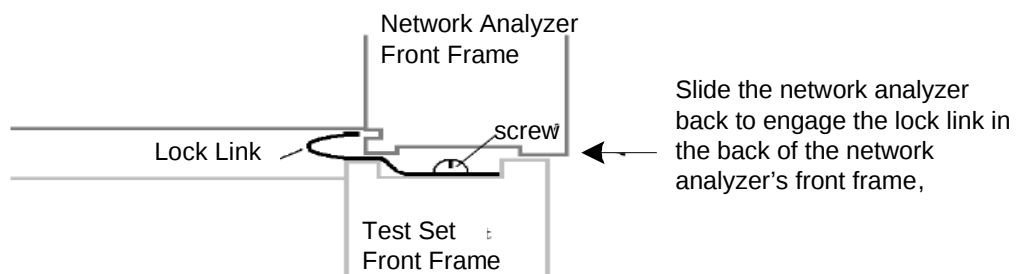
4. Remove the top two standoffs and screws (0515-2317) from the rear panel on the Test Set.
5. Install the two rear locking feet onto the Test Set. The N5242-20138 is the right foot and the N5242-20139 is the left foot. Two screws (0515-2317) are included with this option.

Figure 7 Install Locking Feet on Test Set



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

Figure 8 Locking the Analyzer



7. Secure the PNA-X's lower locking feet to the Test Set upper locking feet, using the spring-loaded screws on the locking feet. If the PNA-X's lower locking feet are not aligned with the screw holes in the Test Set's upper locking feet, loosen the screws securing the feet to the instrument slightly to align and tighten.

Figure 9 Locking Feet Screws



RF Interface Cable Connections (U3021-60101)

Figure 10 on page 15 illustrates the cable configuration of the Test Set to the PNA-X. The cables have been supplied with Kit U3021-60101.

- 1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x8) on the PNA-X. The RCVR R1 to SOURCE OUT reference loop jumpers (x4) remain on the front panel.
- 2. Connect the RF interconnect cables (U3047-20016 and U3047-20017) from the PNA-X to the Test Set in the order listed. As you are connecting each cable, torque to 8 in-lb. Refer to Table 7 and Figure 10 on page 15.

CAUTION

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

Table 7 N5247A RF Interface Cable Connection

Numeric Order	RF Cables	From PNA-X	To Test Set
1	U3047-20017	CPLR ARM	CPLR ARM
2	U3047-20017	RCVR IN	RCVR OUT
3	U3047-20016	CPLR THRU	CPLR THRU
4	U3047-20016	SOURCE OUT	SOURCE IN

Figure 10 illustrates the final two digits of the part number for each cable. The cables must be connected in the numeric order listed in Table 7.

Figure 10 PNA-X RF Interface Cable Connections



3. Connect the PNA-X Test Set I/O cable (N4011-21002) to the Test Set Interface connector on the rear panel.

Figure 11 Rear Panel Test Set I/O Cable



System Operational Check

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

Before beginning this procedure you should complete the following steps:

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

Equipment Setup

- Power On both the Test Set and PNA-X.
- Preset the PNA-X and make the following settings:
 - Set to Multi-Port Mode
 - Frequency range: 10 MHz to 70 GHz
 - IFBW: 1 kHz
 - Scale: 20 dB/Div
 - Set the PNA-X to measure S11

Check Results

The 2.4 mm short will be relocated to each Test Port and an uncorrected Sxx reflection response trace should be displayed that resembles the following plots indicated in the table below. If you suspect an RF signal path problem, refer to the RF cable diagram and check the interface cables associated with this signal path for proper installation.

Table 8 **Reflection Response Results**

Reflection Port	Response Trace	Cable Path Diagram
Ports 1-4	Figure 12 on page 18	Figure 13 on page 18
Ports 5-8	Figure 14 on page 19	Figure 15 on page 19

Figure 12 Typical Reflection Response Ports 1-4

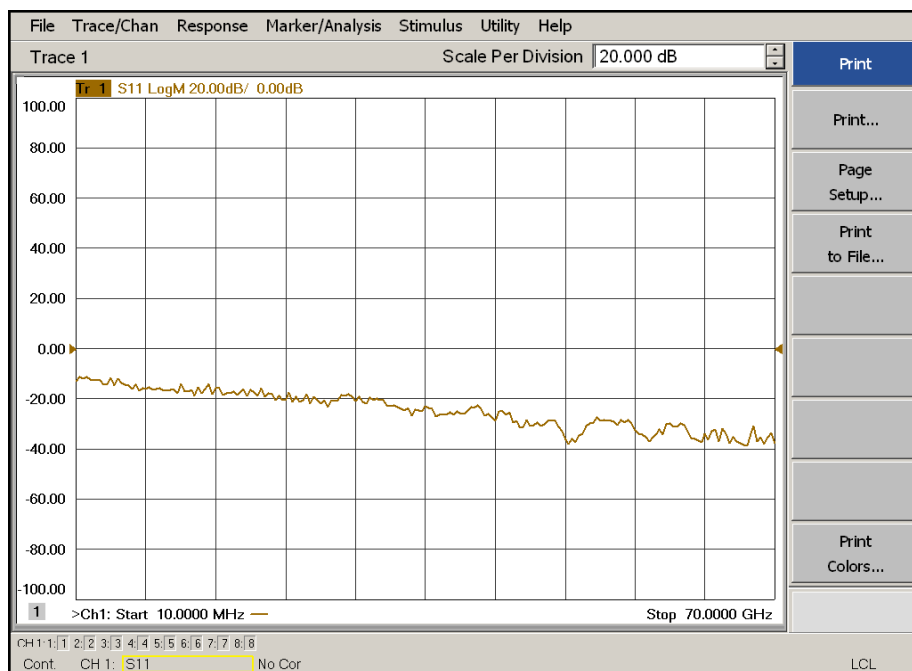


Figure 13 Reflection Response Signal Path Diagram Ports 1-4

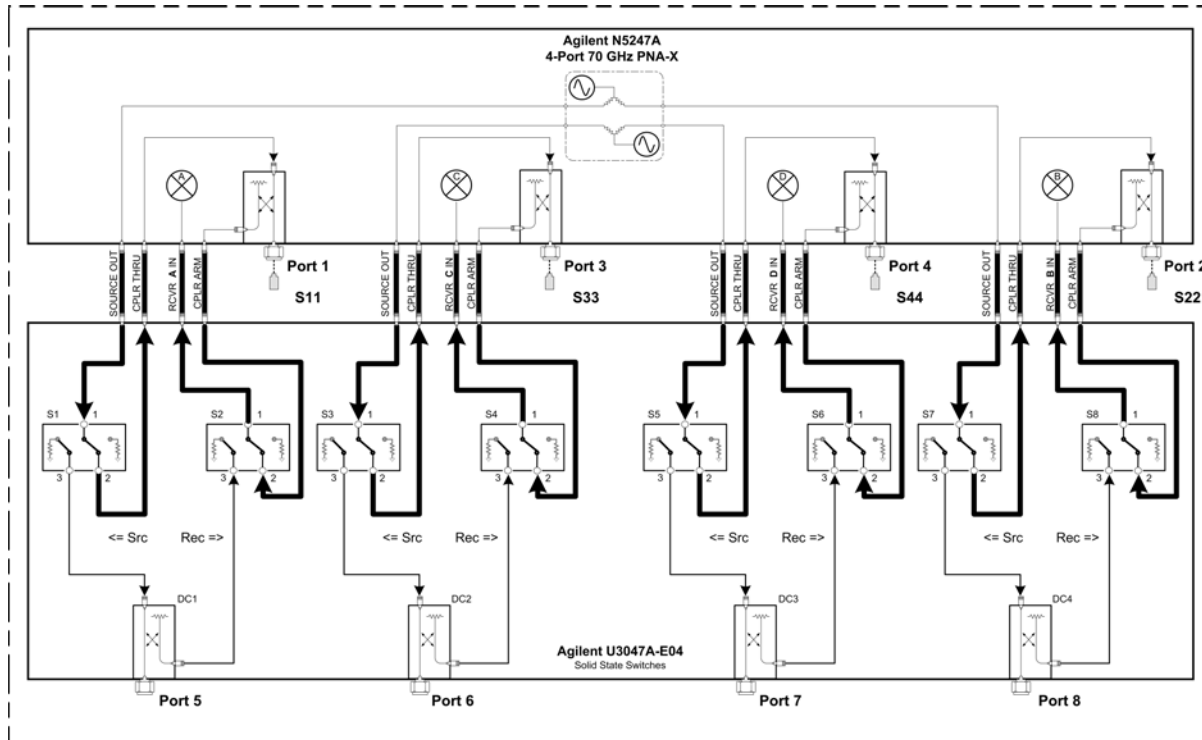


Figure 14 Typical Reflection Response Ports 5-8

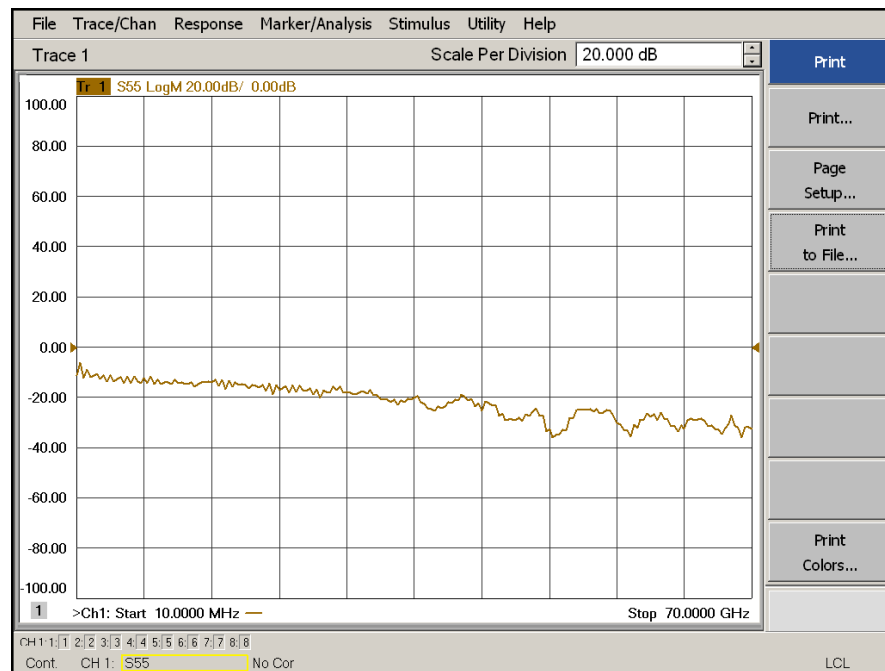
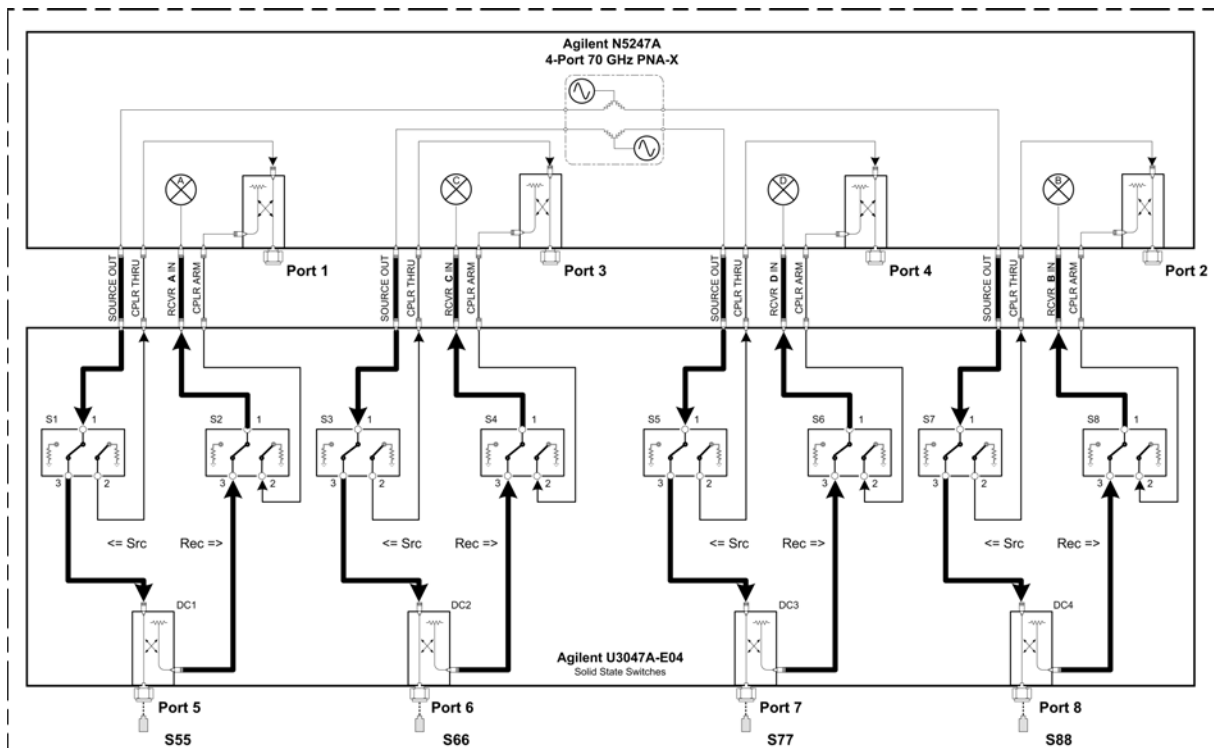


Figure 15 Reflection Response Signal Path Diagram Ports 5-8



Controlling the Test Set

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

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

- "PNA-X Multiport Mode" on page 21.
- "Interface Control Mode" on page 28.
- "GPIB Control Mode" on page 32.

Typeface Key Conventions

The following key conventions are used throughout this document.

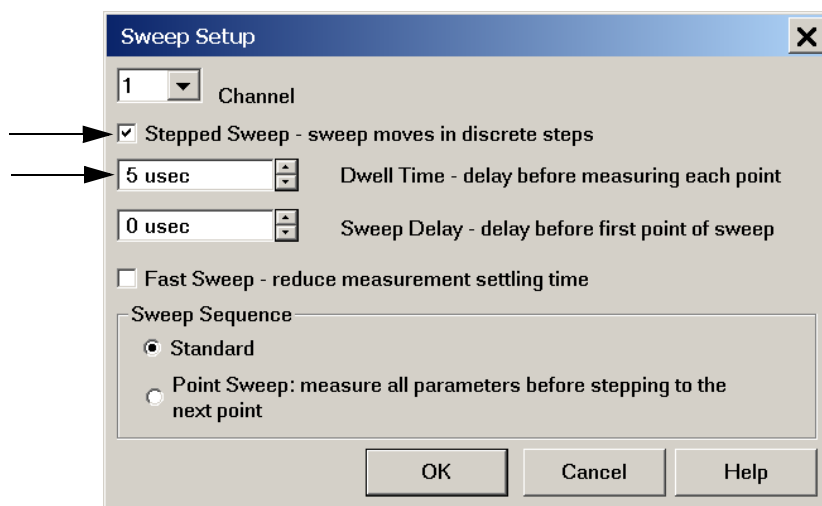
- [HARDKEYS] are labeled front panel keys
- SOFTKEYS are indicated on the instrument display

Sweep Setup for Multiport and Standalone PNA Modes

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

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

Figure 16 PNA Sweep Setup



PNA-X Multiport Mode

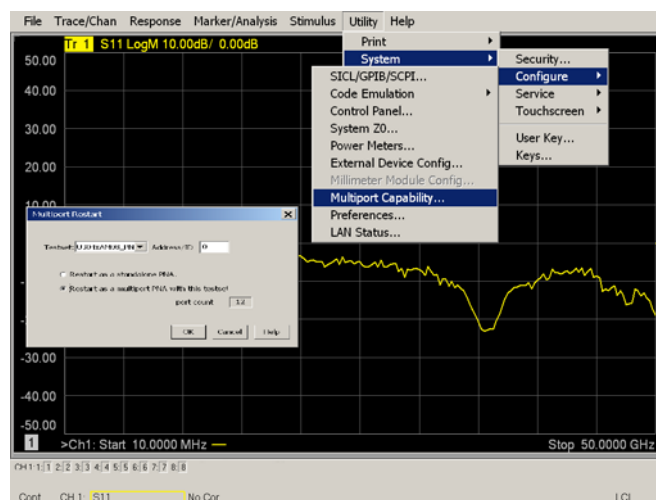
The PNA-X requires Option 551 for multiport mode. The PNA-X must have the Test Set file installed to enable the PNA-X to control the Test Set. The PNA-X multiport mode allows you to select measurement ports, complete an N-Port calibration, operate control lines, and rename test ports. Refer to the Help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

Multiport Mode Operation

1. The Option 551 must be installed for multiport capability. To access the multiport application select **Utility > System > Configure > Multiport Capability**.
2. Select **U3070AE04_PNAX_p4** (8-Port System) from the drop-down menu and select **Restart as a multiport PNA with this testset > OK**. The PNA-X will restart the network application with the Test Set interface features.

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

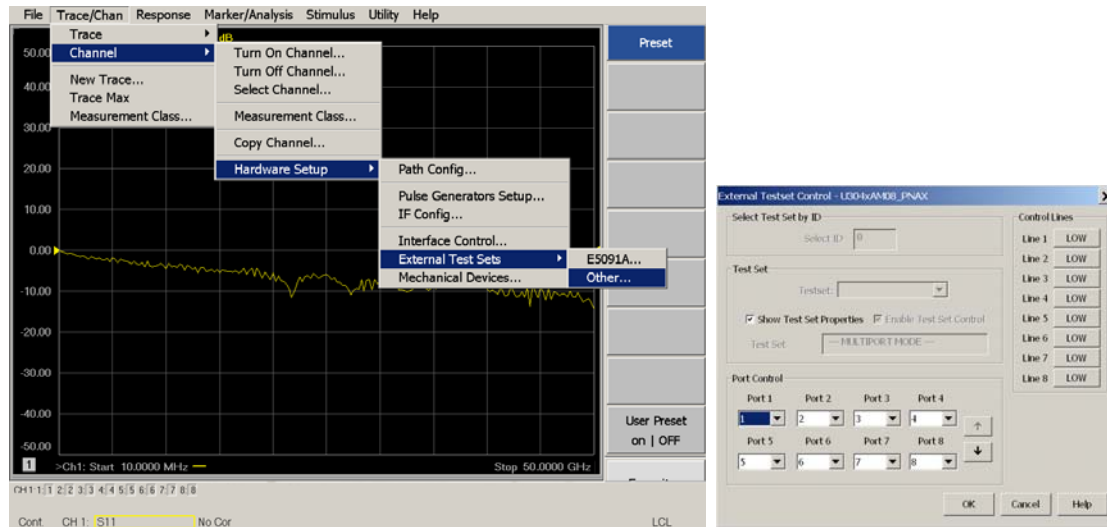
Figure 17 Test Set Selection



External Test Set Control Operation

To verify that the network application has the Test Set interface features, select **Trace/Chan > Channel > Hardware Setup > External Test Set > Other**. The Test Set will be displayed as **External Test Set Control-U3047AE04**.

Figure 18 External Test Set Control



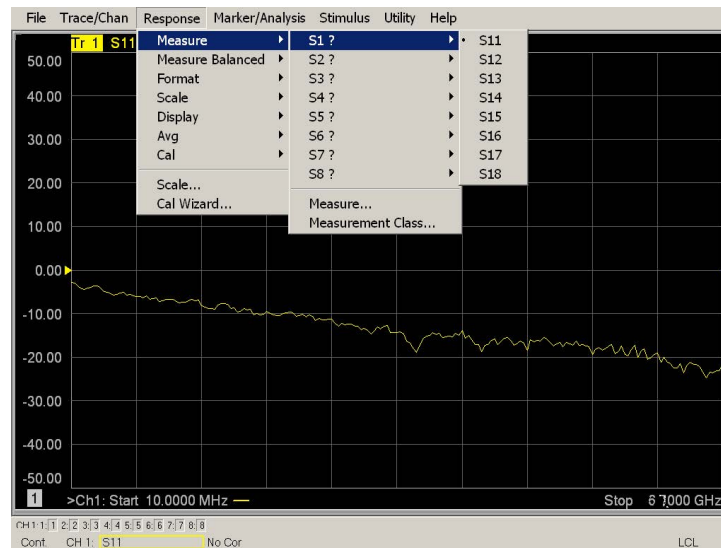
This menu will allow the physical Ports 1 thru 8 to be identified as any port for your convenience. For example, Port 5 can be re-named Port 2.

The **External Test Set Control-U3047AE04** also allows control of the DUT control lines, refer to **“Control Lines” on page 37**. 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. Select the Port Control down arrow for Ports 9 thru 8.

Selecting S-Parameter Measurement

S-Parameter selection can be accomplished using **Response > Measure**. Use the drop-down menu to select 1 of 144 S-Parameters for the 8-Port system. The first number in the Sxx selection is the Receiver Port and the second number will be the Source Port. Any port can be selected to be the Receiver, Source or both, as in S11. The front panel R LED indicates the port is the Receiver and the S LED indicates the port is the Source.

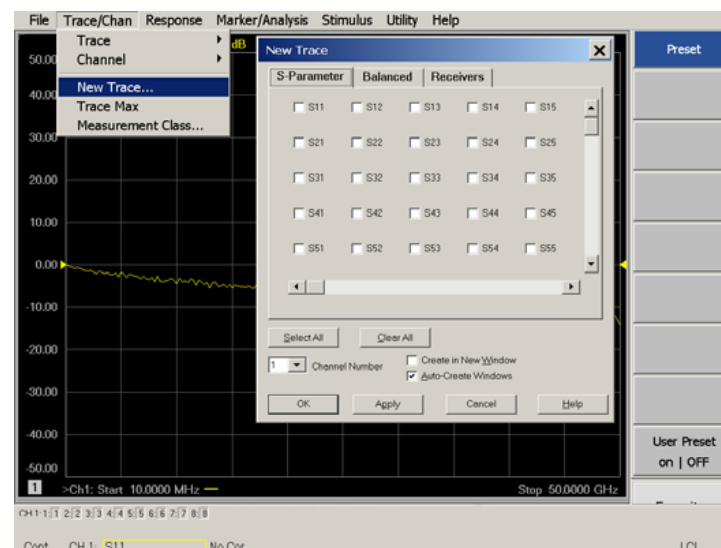
Figure 19 S-Parameter Measurement



Selecting New S-Parameter Measurement

S-Parameter Tab: Multiple S-Parameters can be made by selecting **Trace/Chan > Trace > New Trace**. Use the drop-down menu and select of any of the 144 S-Parameters.

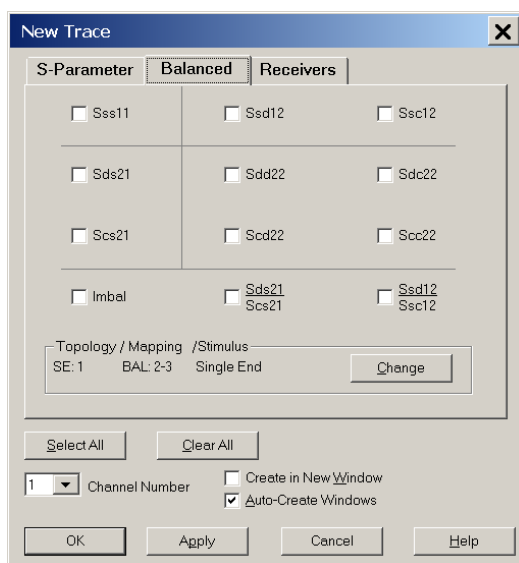
Figure 20 New S-Parameter Measurement



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

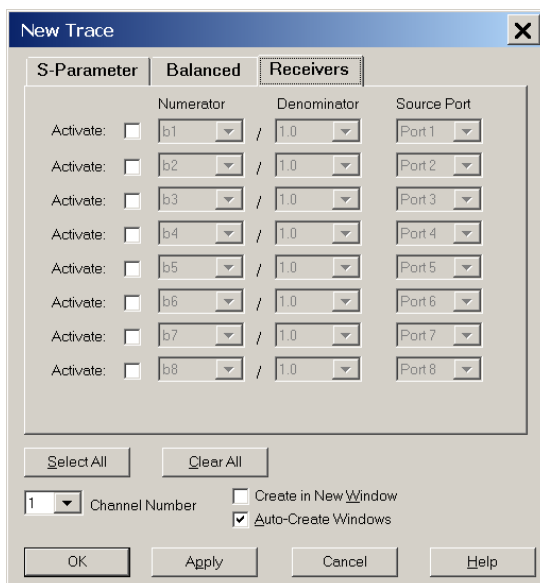
For more information on balanced (differential) component measurement, refer to the Application Note 1373-1 and 1373-2 (5988-5634EN and 5988-5635EN) at keysight.com. In the search menu type “Multiport and Balanced.”

Figure 21 Selecting Balanced Measurements



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

Figure 22 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 PNA-X and Test Set ports.

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

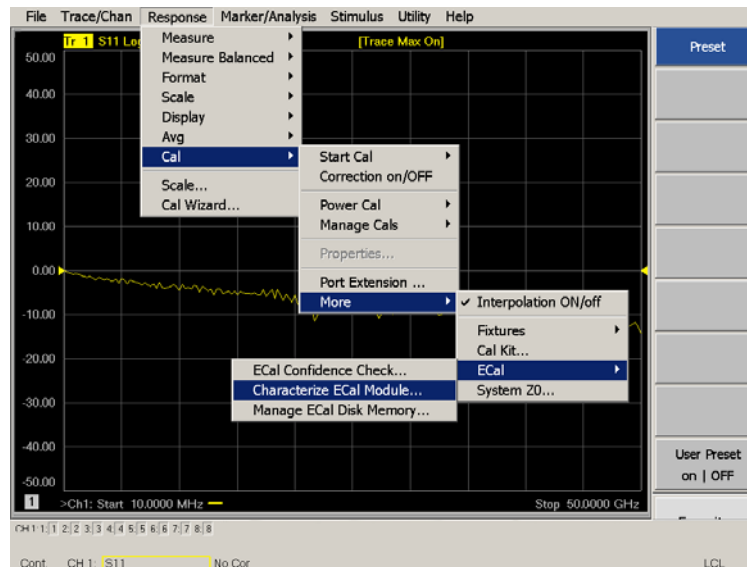
Calibrate at the end of the test port RF cables and any adapters that are used to connect the DUT. This removes the effect on the measurement of the DUT. Failure to do this will create ripple and other measurement errors.

NOTE

If measurement errors occur, ensure the newest version of firmware is installed on the PNA-X. Measurement errors can be a result of firmware algorithms. Consult with Keysight Service or firmware web page for the latest PNA-X Option 551 firmware revisions and history:

<http://na.support.keysight.com/pna/firmware>.

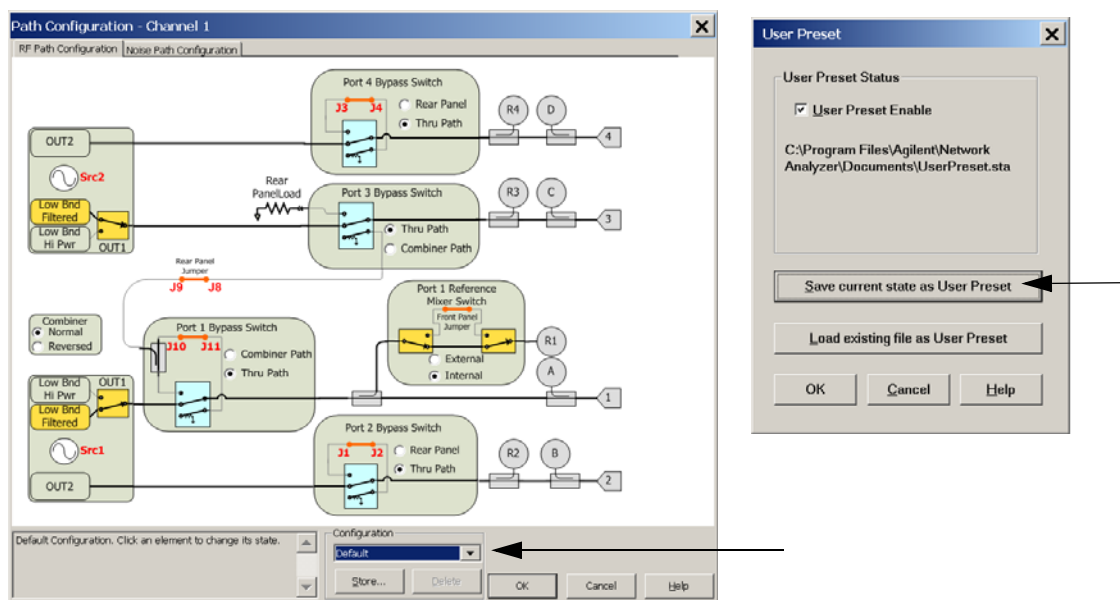
Figure 23 ECal Characterization



NOTE

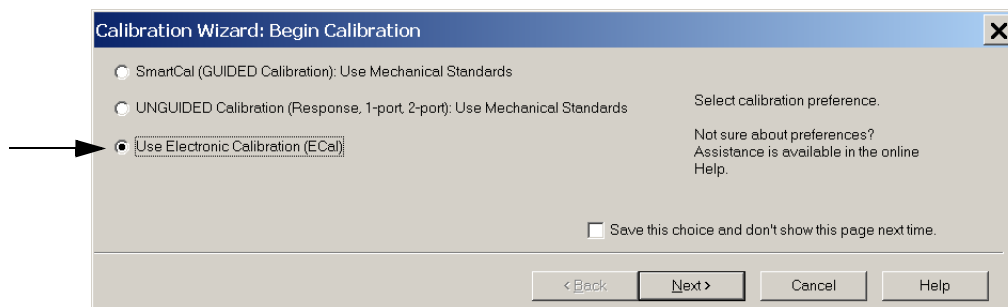
If the PNA-X has Option 029 or H29 (noise figure capability) verify that the path configuration is set to Default. If the PNA-X is not in Default configuration, ports 5 and 9 will not operate correctly. Select **Trace/Chan > Channel > Hardware Setup > Path Cong...** and in the drop-down menu select **Default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

Figure 24 RF Path Configuration



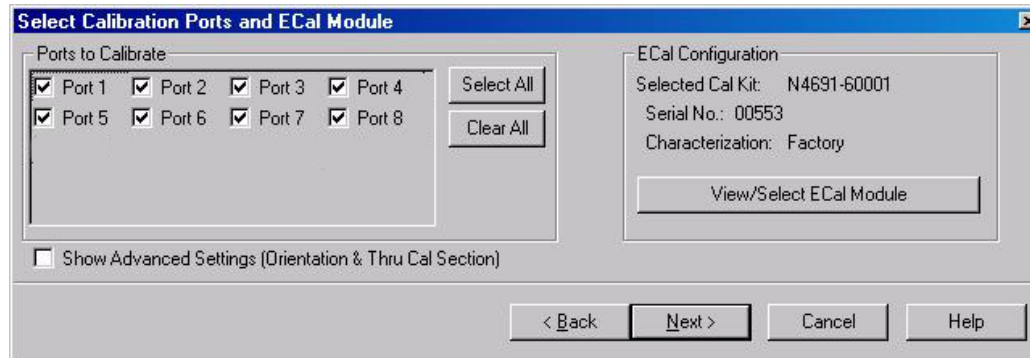
1. On the PNA-X select **Response > Cal Wizard**.
 - a. If using a mechanical cal kit, select **SmartCal (Guided Calibration) > Next**.
 - b. If using an ECal module, connect the ECal to an available PNA-X USB port and select **Use Electronic Calibration (ECal) > Next**.

Figure 25 Begin Calibration



- 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 26 8-Port Calibration



- 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**.
- At the Calibration Completed prompt, select **Save As User Calset**, type the name and **Save**. See **Figure 35 on page 45**.
- After calibrating Test Set ports, use a quality load and short to verify the calibration on each port or end of the test cable. Measure reflection and confirm the return loss is as expected. If the result is not as expected, repeat the calibration without the Test Set and ensure that the PNA-X is in standard (non-multiport) mode.

NOTE

If measurement errors occur, ensure the newest version of firmware is installed on the PNA. Measurement errors can be a result of firmware algorithms. Consult with Keysight Service or firmware web page for the latest PNA Option 551 firmware revisions and history.
<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 PNA-X Help menu, “Rear Panel Tour” and “Interface Control.”

This section includes:

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

NOTE

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

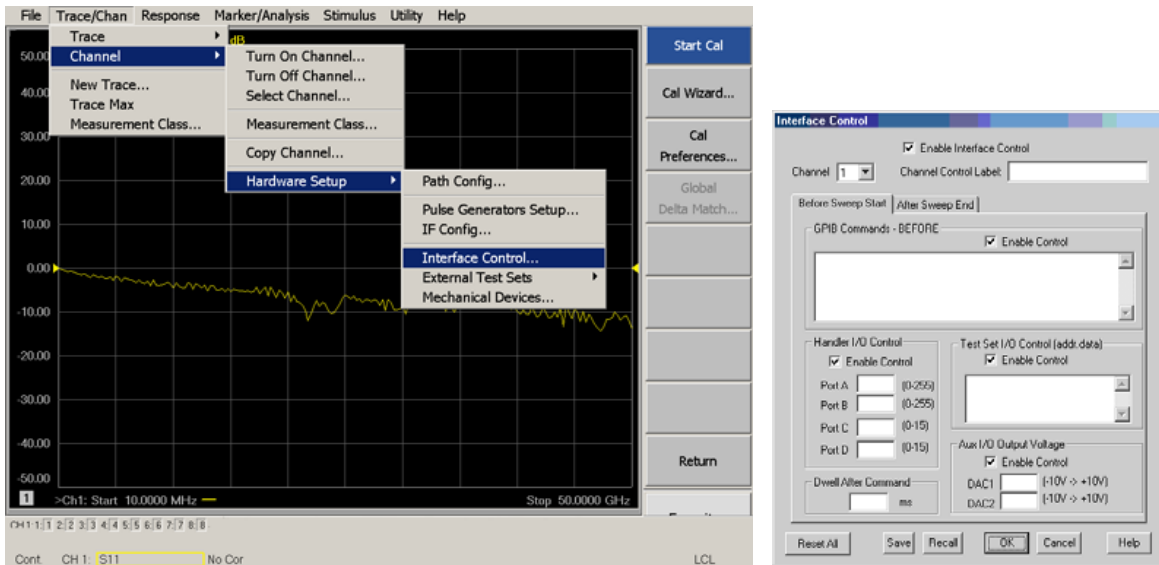
-
- A unique set of control data can be sent for each channel. In addition, a unique set of control data can be sent before the channel sweep starts and after the sweep ends.
 - Interface Control settings can be saved and recalled from the Interface Control dialog box or with Instrument State Save and 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 PNA Help menu.
 1. GPIB Interface
 2. Material Handler Interface
 3. Test Set Interface
 4. Dwell Time

How to Access Interface Control Mode

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

NOTE

The 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 PNA-X. Information regarding this application can be found in the PNA-X Help menu, Interface Control. The application is shown below.



Using Interface Control Mode

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

NOTE

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

Figure 27 Interface Control

The screenshot shows the 'Interface Control' dialog box. It has a title bar 'Interface Control'. Inside, there's a section with a checked checkbox labeled '(1) Enable Interface Control'. Below that is a dropdown menu labeled '(4) Channel' with '1' selected, and a text field labeled '(5) Channel Control Label:'. A tabbed interface shows '(6) Before Sweep Start' as the active tab, with 'After Sweep End' as an alternative. Below the tabs is a section ' GPIB Commands - BEFORE ' with a checked checkbox '(1) Enable Control' and a large text area. Further down, there are two sections: 'Handler I/O Control' with a checked checkbox '(8) Enable Control' and four port selection fields (Port A, B, C, D) with ranges (0-255) or (0-15); and 'Test Set I/O Control (addr.data)' with a checked checkbox '(2) Enable Control' and a list box '(3)' containing '0.0', '16.1', and '32.2'. Below these is 'Aux I/O Output Voltage' with a checked checkbox '(8) Enable Control' and two DAC output fields (DAC1, DAC2) with ranges (-10V -> +10V). At the bottom left is a '(7) Dwell After Command' section with a text field and 'ms' unit. At the very bottom are buttons: 'Reset All', 'Save', 'Recall', 'OK', 'Cancel', and 'Help'.

Enable Interface Control: (1)

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

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

Provides control of the Test Set I/O Interface on the rear panel of the PNA-X. Used to control your Test Set.

Only positive integers are allowed to select switch positions or states of DUT control interface lines. Refer to **“Address and Data Values” on page 35**.

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

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

0.0
16.1
32.2

Channel: (4)

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

Channel Control Label: (5)

Specifies the label to be displayed on the PNA-X screen during the channel sweep.

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

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

Dwell After Command: (7)

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

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

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

Reset All:

Sets all fields on all channels to their default values.

Save and Recall:

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

OK:

Applies the settings and closes the dialog box.

Cancel:

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

Help:

Provides additional information for using the interface control application.

GPIO Control Mode

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

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

Overview of the GPIO Control

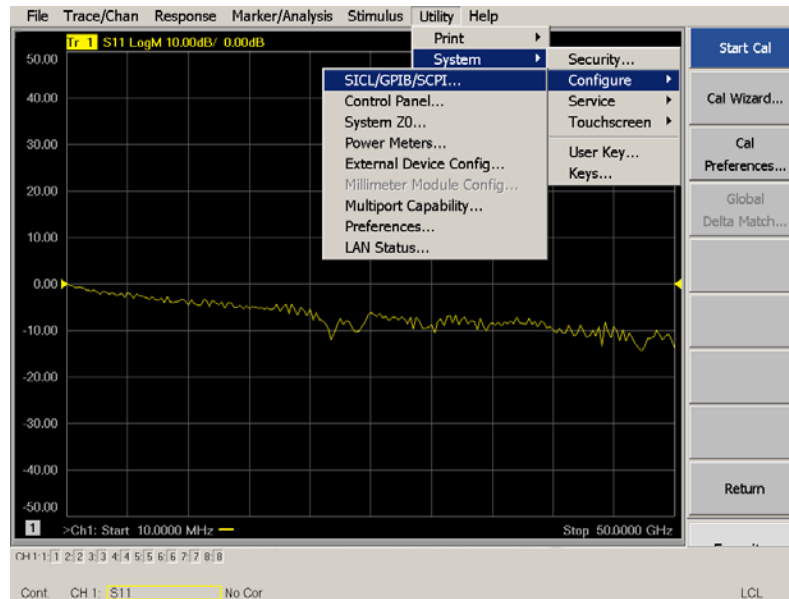
The GPIO Command Processor allows you to send address and data to control an external Test Set, without needing to create a remote program. The user is required to manually input address and data using the GPIO Command Processor Console in the PNA-X Help menu.

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

How to Access GPIB Command Processor

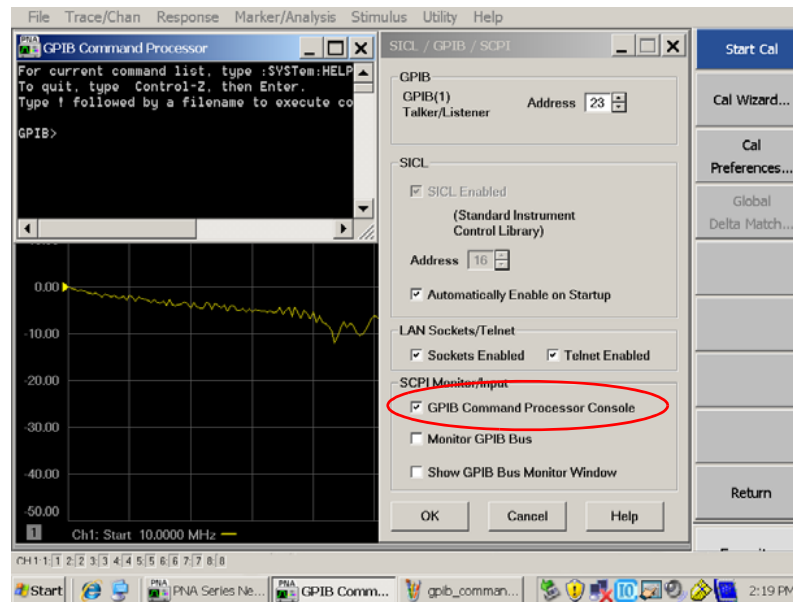
1. To access the GPIB Command Processor select **Utility > System > Configure > SICL/GPIB/SCPI**.

Figure 28 Utility Configure



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

Figure 29 GPIB Command Processor



GPIO Command Processor Console

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

address: a integer number

data: a integer number

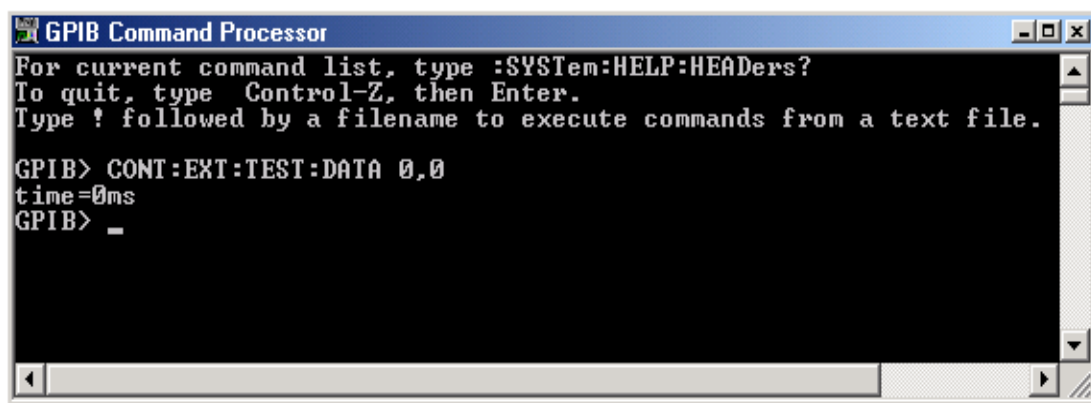
Address and data are separated by a comma. Commands should be separated by a new line, or carriage return.

For example:

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

```
CONT:EXT:TEST:DATA 0,0
```

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



Refer to ["Address and Data Values" on page 35](#).

Address and Data Values

Setting the Test Port Paths with Address and Data

Refer to **Table 9** below and **Figure 30 on page 36** 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 sets the source and receiver paths of the ports. To select a Test Set port configuration both switches must be set to complete the source and receiver paths. Refer to **“Interface Control Mode” on page 28** and in **“GPIB Control Mode” on page 32**.

Example 1: Refer to **Figure 30 on page 36, Interface Control Mode**.

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. The entry will be 0.1 in one command line, and 16.16 in the second line.

Example 2:

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

Port 1 is the Source and Ports 5 is the Receiver.

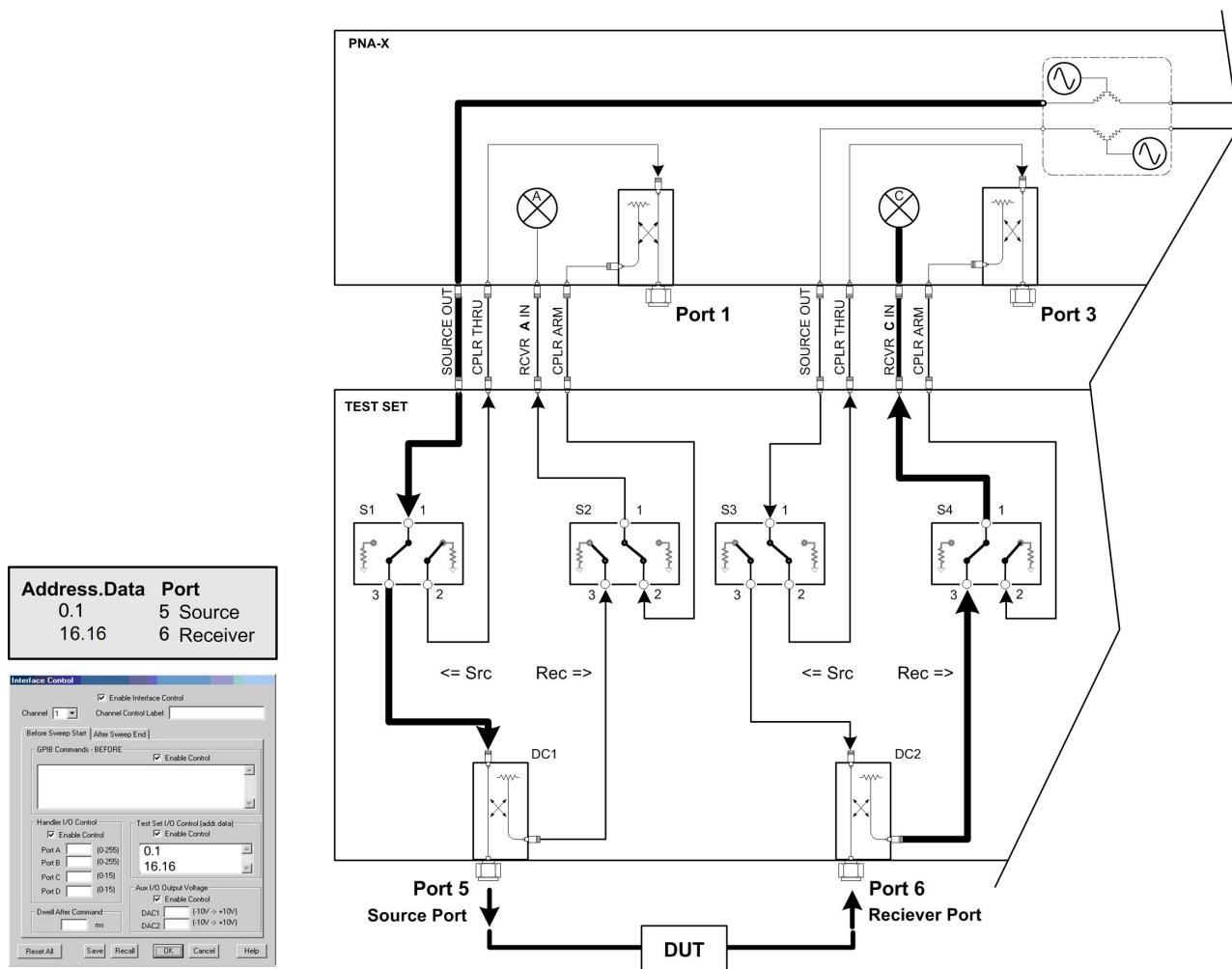
Source Port 1 = address 0, data 0 and Receiver Port 5 = address 0, data 16. The data values are added together, the entry will be 0.17.

Table 9 Test Port Address and Data Values

Address		Source Path		Receiver Path	
	Data	0	1	0	16
0	Ports	1	5	1	5
16	Ports	3	6	3	6
32	Ports	4	7	4	7
64	Ports	2	8	2	8

Refer to **Figure 40, “U3047AE04 RF Block Diagram,”** for in-depth RF path information.

Figure 30 Address and Data Example 1 (Interface Control Mode)



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 22** and **“Setting the Control Lines with Address and Data Values” on page 41**. See **Table 10** 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 31** and **Table 11 on page 38** for control line pin location and description. Refer to **“Internal Voltage Supply Configuration” on page 39** and **“External Voltage Supply Configuration” on page 40** for configurations.

Table 10 **DUT Control Specifications**

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

Figure 31 DUT Control Line Pin Assignment (rear panel view)

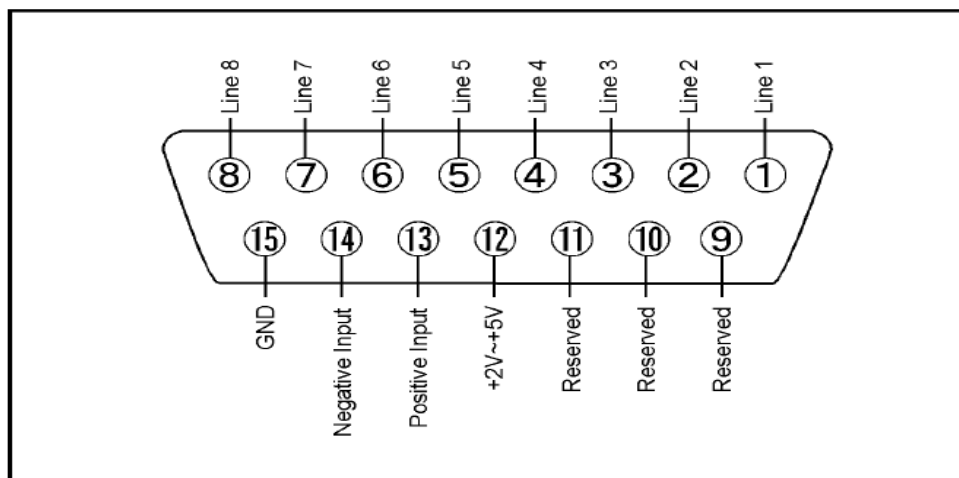


Table 11 DUT Control Line Interface Connector Pin Assignment

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:

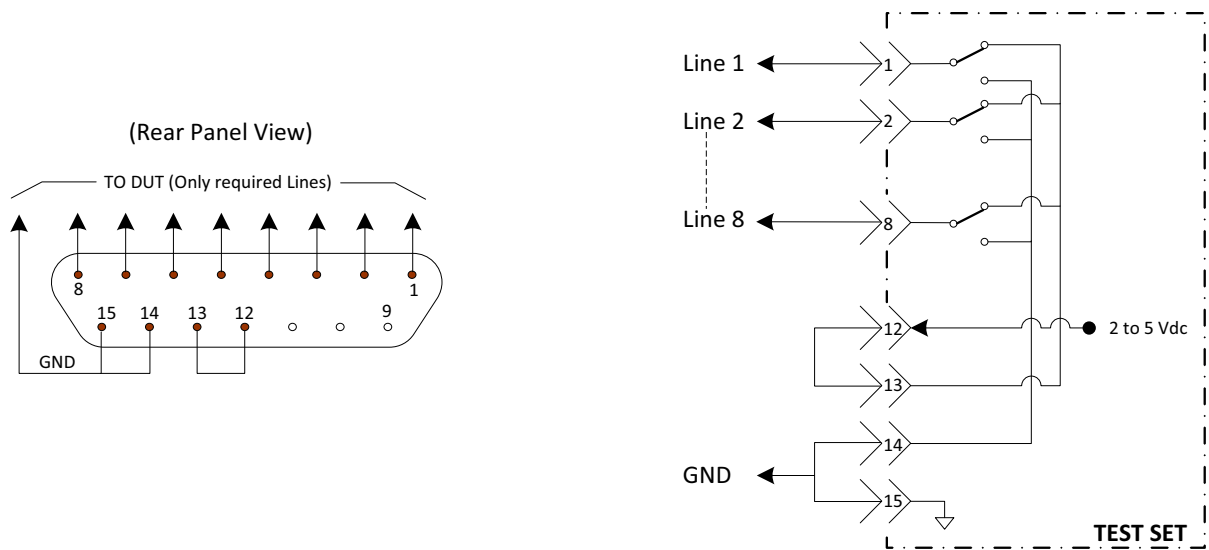
1. Turn On the Test Set.
2. Measure the voltage between pin 12 and 15 using a multimeter.
3. Rotate the voltage adjustment trimmer on the rear panel until the multimeter indicates the selected voltage.

Figure 32 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 32 Internal DC Power Configuration (rear panel view)



External Voltage Supply Configuration

Figure 33 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.

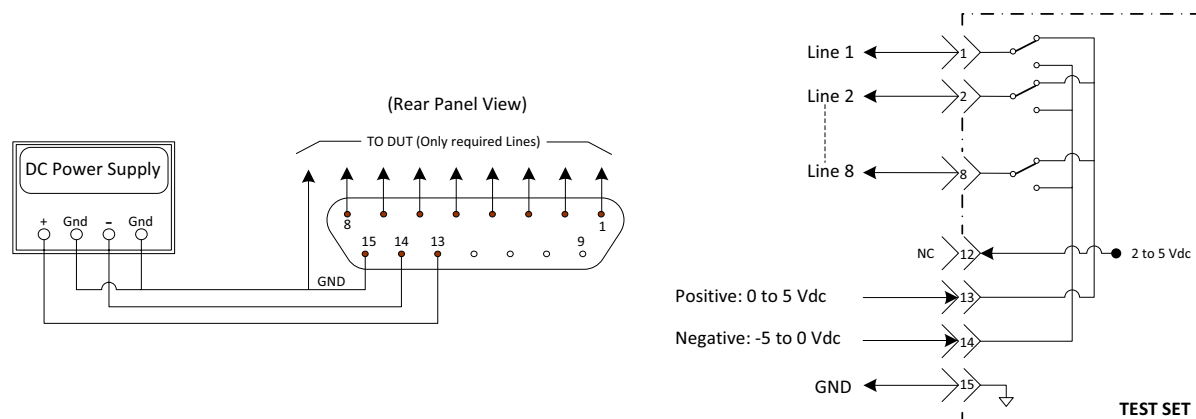
Turning On the Test Set using an External Power Supply

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 33 Test Set to the DUT and External DC Power Supply



Setting the Control Lines with Address and Data Values

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

NOTE

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

Setting the PNA to Standalone Mode

1. Select **Utility > System > Configure > Multiport Capability**. 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 35**, the <address>. <data> values are determined in a similar manor, with the following exceptions:

- **Table 12** will be used.
- The <address> value is always = 112

Table 12 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 32 on page 39**. To reset all control lines to logic high, without having to reset the power switch on the Test Set, make the following PNA entry:

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

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

Listed are two examples to illustrate this concept. Refer to **Figure 28**, 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 PNA 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 PNA Interface Control Mode line entry = 112.6 > OK.

NOTE

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

Cal Kit Operational Check

The following procedure can be used to confirm 1-Port Cal performance of an ECal Module or Mechanical Cal Kit. The operation verification limits provided ensure that your U3047AE04 and PNA-X are operating properly. Refer to **“Verifying a Cal Kit Operational Check Failure” on page 48** 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 PNA-X 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 PNA-X 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 on page 8**.

NOTE

If you suspect that your 8-Port configuration is not operating properly, ensure that all front RF jumper interconnect cables are correctly attached.

Equipment Required

The Keysight U3047AE04 requires that the user be familiar with the equipment listed.

Table 13 Equipment List

Description	Qty
N4694A 1.85 mm ECal Module 10 MHz to 70 GHz (Option 00F or M0F) or 85058B Verification Kit.	1
N5247A Option 400 and 551	1
Set of interconnect cables (PNA-X and Test Set), see “RF Interface Cable Connections (U3021-60101)” on page 15 .	1

Operational Check Procedure

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

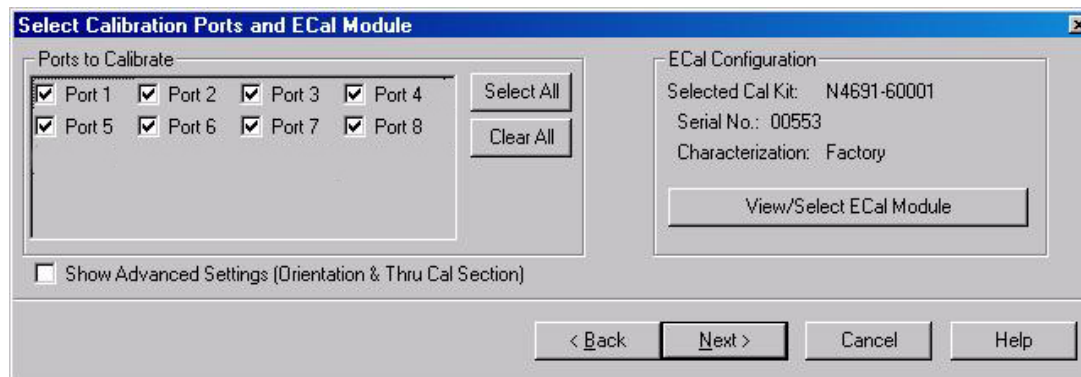
Preparing the Analyzer

1. Connect the Test Set to the 4-Port PNA-X using the interconnect cables as shown in **Figure 10 on page 15** and **Table 7 on page 15**.
2. Turn On the Test Set.
3. On the PNA-X, select **Response > Cal > Manage Cals > Cal Set**. Delete or Rename any Cal Sets titled "999.1" thru "999.8" (8-Port), although it is unlikely that you will find Cal Sets with these names.
4. Verify that the PNA-X is in 8-Port mode. See the bottom of the measurement window.
 - a. If only four S-Parameters are listed, select **Utility > System > Configure > Multiport Capability**. Select **Restart as multiport PNA with this testset** and select **U3047AE04 (8-Port)** from the drop-down menu > **OK**. Refer to **Figure 17 on page 21**.
5. Press **Preset**.
6. Verify that the **[Start Frequency]** is set to **[10 MHz]**.
7. Set **[Stop Frequency]** to **[70 GHz]**.
8. Select **[Power] > Power Level** and enter **[0 dBm]**.
9. Select **Response > Avg > IF Bandwidth > 100 Hz > OK**.
10. Select **Stimulus > Sweep > Number of Points > 401**.
11. Connect the ECal module to an available PNA-X USB port on the front or rear panel. Refer to **Figure 10 on page 15**. This procedure assumes you are using a ECal. If you are not, see **"N524xA 1-Port Calibration and Verification Procedure" on page 45, step 2**.
12. Allow the ECal module, Test Set and PNA-X to warm up for a minimum of 30 minutes.

N524xA 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 34**.
2. Perform a 1-Port Calibration on Port 1. On the PNA-X, select **Response > Cal > Start Cal > Calibration Wizard**.
 - a. If using a mechanical cal kit, select **SmartCal (Guided Calibration) > Next**.
 - b. If using an ECal module, connect the ECal to a PNA-X USB port. Select **Use Electronic Calibration (ECal) > Next**.
3. Continue following the Cal Wizard prompts. In the Select Calibration Ports and ECal Module dialog box click **Clear All**, then select **Port 1 > Next > Measure**.
4. Ensure the ECal you are using is indicated on the right side of the window.

Figure 34 1-Port Calibration

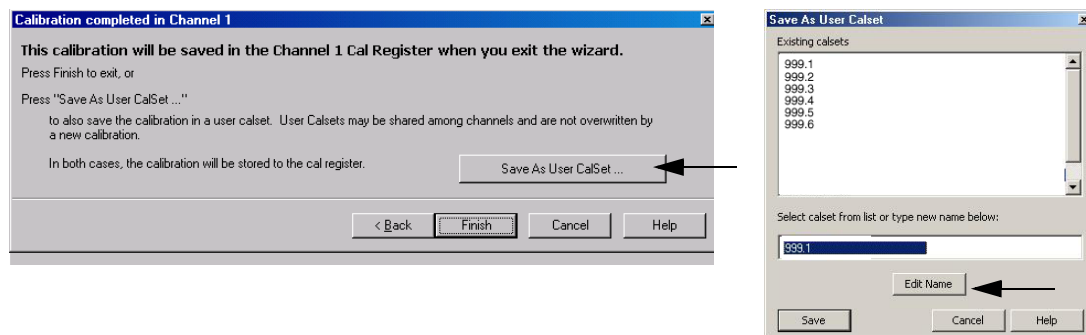


5. Continue to follow the prompts until the Calibration Completed dialog box appears.
6. At the Calibration Completed prompt, select **Save As User Calset**, type the name **999.1**. Overwrite the Calset if it already exists and **Save**.

NOTE

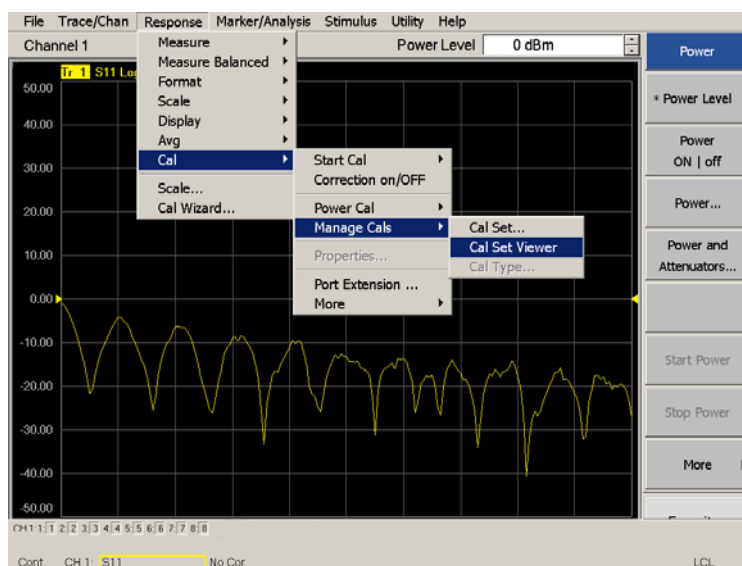
If you do not have a keyboard, select **Save As User Calset > Edit Name** and save as **999.x**. X is the port number you are calibrating. See **Figure 35**. Use the numeric keypad on the PNA-X front panel to enter "999.1."

Figure 35 Calibration Complete Prompt



7. Repeat **step 1** thru **step 6** for Ports 2 thru 8. When finished, there should be 8 Cal Sets saved with the titles “999.1” thru “999.8” (8-Port).
8. Select **Trace/Chan > Trace > Delete Trace**. There should be no traces on the PNA-X screen.
9. To launch the Cal Set Viewer toolbar. Select **Response > Cal > Manage Cals > Cal Set Viewer**.

Figure 36 Calibration, Cal Set Viewer



10. 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. See **Figure 37**.
11. Compare the Reflection Tracking (1,1) trace to the appropriate limits in **Table 6 on page 8**. The trace should be above the limit.
12. Repeat **step 10** and **step 11** for Cal Sets “999.1” thru “999.8” (8-Port).

Figure 37 Reflection Tracking Trace (Port 1-4) with PNA-X

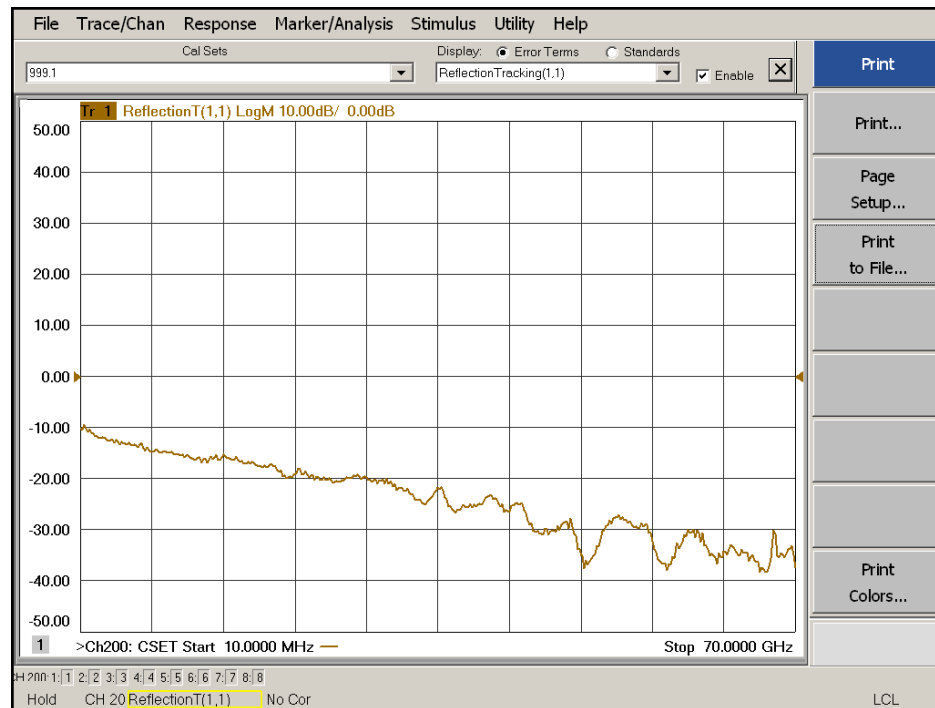
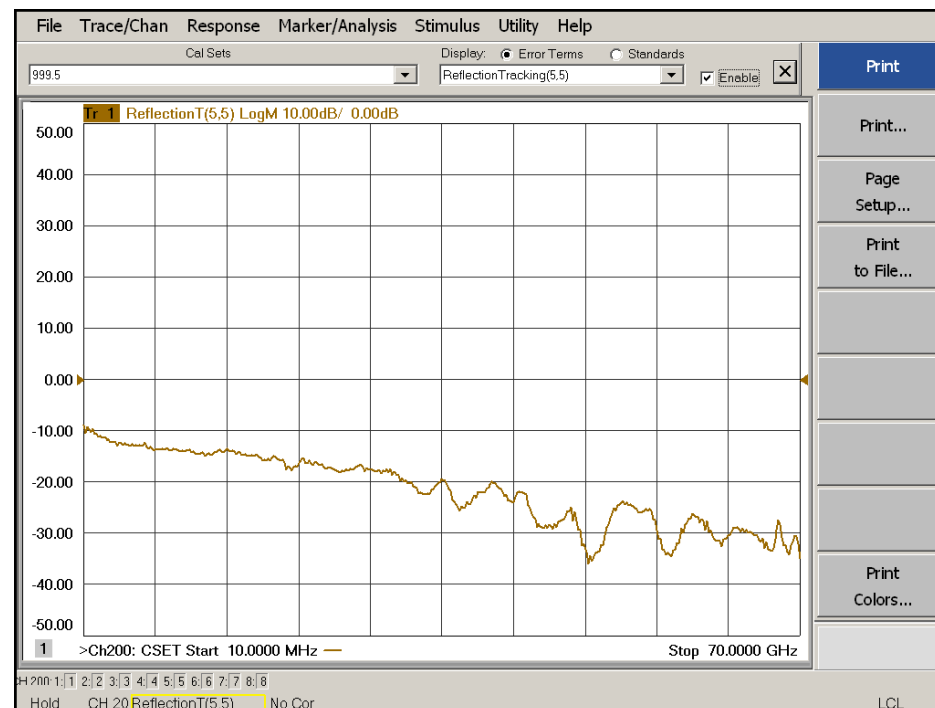


Figure 38 Reflection Tracking Trace (Port 5-8) with PNA-X



Verifying a Cal Kit Operational Check Failure

If your test results fail the Cal Kit Operational Check Reflection Tracking limits, verify the following:

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

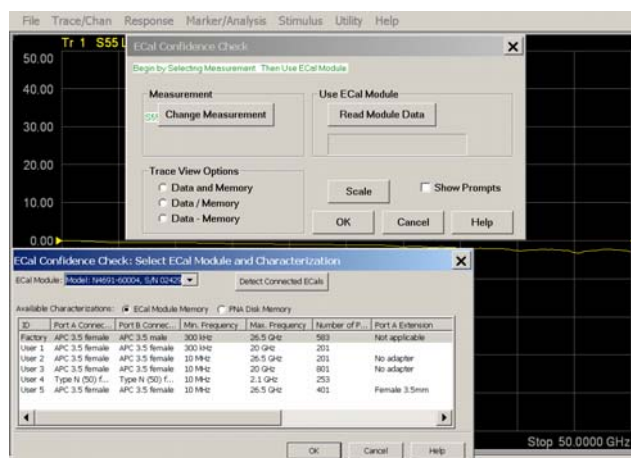
ECal Confidence Check

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

Procedure

1. Perform an 1-Port Cal of the Test Set port being verified.
2. Connect the ECal Module to the Port being verified. Terminate any remaining ports on the ECal module.
3. Select the Cal Set to be verified. Select **[Cal] > Cal Set... > Cal_File > Apply Cal > Close**. 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**.
5. In the ECal Confidence Check window, click **Change Measurement** and select the test port S-parameter **Apply > OK > Read Module Data**.
6. When the "Select ECal Module" prompt appears, select the ECal module you are using and the ECal Module Memory and Factor ID > **OK**.

Figure 39 ECal Confidence Check



Interconnect Cable Verification

1. Perform the **“System Operational Check”** on page 17.
2. If the problem still exists, perform the **“RF Switching Failures”** on page 57.
3. If a power hole or other failure still exists, refer to **“Contacting Keysight”** on page 74.

Service Information

This section provides information to troubleshoot and repair the U3047AE04 test set. Refer to **“Keysight Support, Services, and Assistance” on page 74** 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 www.keysight.com.

Table 14 Available Replacement Parts (SPO)

Description	Keysight Part Number
Power Supply (AC/DC 650W 9- Output)	0950-4729
Fuse (8 A 250 V non-time delay)	2110-0342
Fuse (5 A 250 V non-time delay Socket)	2110-0709
PNA-X Locking Feet	5023-0132
Couplers (Pb-Free)	5087-7754
Fan (rear panel)	87050-60027
Test Set I/O Cable Assembly	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 15 Replaceable Parts (E04)

Description	Keysight Part Number
Screw-Pan Head Machine with thread patch, Torx-T15 M3.5 with 0.6 thread, 12 mm-LG	0515-2317
Switch, Solid State SP2T (70 GHz terminated)	5087-7317
2.4mm Female Short	85056-60021
Dress Nut (couplers)	N5230-20081
PNA-X Test Set Rear Lock Feet (right)	N5242-20138
PNA-X Test Set Rear Lock Feet (left)	N5242-20139
Front Panel LED Board	N5261-60005
Test Set Control Board (programmed)	N5261-60006
DUT Control Board	U3020-63223
RF Cable, Semi-rigid	U3047-20016
RF Cable, Semi-rigid	U3047-20017
SW Interface Board, programmed	U3047-63018
U3047AE04 User's and Service Guide	U3047-90002

System Block Diagram

Figure 40 U3047AE04 RF Block Diagram

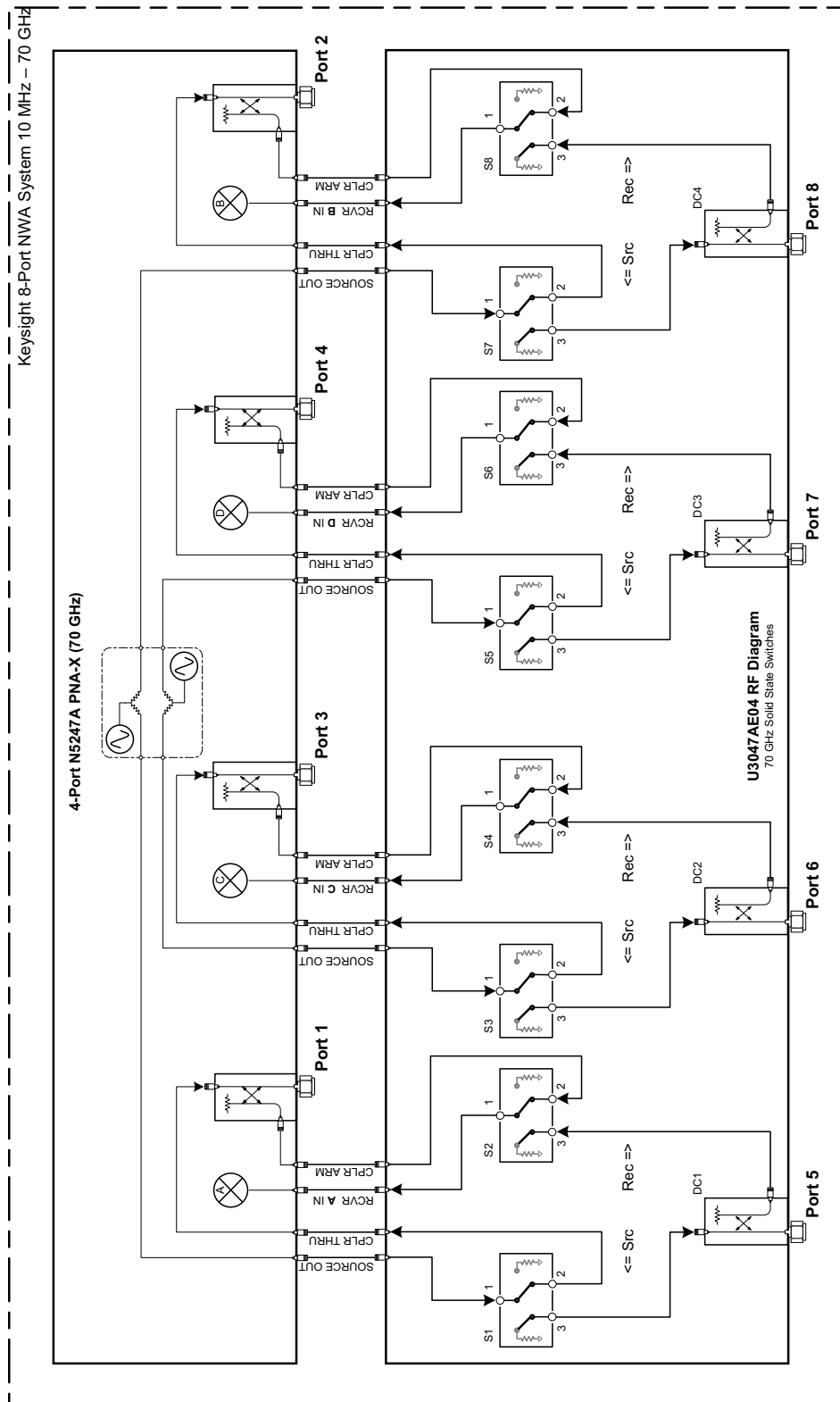
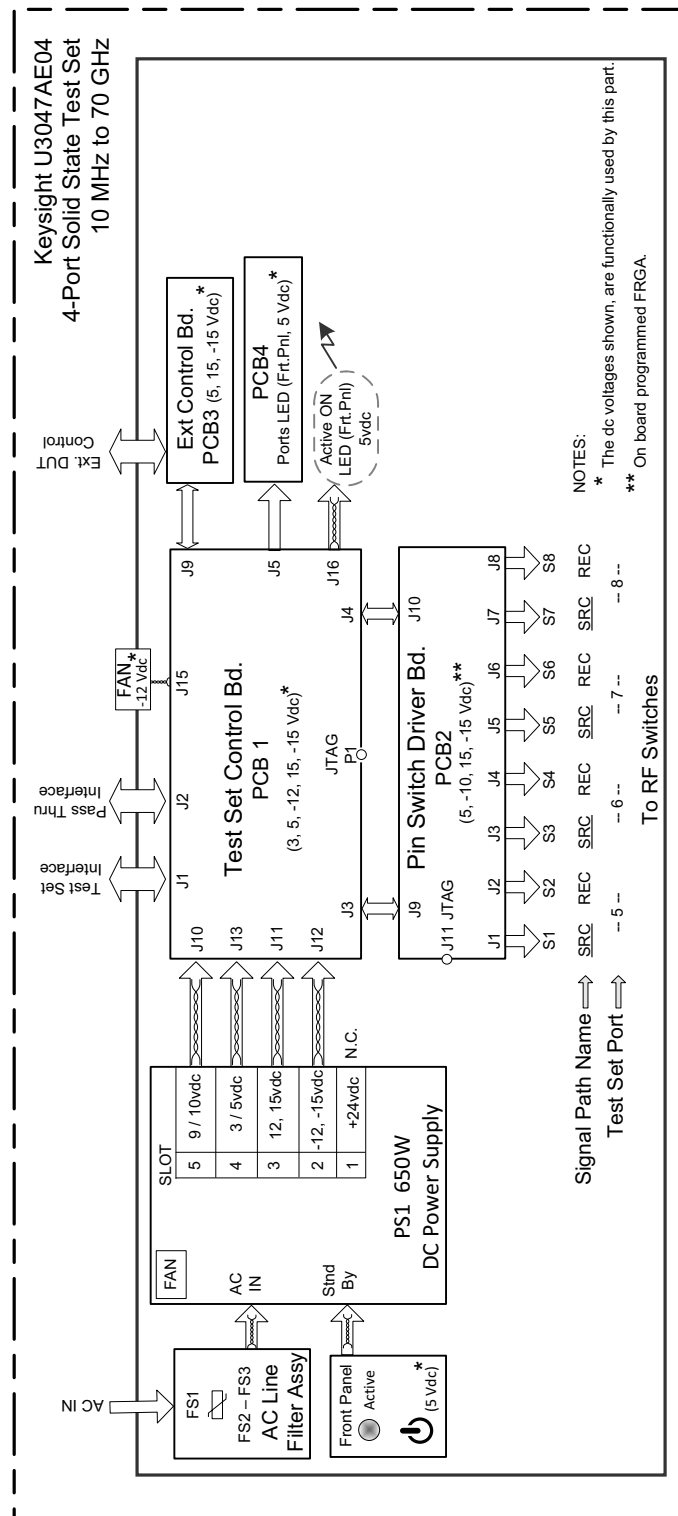


Figure 41 Electrical Block Diagram



Theory of Operation

The following is a description of the operation of the Test Set. Reference the Test Set block diagrams shown in **Figure 30 on page 36**. This section assumes the user has a general understanding of couplers, switches, and network analyzers.

The Test Set adds four test ports to a 4-Port N5247A PNA-X Network Analyzer. The internal RF switches direct the source and receiver signals of the PNA-X to the selected measurement test port.

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

RF Coupler

The Test Set uses four couplers (5087-7725) on the front panel for RF Test Ports 5 - 8. 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.

RF Switch Components

The Test Set uses eight solid-state that have internal 50 Ω termination. The switches select the RF paths from the PNA-X source and receiver through interconnect cables to the Test Set.

Test Set Control Board

The Test Set Control Board (N5261-60006) is a surface mount, printed circuit assembly (PCA). It provides a connection to the power supply, and the PNA Test Set I/O for control of the RF switch paths (through the Switch Interface board (U3047-63018). The front panel "Active" and port LEDs are on only when the PNA has addressed the U3047AE04 Test Set. The rear panel fan is on when the controller board supplies are operational.

Switch Driver Board

The Switch Driver board (U3047-63018) is installed on top of the Test Set Controller Board and provides connections to the solid state RF switches. This board regulates the DC voltage supply (-10 volts) and routes logic signals to the switches through cables connected to plugs J1 to J8.

Front Panel LED Board

One LED board assembly (N5261-60005) are mounted to the front panel. The LED's 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.

DUT Control Board

The DUT Control Board (E5091-66503) 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) converts 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 J10, J11, J12 and J13. The 24 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.

Source and Receiver Switch Paths

SW1 – Source to Ports (1 and 5) Switch 1 provides control of the Source Output path to PNA-X Port 1 and Test Set Port 5. In the state shown in the block diagram, switch 1 routes the RF Source back to the PNA-X Port 1, and the Test Set Source path to Port 5 is terminated.

SW3 – Source to Ports (3 and 6) Switch 3 provides control of the Source Output path to PNA-X Port 3 and Test Set Port 6. In the state shown in the block diagram, switch 3 routes the RF Source back to the PNA-X Port 3, and the Test Set Source path to Ports 6 is terminated.

SW6 – Source to Ports (4 and 7) Switch 6 provides control of the Source Output path to PNA-X Port 4 and Test Set Port 7. In the state shown in the block diagram, switch 6 routes the RF Source back to the PNA-X Port 4, and the Test Set Source path to Ports 7 is terminated.

SW8 – Source to Ports (2 and 8) Switch 2 and 8 provide control of the Source Output path to PNA-X Port 2 and Test Set Port 8 and 12. In the state shown in the block diagram, switch 13 routes the RF Source back to the PNA-X Port 2, and the Test Set Source path to Ports 8 and 12 are terminated.

SW2 – Receiver to Ports (1 and 5) Switch 2 provides control of the Receiver Input path to PNA-X Port 1 and Test Set Port 5. In the state shown in the block diagram, switch 2 routes the Port 1 CPLR ARM to the Receiver, and Test Set Ports 5 CPLR ARM path is terminated.

SW4 – Receiver to Ports (3 and 6) Switch 7 and 8 provide control of the Receiver Input path to PNA-X Port 3 and Test Set Ports 6. In the state shown in the block diagram, switch 4 routes the Port 3 CPLR ARM to the Receiver, and Test Set Ports 6 CPLR ARM path is terminated.

SW5 – Receiver to Ports (4 and 7) Switch 11 and 12 provide control of the Receiver Input path to PNA-X Port 4 and Test Set Ports 7. In the state shown in the block diagram, switch 11 routes the Port 4 CPLR ARM to the Receiver, and Test Set Ports 7 CPLR ARM path is terminated.

SW7 – Receiver to Ports (2 and 8) Switch 15 and 16 provide control of the Receiver and Input path to PNA-X Port 2 and Test Set Port 8. In the state shown in the block diagram, switch 7 routes the Port 2 CPLR ARM to the Receiver, and Test Set Ports 8 CPLR ARM path is terminated.

Troubleshooting the Test Set

If the U3047AE04 is not operating properly, use the following procedures to aid in isolating the source of the non-RF related failures. Typical failures may be the loss of the rear panel fan or front panel indicator lights.

WARNING

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

WARNING

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

Non-RF Failures

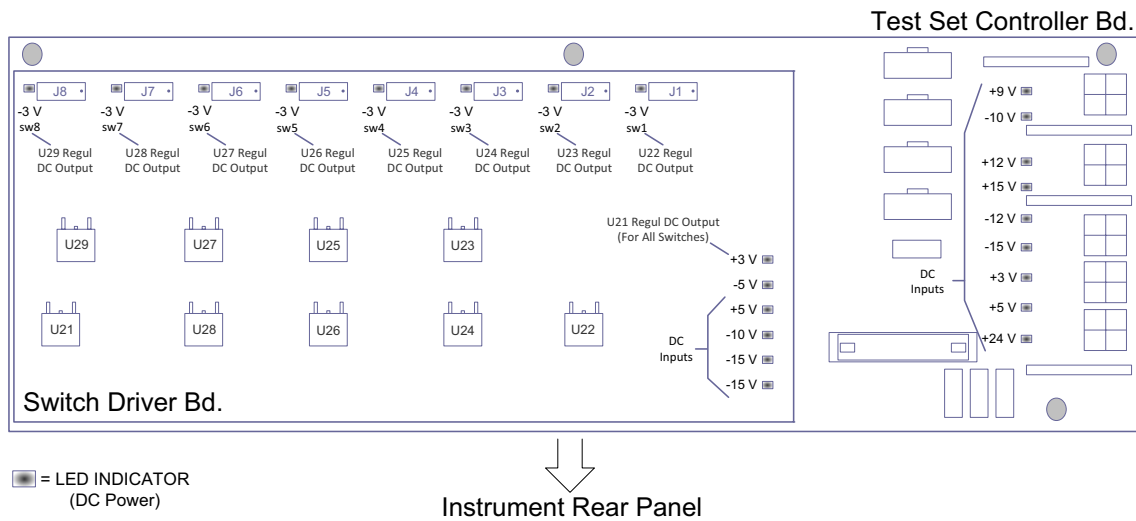
1. Verify that the front panel Power Switch is operational.
2. The rear panel fan and front panel Active LED should operate when the Standby Switch is in the On position.
3. AC line voltage checks (remove AC power from the instrument).
 - a. Ensure the proper AC line voltage is present at the instrument line cord.
 - b. Remove the AC power cord from the instrument. Confirm the instrument AC line module fuse is operational. See **Figure 4 on page 11**.
 - c. 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 50 on page 67**.
4. 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. Both rear panel and internal power supply fans should be operational and the Active LED should be On. Verify that the DC LEDs indicators are On. Refer to **Figure 42 on page 57**.
 - c. If there is no DC power, suspect the power supply module or standby switch. The actual power supply terminal connection should also be confirmed with a DVM.
 - d. If all of the DC Input LEDs are On and the fan is not working, replace fan.
 - e. If all of the DC Input LEDs are On and the switch driver board +3 or -3 Vdc LED's are Off, remove the suspect switch wire connector from J1 to J8. If there is no +3 to -3 Vdc LEDs, replace the switch driver board.

NOTE

The +24 Vdc indicator is not used in this instrument (Off is normal).

5. Front panel R and S indicator LED check.
 - a. If the indicators are not operating, continue to **"RF Switching Failures", step 1**.

Figure 42 DC Power Status LEDs



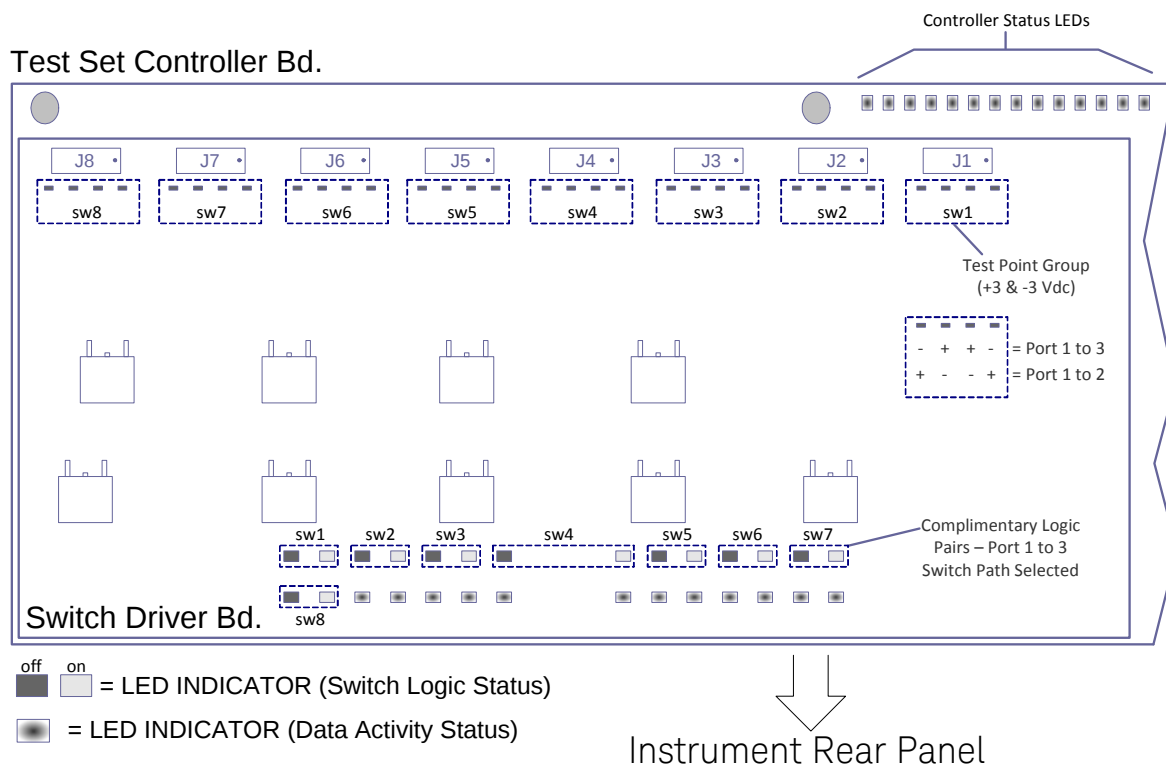
RF Switching Failures

Typical failures may be the loss of front panel R, S LED or RF switch control failure. The internal RF switches used in this instrument are controlled by the +3 and -3 Vdc voltages from the Switch Driver Bd.

1. Confirm that the PNA and Test Set are properly connected using the Test Set I/O cable (8120-6818). See [Figure 11 on page 16](#).
2. Using multiport mode (Option 551), verify that the PNA firmware is correct, and that the Test Set file is loaded into the PNA. Refer to [“Network Analyzer Requirements” on page 3](#).
3. Using the I/O command values, confirm that the correct address and data values are used. Refer to [“Address and Data Values” on page 35](#).
4. Follow the [“Non-RF Failures” on page 56](#) procedure if not already done so.
5. Front Panel R and S indicator LED Check.
 - a. Confirm that the Test Set Controller Board Status LEDs are On. Refer to [Figure 43 on page 58](#). If the LEDs are off remove the Switch Driver board, if the LEDs remain off, replace the Controller board.
 - b. If the Status LED's are On and the front panel Active LED is On, suspect the front panel LED board or the ribbon cable and replace as needed.
6. Confirm the DC +3 and 3 Vdc voltage LEDs as shown in [Figure 42 on page 57](#).

7. Verify the Switch Driver board, “Complimentary Logic LED pairs” shown in **Figure 43**.
 - a. Ensure that each switch LED pair; one is on and one is off. If not, replace the Switch Driver board.
 - b. Verify the RF Switch Drive board voltages by connecting a voltmeter to the four groups of test points. There are only two switch drive voltage conditions shown. All test points should have +3 or –3 Vdc present. If the test point voltages are incorrect, remove the specific RF switch connector from J1– J8.
 - c. If the test point voltages are incorrect, replace the Switch Drive board.
 - d. If the test point voltages are correct, suspect a faulty RF switch.

Figure 43 Controller Board



RF Switch Path Testing

If you suspect an RF signal path problem, the following procedure will confirm all RF signal paths through the Test Set.

Table 16 RF Signal Path Insertion Loss (S21)

RF Path Description	Signal	Insertion Loss (typical)
Source IN to CPLR THUR	Source	Figure 44
Source IN to Ports 5 - 8	Source	Figure 45
RCVR OUT to CPLR ARM	Receiver	Figure 46
RCVR Out to Ports 5 - 8	Receiver	Figure 47

Equipment Required

- N5247A PNA-X
- Two RF Flex Cables with 1.85 mm connectors (8121-1445 or equivalent)
- Three 1.85 mm Adapters (female to female)
- Test Set I/O Cable (8120-6818)

Equipment Setup

1. Connect the Test Set I/O cable (8120-6818) from the PNA to Test Set. Refer to **Figure 11 on page 16**. Set PNA to "Standalone mode" (Test can not be performed in Multiport mode).
2. Connect the RF flex cables with the adapters to the PNA Ports 1 and 2. Connect the cables together using a 1.85 mm adapter.
3. Set the following:
 - Frequency range: 10 MHz to 70 GHz, (or the frequency range of the PNA you are using)
 - Ref Level: 0 dB
 - Scale: 10 dB
 - Power Level: 0 dBm
 - IF BW: 1 kHz
4. Select measure S21 trace and perform a Trace Normalization.

Source Signal Path Insertion Loss Test (S21)

Refer to **Table 16, “RF Signal Path Insertion Loss (S21),” on page 59.**

Test Set Port 5, SOURCE IN to CPLR THRU

- Set Test I/O addr.data 0.0
- Connect PNA Port 1 flex cable to Test Set Port 5 CPLR THRU.
- Connect PNA Port 2 flex cable to Test Set Port 5 SOURCE IN.

Test Set Port 6, SOURCE IN to CPLR THRU

- Set Test I/O addr.data 16.0
- Connect PNA Port 1 flex cable to Test Set Port 6 CPLR THRU.
- Connect PNA Port 2 flex cable to Test Set Port 6 SOURCE IN.

Test Set Port 7, SOURCE IN to CPLR THRU

- Set Test I/O addr.data 32.0
- Connect PNA Port 1 flex cable to Test Set Port 7 CPLR THRU.
- Connect PNA Port 2 flex cable to Test Set Port 7 SOURCE IN.

Test Set Port 8, SOURCE IN to CPLR THRU

- Set Test I/O addr.data 64.0
- Connect PNA Port 1 flex cable to Test Set Port 8 CPLR THRU.
- Connect PNA Port 2 flex cable to Test Set Port 8 SOURCE IN.

Test Set Port 5, SOURCE IN to Port 5

- Set Test I/O addr.data 0.1
- Connect PNA Port 1 flex cable to Test Set Port 5.
- Connect PNA Port 2 flex cable to Test Set SOURCE IN.

Test Set Port 6, SOURCE IN to Port 6

- Set Test I/O addr.data 16.1
- Connect PNA Port 1 flex cable to Test Set Port 6.
- Connect PNA Port 2 flex cable to Test Set SOURCE IN.

Test Set Port 7, SOURCE IN to Port 7

- Set Test I/O addr.data 32.1
- Connect PNA Port 1 flex cable to Test Set Port 7.
- Connect PNA Port 2 flex cable to Test Set SOURCE IN.

Test Set Port 8, SOURCE IN to Port 8

- Set Test I/O addr.data 64.1
- Connect PNA Port 1 flex cable to Test Set Port 8
- Connect PNA Port 2 flex cable to Test Set SOURCE IN.

Receiver Signal Path Insertion Loss Test (S21)

Test Set Port 5, RCVR OUT to CPRL ARM

- Set Test I/O addr.data 0.0
- Connect PNA Port 1 flex cable to Test Set Port 5 CPLR ARM.
- Connect PNA Port 2 flex cable to Test Set Port 5 RCVR OUT.

Test Set Port 6 RCVR OUT to CPRL ARM

- Set Test I/O addr.data 16.0
- Connect PNA Port 1 flex cable to Test Set Port 6 CPLR ARM.
- Connect PNA Port 2 flex cable to Test Set Port 6 RCVR OUT.

Test Set Port 7, RCVR OUT to CPRL ARM

- Set Test I/O addr.data 32.0
- Connect PNA Port 1 flex cable to Test Set Port 7 CPLR ARM.
- Connect PNA Port 2 flex cable to Test Set Port 7 RCVR OUT.

Test Set Port 8, RCVR OUT to CPRL ARM

- Set Test I/O addr.data 64.0
- Connect PNA Port 1 flex cable to Test Set Port 8 CPLR ARM.
- Connect PNA Port 2 flex cable to Test Set Port 8 RCVR OUT.

Test Set Port 5, RCVR OUT to Port 5

- Set Test I/O addr.data 0.16
- Connect PNA Port 1 flex cable to Test Set Port 5.
- Connect PNA Port 2 flex cable to Test Set Port 5 RCVR OUT.

Test Set Port 6, RCVR OUT to Port 6

- Set Test I/O addr.data 16.16
- Connect PNA Port 1 flex cable to Test Set Port 6.
- Connect PNA Port 2 flex cable to Test Set Port 6 RCVR OUT.

Test Set Port 7, RCVR OUT to Port 7

- Set Test I/O addr.data 32.16
- Connect PNA Port1 flex cable to Test Set Port 7.
- Connect PNA Port 2 flex cable to Test Set Port 7 RCVR OUT.

Test Set Port 8, RCVR OUT to Port 8

- Set Test I/O addr.data 64.16
- Connect PNA Port 1 flex cable to Test Set Port 8.
- Connect PNA Port 2 flex cable to Test Set Port 8 RCVR OUT.

Figure 44 Source IN to CPLR THRU Path (typical)

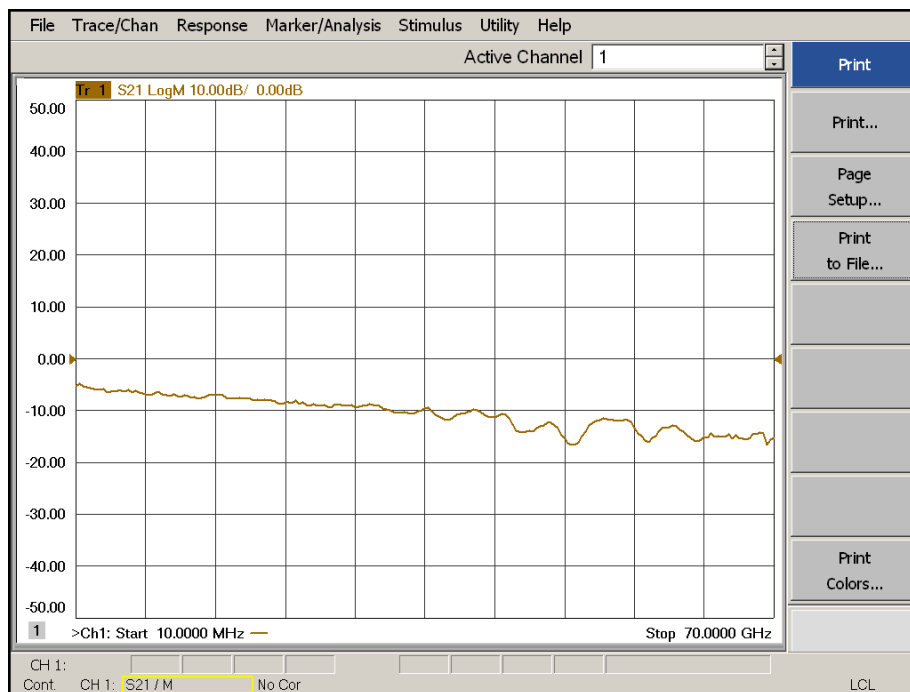


Figure 45 Source IN to Ports 5 - 8 Path (typical)

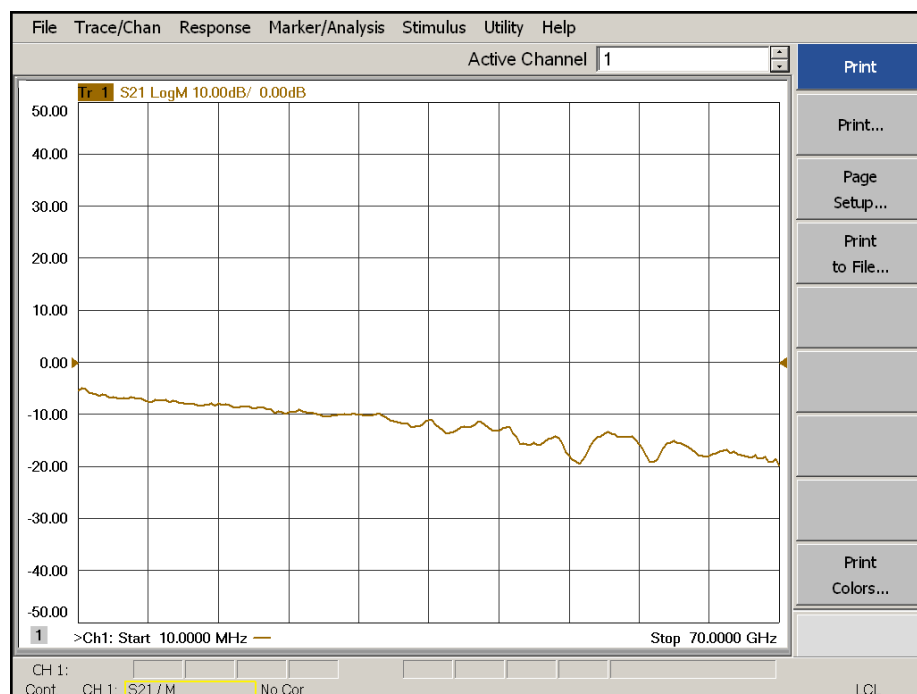


Figure 46 RCVR Out to CPLR ARM Path (typical)

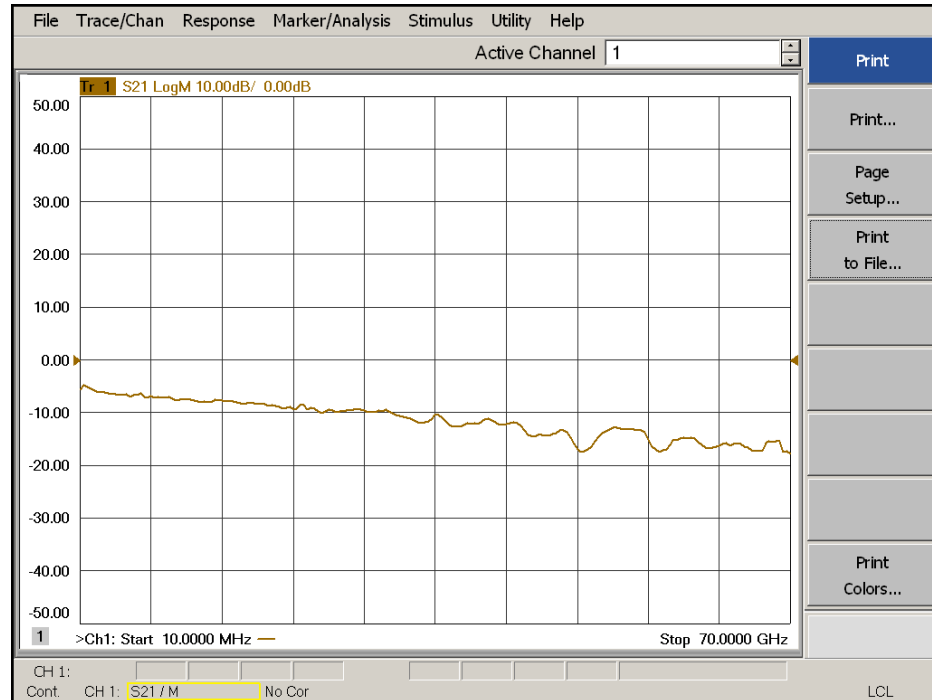
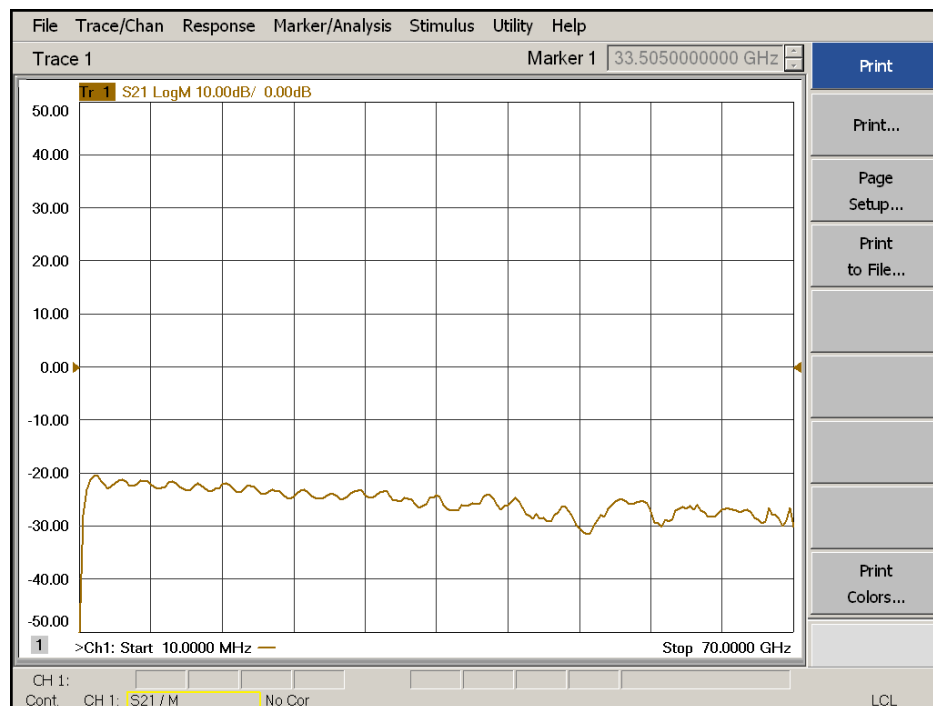


Figure 47 RCVR OUT to Port 5 - 8 Path (typical)



RF Performance Fails

If the U3047AE04 operates correctly, but RF performance fails the **“Operational Check Procedure” on page 44**. The following procedures can be used to isolate the failed component. Suspect the coax switches (5087-7317), RF cables, or coupler (5087-7225).

NOTE

The RF performance of the U3047AE04 depends on the performance of the PNA. Ensure the PNA is meeting specification before continuing.

1. Verify that the test set and PNA SOURCE, RCVR, CPLR THRU, and CPLR ARM connectors are clean and that the center pins are not damaged.
2. Verify the interface and internal RF cables are cleaned and not damaged. **“Verifying a Cal Kit Operational Check Failure” on page 48**.
3. Review the **“Cal Kit Operational Check” on page 43** and verify the results for the port that is failing.
4. Reflection tracking trace shows a power hole, or is below the test limit line, perform the switch path test for the port that is failing. Refer to **“RF Switch Path Testing” on page 59**.
5. Directivity trace fails (above -10dB), replace the couplers (5087-7225).
6. Source or load match fails (above -10 dB), replace the coax switch (5087-7317).
7. Isolation is poor between ports, inspect the RF connections. If it continues to fail replace the coax switch (5087-7317). The RF cables require proper torque (10 in-lb) and can be damaged by over tightening.

Control Lines are not Working

If the U3047AE04 operates correctly and the rear panel control lines are not functioning, the following procedures can be used to verify the component failure. Suspect the DUT Control board (E5091-66503).

1. Verify that the control voltage pins on the DUT control are connected correctly. Refer to **“Control Lines” on page 37**.
2. Verify that the control pot is centered (5V). Refer to **Figure 3 on page 10**.
3. Verify the ribbon cable connection.
4. Replace the DUT control board (E5091-66503).
5. Replace the test set control board (N5261-60006).

Troubleshooting Diagram

Figure 48 Test Set

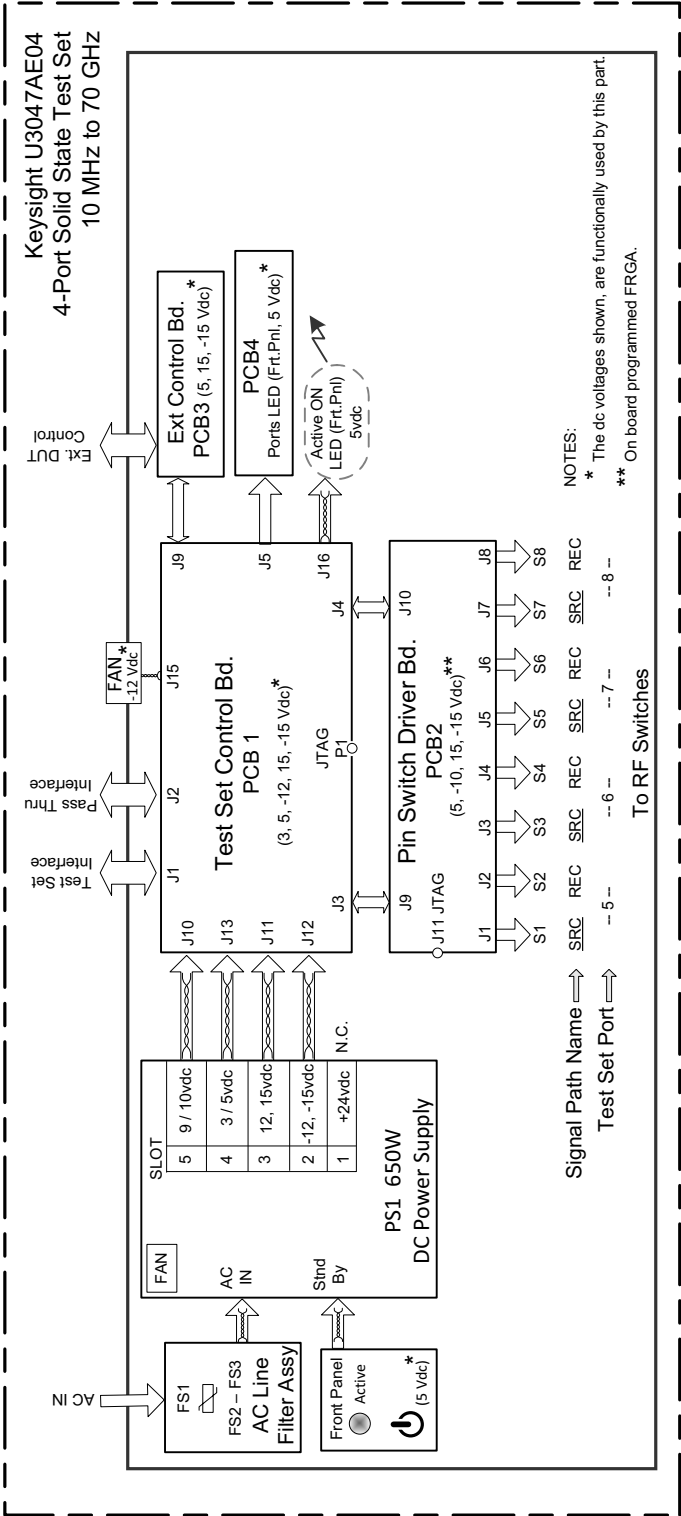


Figure 49 Test Set Top View

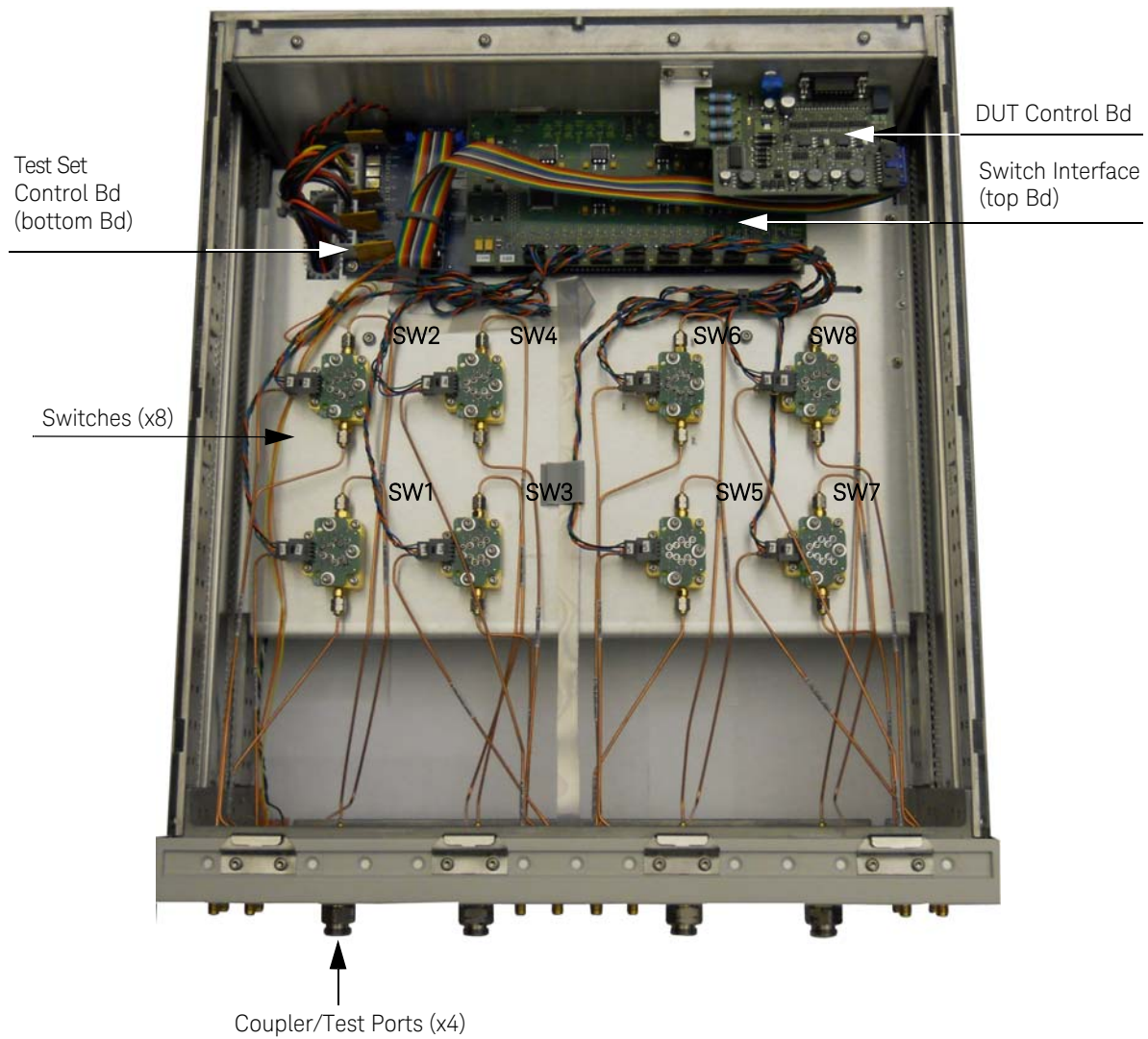
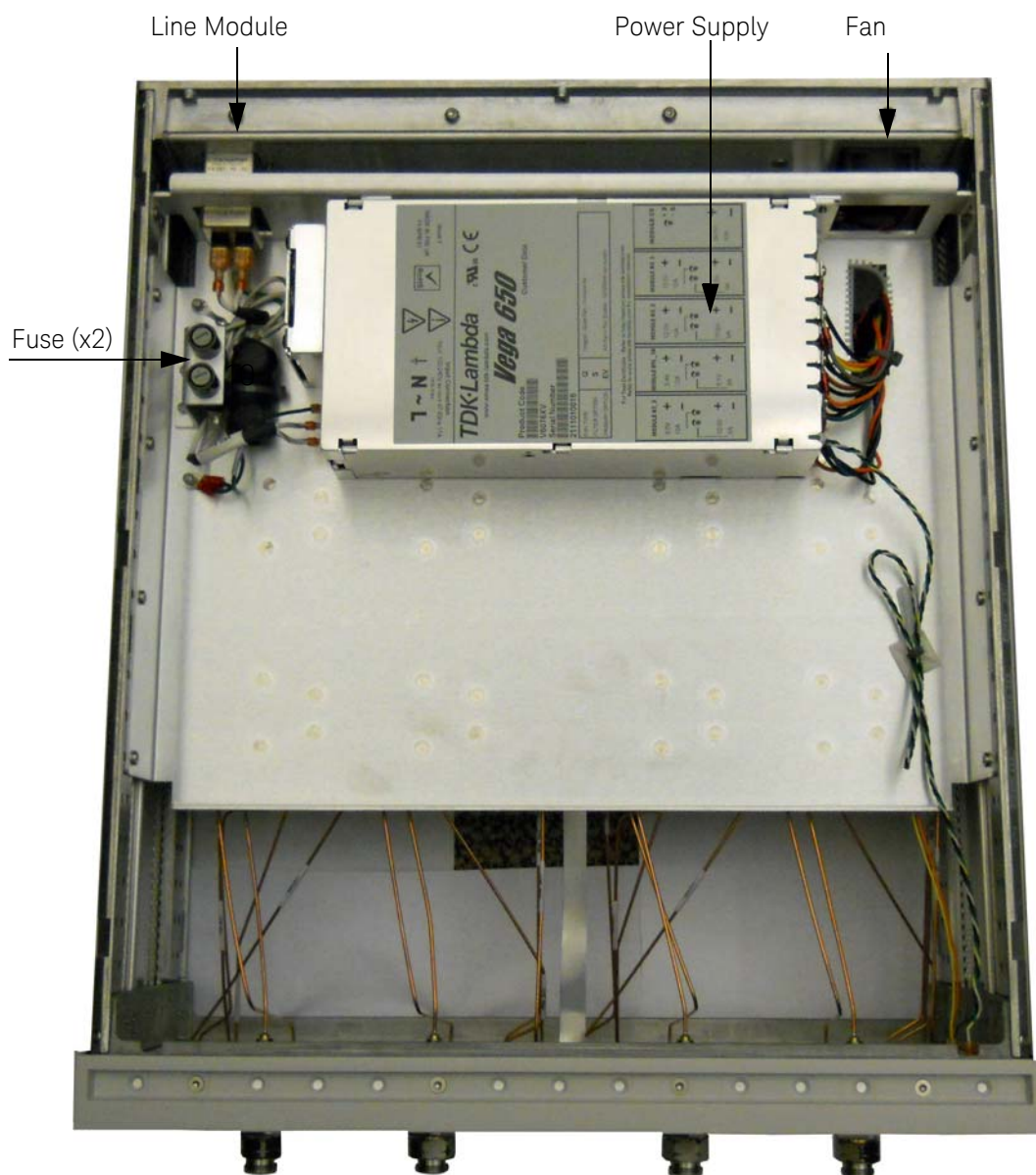


Figure 50 Test Set Bottom View



Safety and Regulatory Information

Introduction

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

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

Safety Earth Ground

WARNING

This is a Safety Class I Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall 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:

<https://regulations.about.keysight.com/DoC/default.htm>

Statement of Compliance

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

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, per IEC 61010 Second Edition.

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 U3047AE04 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

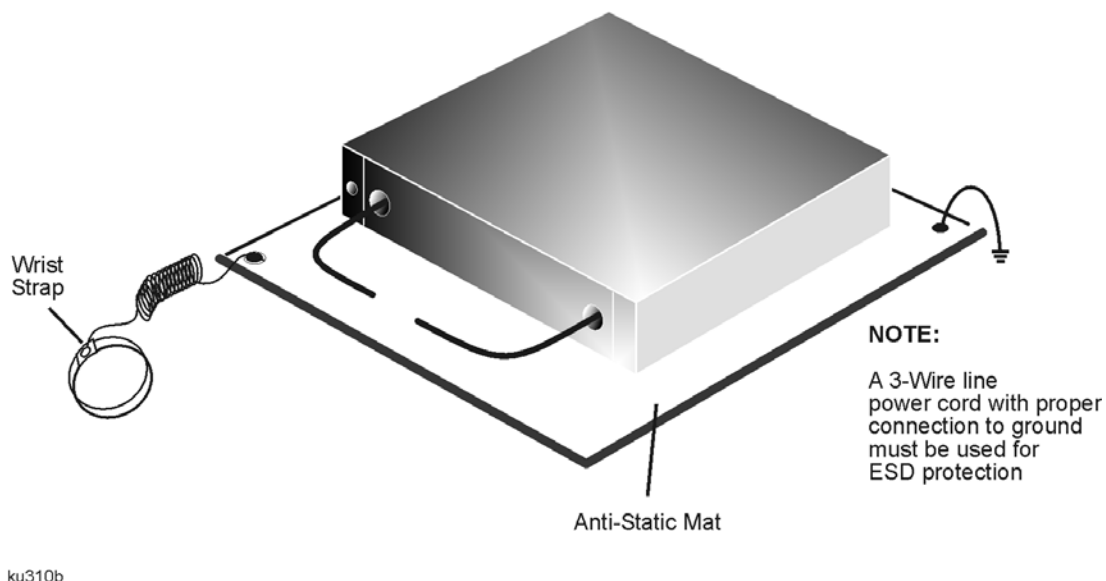
If flammable cleaning materials are used, the material shall not be stored, or left open in the area of the equipment. Adequate ventilation shall be assured to prevent the combustion of fumes, or vapors.

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 M Ω resistor in series with it, when handling components and assemblies or when making connections.
- *always* wear a heel strap (9300-1126) when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.
- *always* ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port or cable connector briefly.
- *always* ground the center conductor of a test cable before making a connection to the analyzer test port or other static-sensitive device. This can be done as follows:
 1. Connect a short 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 51 ESD Protection Setup



Regulatory Information

Instrument Markings

This section contains information that is required by various government regulatory agencies.

	The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.
	The AC symbol indicates the required nature of the line module input power.
	This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive).
	This symbol indicates that the power line switch is ON.
	This symbol indicates that the power line switch is in the STANDBY position.
	This symbol indicates that the power line switch is in the OFF position.
	This symbol is used to identify a terminal which is internally connected to the product frame or chassis.
	The CE mark is a registered trademark of the European Community.
ccr.keysight@keysight.com Keysight email address is provided as part of the requirements for CE compliance.	
	The CSA mark is a registered trademark of the CSA International.
	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
	This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001). Cet appareil ISM est conforme à la norme NMB du Canada.
	Direct Current.
IP 2 0	The instrument has been designed to meet the requirements of IP 2 0 for egress and operational environment.
	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.

Battery Collection

Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Keysight Technologies for disposal. Refer to **“Contacting Keysight” on page 74** for assistance.

Compliance with German Noise Requirements

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrrerordnung-3. GSGV Deutschland).

Acoustic Noise Emission/Geraeuschemission	
LpA<70 dB	Lpa<70 dB
Operator Position	am Arbeitsplatz
Normal Operation	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

EMC Information

Complies with European EMC Directive 2014/30/EU

- IEC/EN 61326-2-1
- CISPR Pub 11 Group 1, Class A
- AS/NZS CISPR 11
- This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme a la norme NMB du Canada.

Keysight Support, Services, and Assistance

Service and Support Options

The standard product warranty is a *one-year return to Keysight Technologies* service warranty.

NOTE

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

Contacting Keysight

Assistance with test and measurement needs and information, or finding a local Keysight office, is available on the Internet at:

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

Keysight PNA Series – Service & Support Home Page:

<http://na.support.keysight.com/pna>

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.service.keysight.com>.

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

