Keysight Technologies

U3022AE06

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.

KEYSIGHT TECHNOLOGIES

User's and Service Guide

Notices

Trademark Acknowledgments

Manual Part Number

U3022-90004

Edition

Edition 3, December 2020

Supersedes: May 2015

Printed in USA/Malaysia

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

Warranty

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

Technology Licenses

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

U.S. Government Rights

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

Safety Notices

CAUTION

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

WARNING

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

What's Changed

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

U3022AE06

Table of Contents

Table of Contents

U3022AE06

KEYSIGHT TECHNOLOGIES

Introduction

This document describes how to use and service the U3022AE06 Multiport Test Set.

Figure 1 N5230A 4-Port PNA-L with U3022AE06

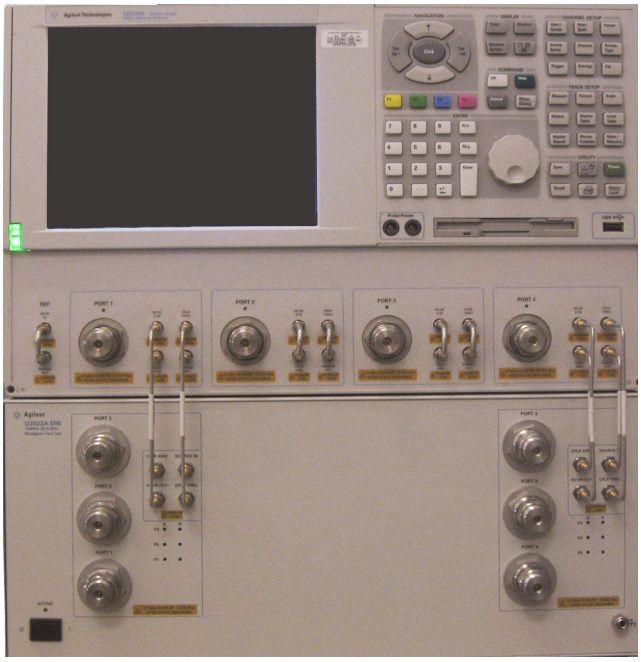


Figure 2 E8362B 2-Port PNA with U3022AE06

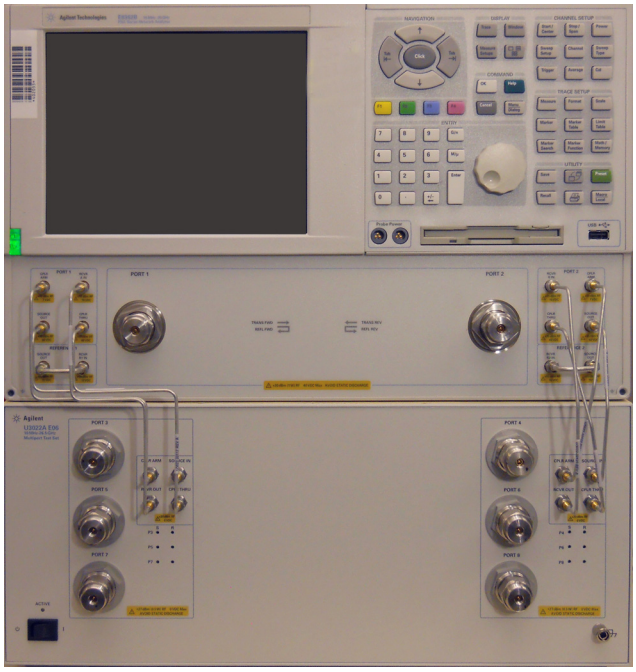


Figure 3 N5222A or N5242A 2-Port PNA-X with U3022AE06

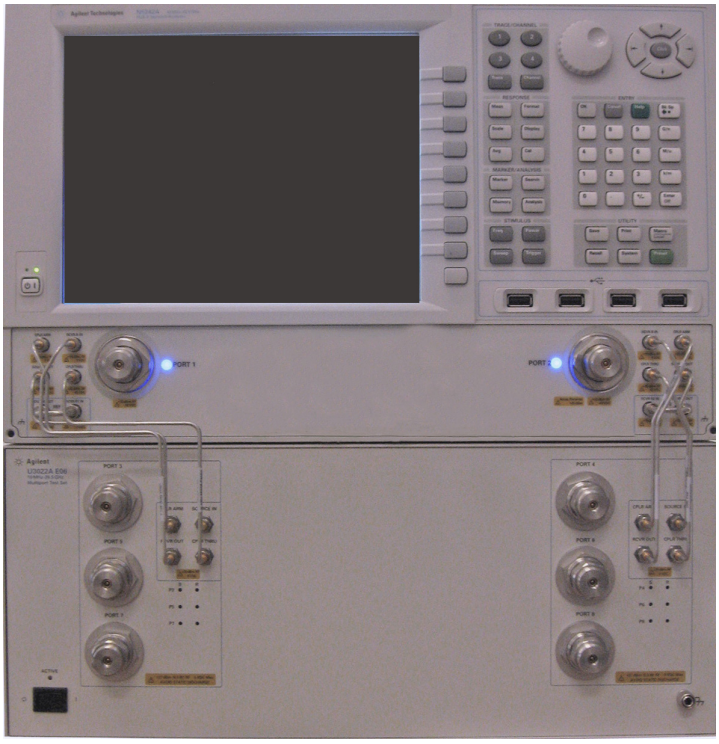
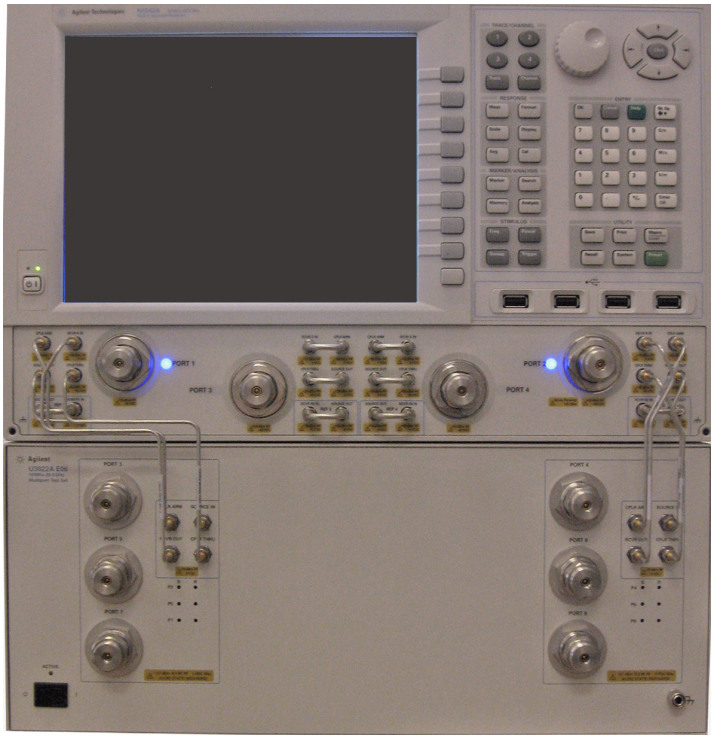


Figure 4 N5222A or N5242A 4-Port PNA-X with U3022AE06



Description

The U3022AE06 is a Multiport Test Set designed to be configured with a 2 or 4-Port, N5222A, N5224A, N5225A, N5227A or E8362B/C PNA, N5230A/C or N5232A PNA-L or N5242A PNA-X for a 8 or 10-Port network analyzer measurement system.

- 6 Test Ports (3.5 mm male connectors)
- High Speed Solid State RF switching
- Frequency Range of Operation:
  - 10 MHz to 26.5 GHz (Standard Option 700)
  - 10 MHz to 20 GHz (Option 001 or 002)
  - Test Set I/O interface for operational control. An external personal computer is not required.

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

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

Network Analyzer Requirements

All network analyzers require Option 551 for multiport operation (N-Port error correction and measurement capability). Table 1 provides a listing of additional Analyzer option requirements.

The test set files indicated in Table 1 must be installed into the Analyzer file directory: C: Program Files\Agilent\Network Analyzer\testsets

Table 1 Configuration Requirements

2-Port Analyzer	Series	Options	Test Set File	System Figures
E8362B/C	PNA	014	U3022ae06_p2.tsx	Figure 2 on page 6
N5222/4/5/7A	PNA	201, 217 or 219	U3022ae06_pnax_p2.tsx	Figure 3 on page 7
N5232A	PNA-L	216	U3022ae06_p2.tsx	Figure 1 on page 6
4-Port Analyzer	**Series**	**Options**	**Test Set File**	**System Figures**
N5222/4/5/7A	PNA	401, 417 or 419	U3022ae06_pnax_p4.tsx	Figure 4 on page 7
N5230A/C	PNA-L	145, 146, 245 or 246	U3022ae06_p4.tsx	Figure 1 on page 6
N5232A	PNA-L	416	U3022ae06_p4.tsx	Figure 1 on page 6[a]
N5242A	PNA-X	400	U3022ae06_pnax_p4.tsx	Figure 4 on page 7

a. Figure 1 on page 6 is not the N5232A, but the port configuration is similar.

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

- Network Analyzer - http://www.keysight.com/find/pna
- U3022AE06 Test Set Files - http://na.support.keysight.com/multiport (see test set files)

Available Options

Test Set Option

The U3022AE06 three available options:
Refer to “System Block Diagram” on page 75.

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

NOTE

The Options 700, 001, and 002 limit the frequency range due to blocking capacitors in the switches and amplifier performance. Solid state switches degrade frequencies below 2 MHz, and 001 or 002 amplifiers degrade performance above 18 GHz.

Accessory Options

Installation instructions are included in the option package.

- Option 1CM - Rack-mount Kit (5063-9215)
- Option 1CN - Front Handle Kit (5063-9228)
- Option 1CP - Rack-mount with front handle Kit (5063-9222)

Network Analyzer Interface Kit Options

The U3022AE06 requires one of the following kits to interface the Test Set with your Analyzer. The interface kit model option includes the hardware lock-link and cable kit listed in Table 2.

Table 2 Interface Kit Options

8-Port System	**Interface Kit Option**	**Hardware Lock-link Kit**	**Cable Kit - Conn. Type**
E8362B/C Opt 014 (PNA)	U3021PL3-262	U3021-60001[a]	U3021-60043, SMA m/m[b]
N5232A Opt 216 (PNA-L)	U3021PL3-430	U3021-60001[a]	U3021-60045, SMA m/m[c]
N5222A Opt 201, 217 or 219 (PNA)	U3021PL3-242	U3021-60002[d]	U3021-60046, SMA m/m[e]
N5224/5/7A Opt 201, 217 or 219 (PNA)	U3021PL3-247	U3021-60003[f]	U3021-60050, SMA m/1.85 m[g]
10-Port System	**Interface Kit Option**	**Hardware Lock-link Kit**	**Cable Kit - Conn. Type**
N5222A Opt 401, 417 or 419 (PNA)	U3021PL3-442	U3021-60002	U3021-60047, SMA m/m[e]
N5232A Opt 416 (PNA-L)	U3021PL3-430	U3021-60001[a]	U3021-60045, SMA m/m[c]
N5242A Opt 400 (PNA-X)	U3021PL3-442	U3021-60002[d]	U3021-60047, SMA m/m[e]
N5225A & N5227A PNA N5245A and N5247A (PNA-X)	U3021PL3-247	U3021-60003[f]	U3021-60050, SMA m/2.4 m[g]

a. Refer to "Hardware Lock-link Kit Installation (U3021-60001)" on page 19.
b. Refer to "RF Interface Cable Connections (U3021-60043)" on page 30.
c. Refer to "RF Interface Cable Connections (U3021-60045)" on page 28.
d. Refer to "Hardware Lock-link Installation (U3021-60002)" on page 22.
e. Refer to "RF Interface Cable Connection (U3021-60046 or U3021-60047)" on page 32.
f. Refer to "Hardware Lock-link Installation (U3021-60003)" on page 25.
g. Refer to "RF Interface Cable Connection (U3021-60050)" on page 34.

General Specifications

Specifications for the Test Set are characteristic for the system performance of the Analyzer and Test Set. Actual performance of the system is based on the customer's Analyzer and options that are used with the Test Set. A functional certificate is only offered for the Test Set.

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

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

NOTE

When connected to an 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 Analyzer and also reduces dynamic range. The reflection tracking values measured in the "Cal Kit Operational Check" on page 64 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 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 to the Analyzer.
- U3022AE06 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 only be inserted into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.

Environmental Requirements

Refer to your Analyzer's standard documentation for environmental requirements.

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

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

Equipment Heating and Cooling

If necessary, install air conditioning and heating to maintain the ambient temperature within the appropriate range.

CAUTION

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

Required Conditions for Accuracy Enhanced Measurement

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

Dimensions and Space Requirements

Standard installation of the Test Set and Analyzer includes configuration and installation on a customer provided lab bench, or table top of adequate size and strength. For weight, dimensions and space requirements, refer to the network analyzer documentation that you are using to configure the Test Set.

Table 3 Instrument Dimensions

Model	Weight	Height	Width	Depth
U3022AE06	11.4 kg (25 lb)	19.1 cm (7.5 in)	42.5 cm (16.7 in)	43.2 cm (17 in)

Frequency Range and Power Levels

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

CAUTION It is recommend that you do not operate components near damage levels (+30 dBm, 7 Vdc). The power levels must be 3 dB below maximum level to ensure no damage.

Table 4 Recommended Maximum Power Levels and Vrms[a]

U3022AE06 Test Port RF Power Levels	
PORT 3-8	+27 dBm 5 Vdc
U3022AE06 Access Ports:	
SOURCE OUT	+20 dBm 2.2 Vdc
CPLR ARM	+20 dBm 2.2 Vdc
CPLR THRU	+20 dBm 2.2 Vdc
RCVR OUT	+20 dBm 2.2 Vdc

a. Formula for 50 Ω system. $P(dBm) = 10\ Log_{10}\ (V_{rms}^2/0.05)$

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

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

Typical Reflection Tracking

Specifications for the Test Set are typical. System performance for the Analyzer and Test Set are only characteristic and intended as non-warranted information.

NOTE Typical performance is based on 1 to 2 units performance. Refer to Table 5 and Table 6.

Table 5 Typical Reflection Tracking PNA-L

Frequency	Standard 700	Option 001	Option 002
300 MHz to 10 MHz[a]	-80	-100	-100
10 MHz to 4 GHz	-2	+2	+1
4 GHz to 6 GHz	-7	+1	+0
6 GHz to 10.5 GHz	-8	-2	-3
10.5 GHz to 13.5 GHz	-13	-3	-4
13.5 GHz to 15 GHz	-15	-3	-4
15 GHz to 20 GHz	-20	-13	-15

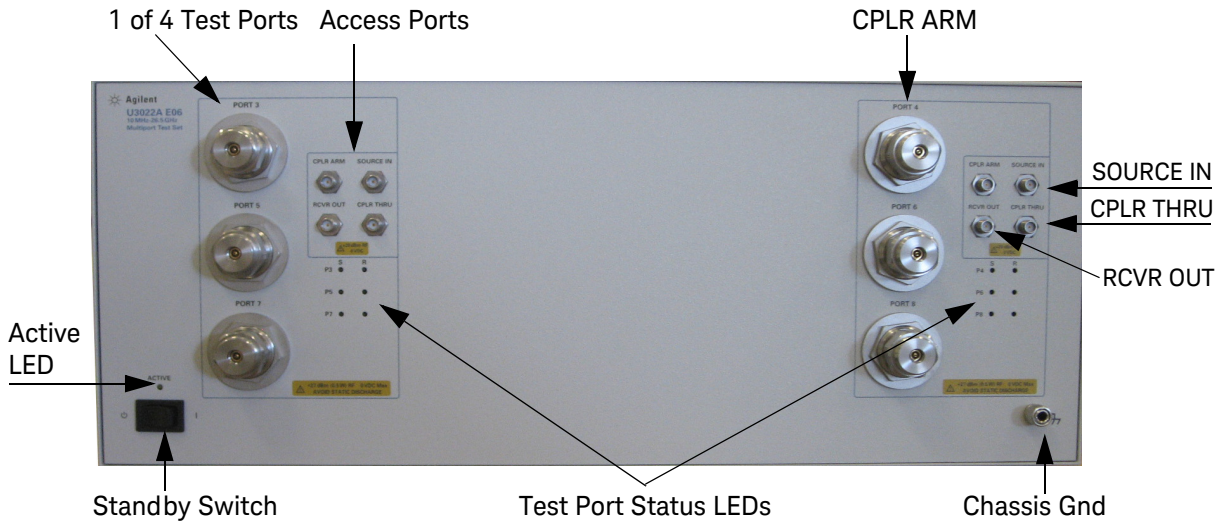
a. Generally improves at 3 MHz to -6 dBm.

Table 6 Typical Reflection Tracking PNA and PNA-X

Frequency	Standard 700	Option 001	Option 002
10 MHz to 50 MHz	-2	+5	+4
50 MHz to 500 MHz	-3	+5	+4
500 MHz to 3.2 GHz	-8	+2	+1
3.2 GHz to 10 GHz	-12	-2	-3
10 GHz to 16 GHz	-15	-4	-5
16 GHz to 20 GHz	-20	-13	-15
20 GHz to 24 GHz	-24	-21	-23
24 GHz to 26.5 GHz	-25	-35	-37

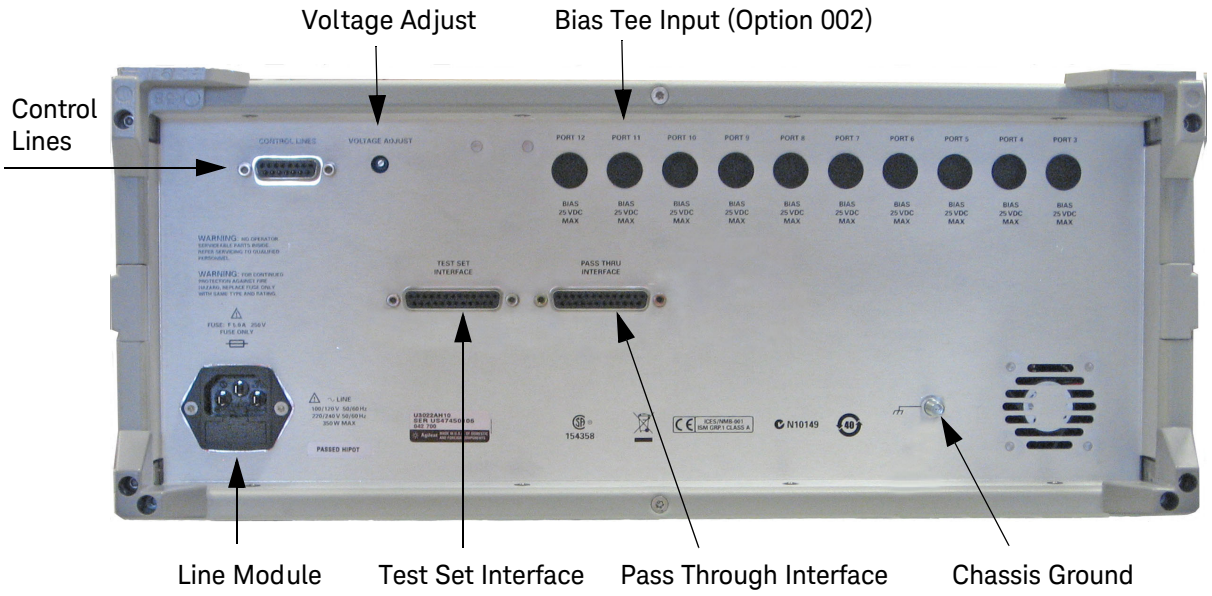
Front and Rear Panel Features

Figure 5 U3022AE06 Front Panel



Test Ports 3.5 mm Bulkhead (male)	Ports 3-8
Access Ports – SMA (female)	· CPLR ARM · SOURCE IN · CPLR THRU · RCVR OUT (A-D)
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).
Test Port Status LED's	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	The switch is only a Standby switch, not a AC line power switch.
Active LED	The Active LED is *on w*hen the Test Set is connected and addressed by a Analyzer. The LED is *off* when the Test Set is in Standby, or not addressed by the Analyzer.

Figure 6 U3022AE06 Rear Panel



Control Lines and Voltage Adjust For further information pertaining to control lines and voltage adjustments see "Control Lines" on page 58.

Bias Tee Input - Option 002 (only) BNC female connectors.

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

Pass Through Interface Connection to another Test Set.

Test Set Interface The Test Set Interface connector is used to send address and data to the Test Set from the Analyzer.

Line Module

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

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

Available Fusses

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

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

Figure 7 Line Module and Fuse

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

Hardware Lock-link Kit Installation (U3021-60001)

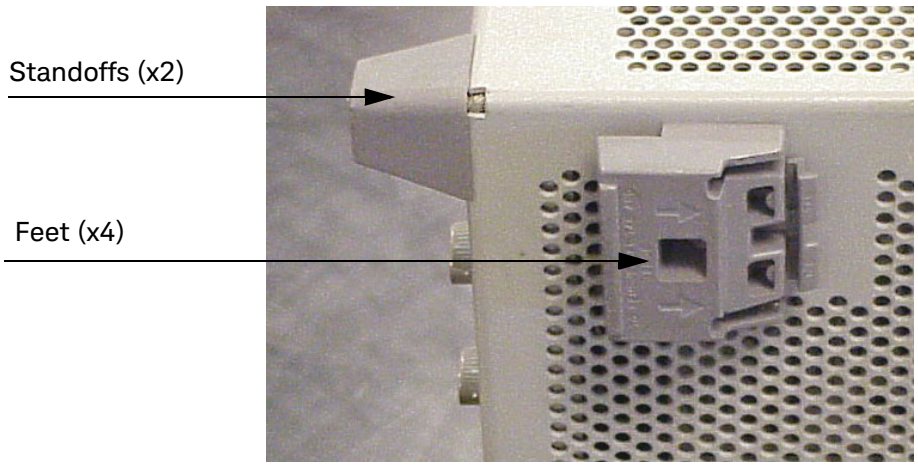
If your system is to be rack mounted, this installation procedure does not have to be performed.

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

Locking the Test Set to the Analyzer

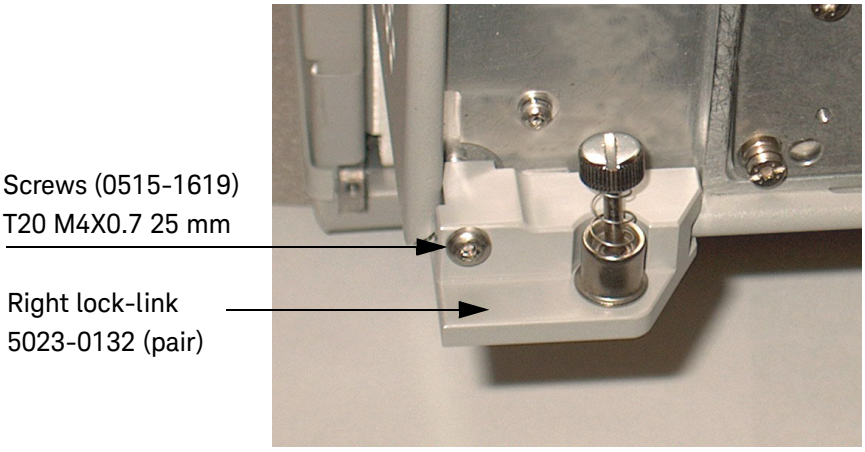
1. The lock-link kit (U3021-60001) includes the following:
   - 5023-9253 - Lock-link kit (left, 5022-2816 & right 5022-2817), Test Set
   - 5023-0132 - Lock-link kit (left, right and screws), Analyzer
2. Remove the feet from the bottom of the Analyzer.
3. Remove the 2 lower standoffs from the rear panel on the Analyzer using a T20 Torx driver.

Figure 8 Rear Bottom Feet



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

Figure 9 Install Lock-links

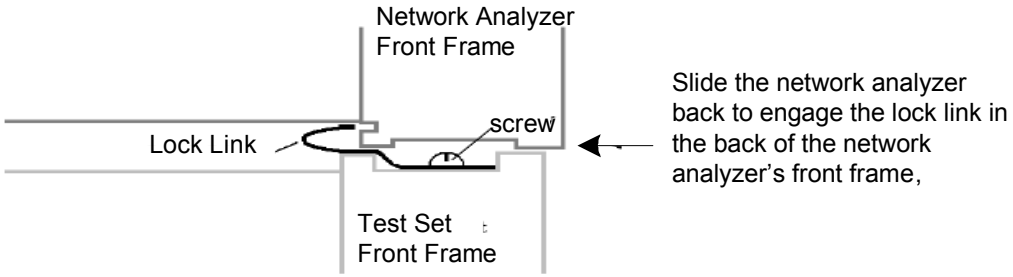


5. Remove the two upper standoffs from the rear panel on the Test Set.
6. Install the left and right lock-links onto the Test Set.

Figure 10 Install Rear Lock-links to the Test Set

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.

Figure 11 Locking the Analyzer



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

Figure 12 Lock-Link Screws

NOTE Refer to "Network Analyzer Interface Kit Options" on page 11.

Hardware Lock-link Installation (U3021-60002)

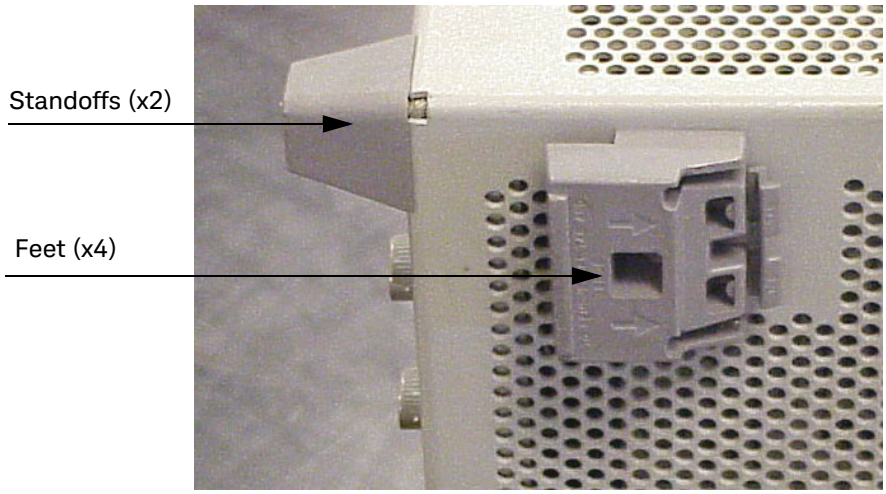
If your system is to be rack mounted, this installation procedure does not have to be performed.

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

Locking the Test Set to the Analyzer

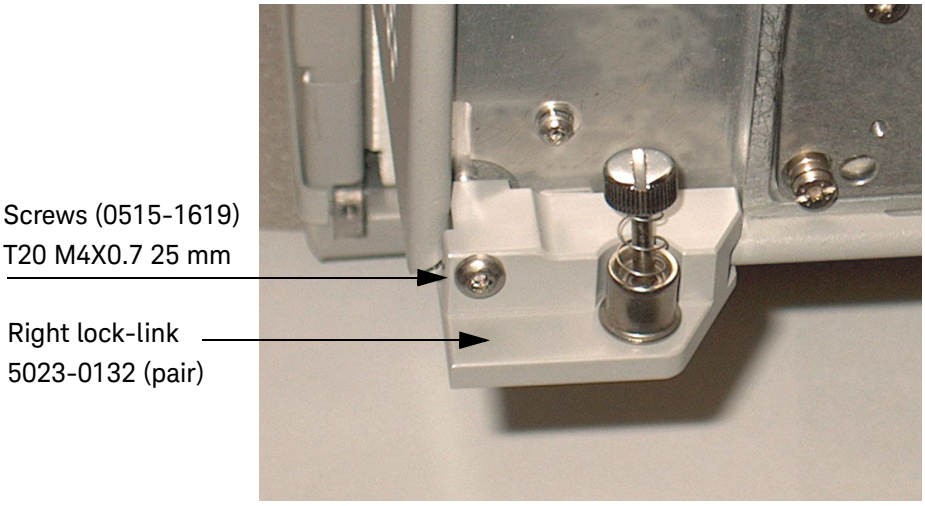
1. The lock-link kit (U3021-60002) includes the following:
   - 5023-0132 - Lock-link kit (left, right and screws), Analyzer
   - 5023-2317 - Screw T15 M3.5x0.6 12 mm
   - N5242-20138 – Right Lock-link, Test Set
   - N5242-20139 – Left Lock-link, Test Set
2. Remove the feet from the bottom of the Analyzer.
3. Remove the 2 lower standoffs from the rear panel on the Analyzer using a T20 Torx driver.

Figure 13 Rear Bottom Feet



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

Figure 14 Install Lock-links

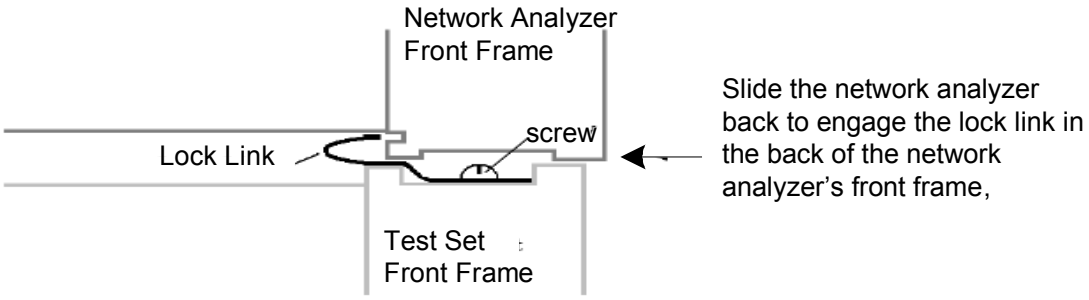


5. Remove the top two standoffs from the rear panel on the Test Set.
6. Install the left and right lock-links onto the Test Set.

Figure 15 Install Lock-link on Test Set

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 16 Locking the Analyzer



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-link are not aligned with the screw holes, loosen the screws securing the lock-link to the instrument slightly to align and tighten.

Figure 17 Lock-Link Screws

Hardware Lock-link Installation (U3021-60003)

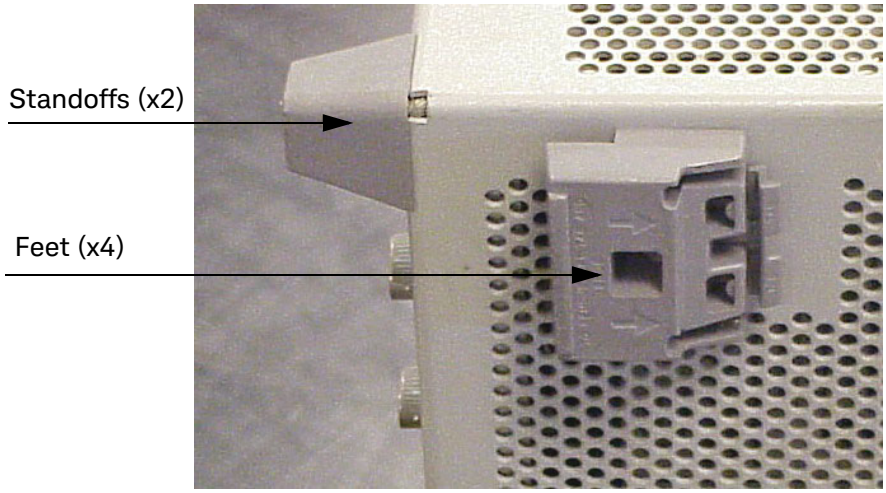
If your system is to be rack mounted, this installation procedure does not have to be performed.

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

Locking the Test Set to the Analyzer

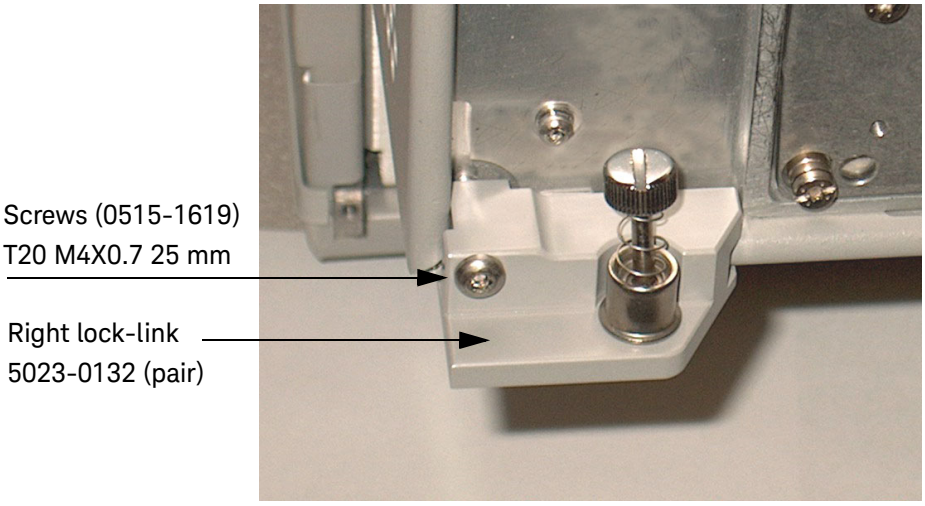
1. The lock-link kit (U3021-60003) includes to interface the Test Set to the Analyzer.
   - 5023-0132 - Lock-links kit (left, right pair and screws), Analyzer
   - 0515-2317 - Screw T15 M3.5 x 0.6 12 mm
   - N5245-20130 - Right Lock-link, Test Set
   - N5245-20131 - Left Lock-link, Test Set
2. Remove the feet from the bottom of the Analyzer.
3. Remove the 2 lower standoffs from the rear panel on the Analyzer.

Figure 18 Rear Bottom Feet



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

Figure 19 Install Lock-links

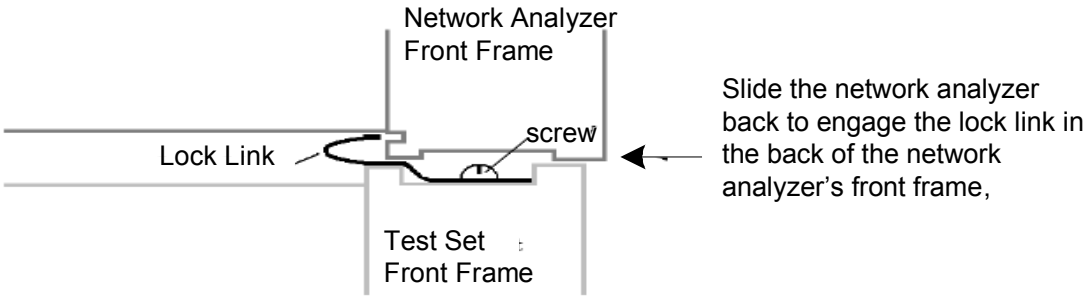


5. Remove the top two standoffs from the rear panel on the Test Set using a T20 torx driver.
6. Install the two rear lock-links onto the Test Set. Looking at the front panel, the N5242-20130 is the right foot and the N5242-20131 is the left foot. Two screws (0515-2317) are included with this option.

Figure 20 Install Lock-link on Test Set

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 21 Locking the Analyzer



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-link are not aligned with the screw holes, loosen the screws securing the lock-link to the instrument slightly to align and tighten.

Figure 22 Lock-Link Screws

RF Interface Cable Connections (U3021-60045)

4-Port Analyzer

Figure 23 on page 29 illustrates the cable configuration of the Test Set to a 4-Port analyzer. The cables have been supplied with kit (U3021-60045).

Cable Connection Procedure

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x4) on the PNA-L. The RCVR R1 to SOURCE OUT reference loop jumper (x1) remain on the front panel.
2. Connect the RF interconnect cables from the PNA-L to the Test Set. As you are connecting each cable, torque to 8 in-lb. Refer to Table 7 and Figure 23 on page 29.

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

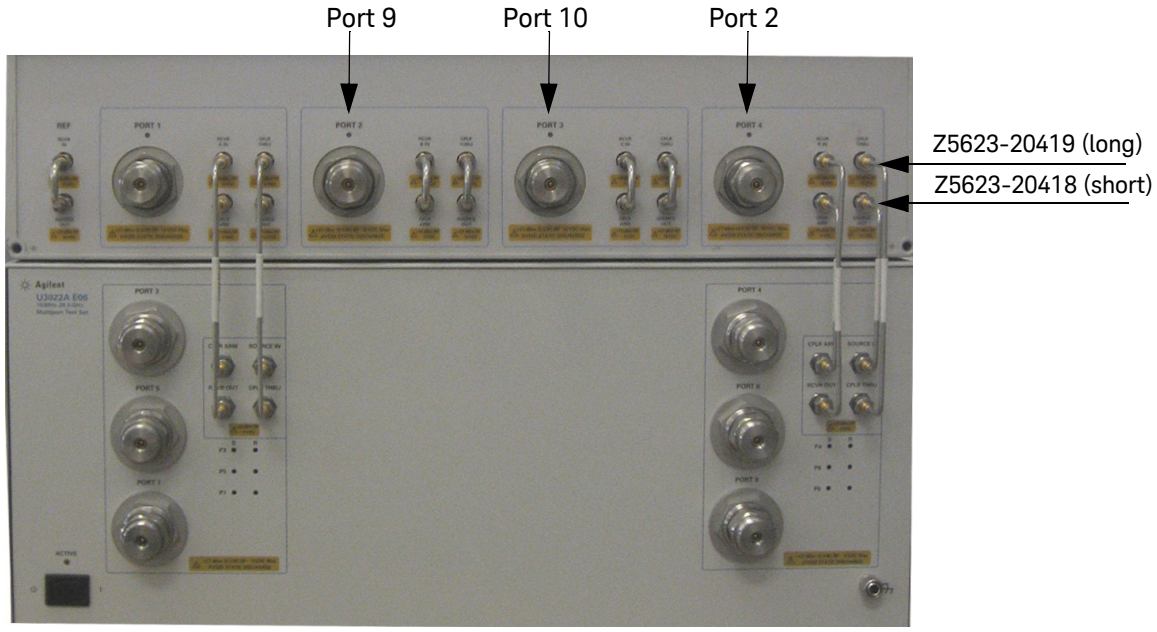
CAUTION Each end of the interconnect RF cables have a different length from the bend. When connecting the RF Interconnect cables be sure that the longer end (from the bend) is connected to the Analyzer.

Table 7 10-Port Interface Cable Connection (U3021-60045)

RF Cables	From: PNA-L	To: Test Set
Z5623-20418	SOURCE OUT	SOURCE OUT
Z5623-20418	CPLR ARM	CPLR ARM
Z5623-20419	CPLR THRU	CPLR THRU
Z5623-20419	RCVR IN	RCVR OUT

Figure 23 is not the N5232A Analyzer, but the access port configuration is similar. Refer to Table 7.

Figure 23 10-Port Interface Connections



3. Add the front panel port labels from the cable kit (U3021-60045) over the Analyzer's port numbers.
   - Port 2 over Port 4 (U3022-80004)
   - Port 9 over Port 2 (U3022-80006)
   - Port 10 over Port 3 (U3022-80007)

Refer to “System Operational Checks” on page 37 for turn-on verification of the multiport system.

RF Interface Cable Connections (U3021-60043)

2-Port Analyzer

Figure 24 illustrates the cable configuration of the Test Set to the analyzer. The cables have been supplied with Cable Kit (U3021-60043).

Cable Connection Procedure

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x4) on the PNA-L. The RCVR R1 to SOURCE OUT reference loop jumper (x1) remain on the front panel.
2. Connect the RF interconnect cables from the PNA 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 24 on page 31.

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

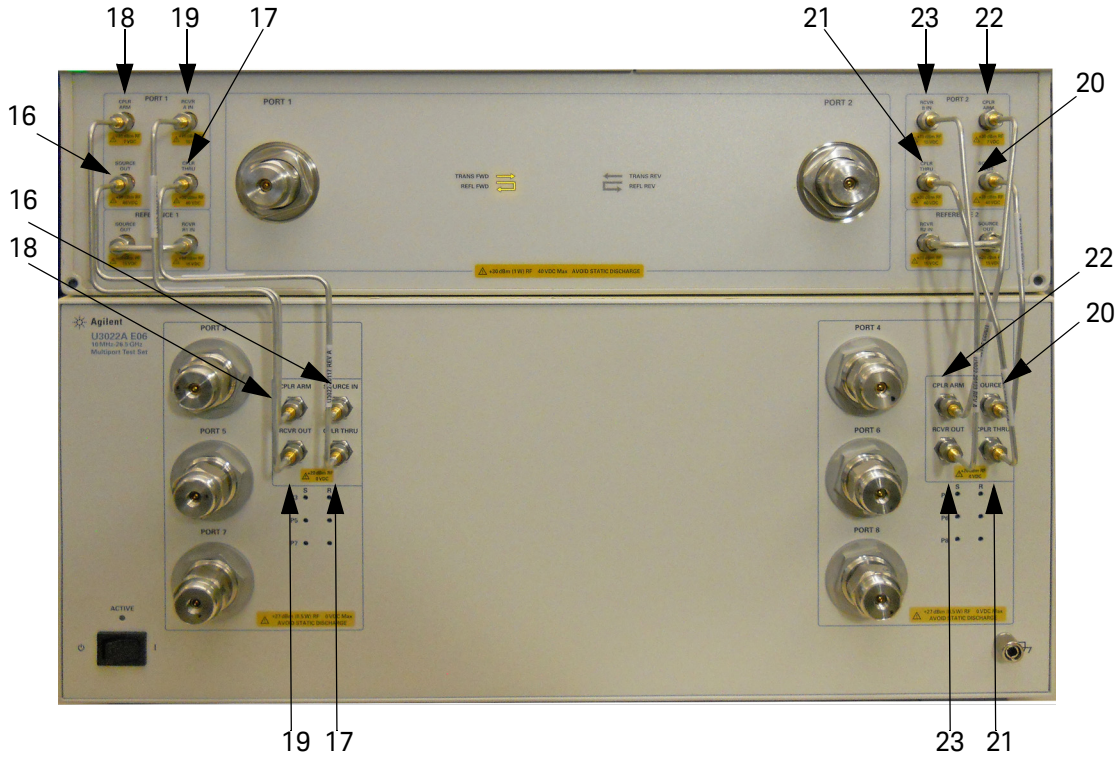
CAUTION Each end of the interconnect RF cables have a different length from the bend. When connecting the RF Interconnect cables be sure that the longer end (from the bend) is connected to the Analyzer.

Table 8 8-Port RF Cable Connection (U3021-60043)

Numeric Order	RF Cables	From: PNA_X	To: Test Set
1	U3022-20116	Port 1 SOURCE OUT	Ports 3, 5 and 7 SOURCE IN
2	U3022-20117	Port 1 CPLR THRU	Port 3, 5 and 7 CPLR THRU
3	U3022-20118	Port 1 CPLR ARM	Port 3, 5 and 7 CPLR ARM
4	U3022-20119	Port 1 RCVR A IN	Port 3, 5 and 7 RCVR OUT
5	U3022-20122	Port 2 CPLR ARM	Ports 4, 6 and 8 CPLR ARM
6	U3022-20120	Port 2 SOURCE OUT	Port 3, 5 and 7 SOURCE IN
7	U3022-20121	Port 2 CPLR THRU	Port 3, 5 and 7 CPLR THRU
8	U3022-20123	Port 2 RCVR B IN	Port 3, 5 and 7 RCVR OUT

Figure 24 illustrates the final two digits of the part number for each cable. The cables must be connected in the numeric order listed in Table 8.

Figure 24 8-Port Interface Connections



RF Interface Cable Connection (U3021-60046 or U3021-60047)

RF Interface Cable Connections

Figure 25 on page 33 illustrates the cable configuration of the Test Set to a 4-Port analyzer. The cables have been supplied with the kit (U3021-60046 or 60047).

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x8) on the PNA or PNA-X. The RCVR R1 to SOURCE OUT reference loop jumper (x2 or x4) remain on the front panel.
2. Connect the RF interconnect cables from the PNA or PNA-X to the Test Set in the order listed. As you are connecting each cable, torque to 8 in-lb. The longer, straight end of each cable is connected to the Test Set. Refer to Table 9 on page 33 and Figure 25 on page 33.
3. Add the front panel port labels from the cable kit (U3021-60046) over the Analyzer's port numbers.
   - Port 9 over Port 3 (U3022-80006)
   - Port 10 over Port 4 (U3022-80008)

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

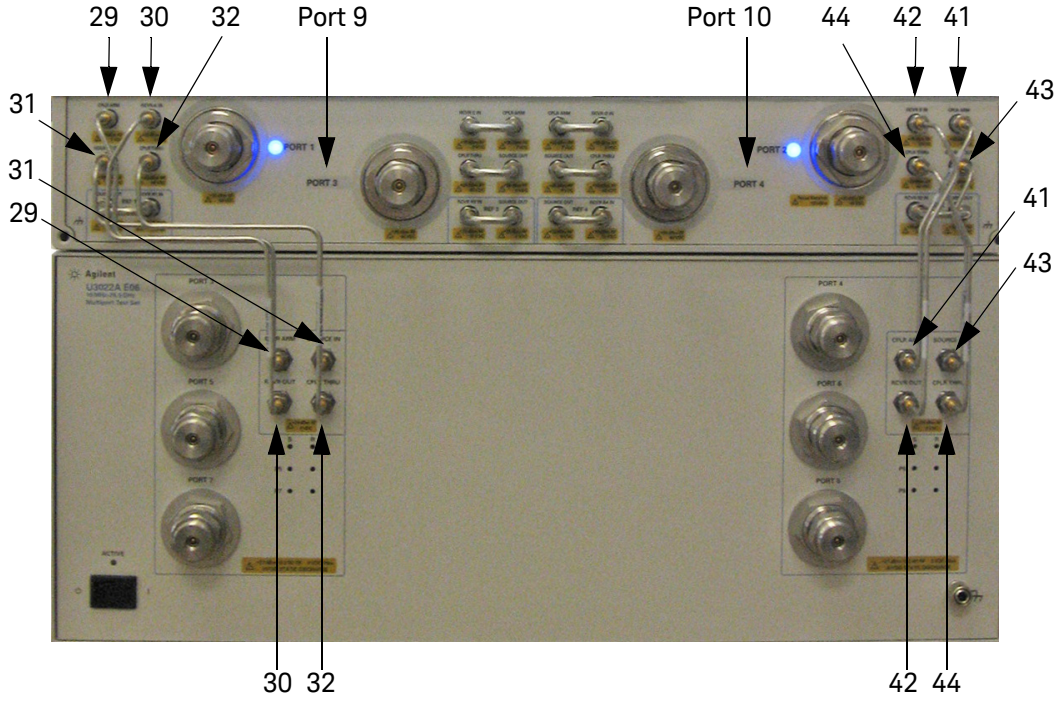
Table 9 N5222A/42A RF Interface Cable Connection (U3021-60046 or U3021-60047)

Numeric Order	RF Cables	From: PNA or PNA-X	To: Test Set
1	U3042-20031	Port 1 SOURCE OUT	Ports 3, 5 and 7 SOURCE IN
2	U3042-20032	Port 1 CPLR THRU	Port 3, 5 and 7 CPLR THRU
3	U3042-20029	Port 1 CPLR ARM	Port 3, 5 and 7 CPLR ARM
4	U3042-20030	Port 1 RCVR A IN	Port 3, 5 and 7 RCVR OUT
5	U3042-20041	Port 2 CPLR ARM	Ports 4, 6 and 8 CPLR ARM
6	U3042-20043	Port 2 SOURCE OUT	Port 3, 5 and 7 SOURCE IN
7	U3042-20044	Port 2 CPLR THRU	Port 3, 5 and 7 CPLR THRU
8	U3042-20042	Port 2 RCVR B IN	Port 3, 5 and 7 RCVR OUT

Figure 25 illustrates the final two digits of the part number for each cable. The cables must be connected in the numeric order listed in Table 9.

NOTE Kit U3021-60047 contains eight extra cables that are not listed above and are not used in this interface connection

Figure 25 N5242A RF Interface Cable Connections



RF Interface Cable Connection (U3021-60050)

RF Interface Cable Connections

Figure 26 on page 35 illustrates the cable configuration of the Test Set to a 4-Port analyzer. The cables have been supplied with the kit (U3021-60050).

1. Remove the SOURCE OUT to CPLR THRU and RCVR IN to CPLR ARM jumpers (x8) on the PNA or PNA-X. The RCVR R1 to SOURCE OUT reference loop jumper (x2 or x4) remain on the front panel.
2. Connect the RF interconnect cables from the PNA or PNA-X to the Test Set in the order listed. As you are connecting each cable, torque to 8 in-lb. The longer, straight end of each cable is connected to the Test Set. Refer to Table 10 on page 35 and Figure 26 on page 35.
3. Add the front panel port labels from the cable kit (U3021-60050) over the Analyzer's port numbers.
   - Port 9 over Port 3 (U3022-80006)
   - Port 10 over Port 4 (U3022-80008)

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

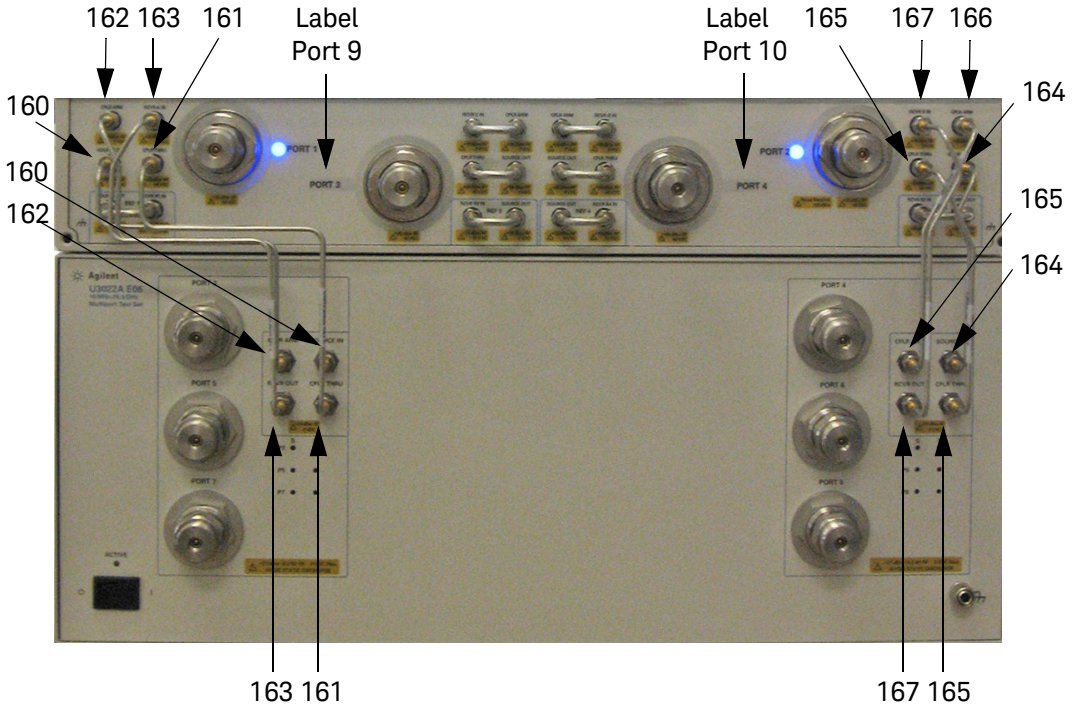
Table 10 N5247A RF Interface Cable Connection (U3021-60050)

Numeric Order	RF Cables	From: PNA-X	To: Test Set
1	U3022-20160	Port 1 SOURCE OUT	Ports 3, 5 and 7 SOURCE IN
2	U3022-20161	Port 1 CPLR THRU	Port 3, 5 and 7 CPLR THRU
3	U3022-20162	Port 1 CPLR ARM	Port 3, 5 and 7 CPLR ARM
4	U3022-20163	Port 1 RCVR A IN	Port 3, 5 and 7 RCVR OUT
5	U3022-20166	Port 2 CPLR ARM	Ports 4, 6 and 8 CPLR ARM
6	U3022-20164	Port 2 SOURCE OUT	Port 3, 5 and 7 SOURCE IN
7	U3022-20165	Port 2 CPLR THRU	Port 3, 5 and 7 CPLR THRU
8	U3022-20167	Port 2 RCVR B IN	Port 3, 5 and 7 RCVR OUT

Figure 25 illustrates the final three digits of the part number for each cable. The cables must be connected in the numeric order listed in Table 9.

NOTE Apply the Port 9 and 10 labels over Ports 3 and 4 on the PNA-X.

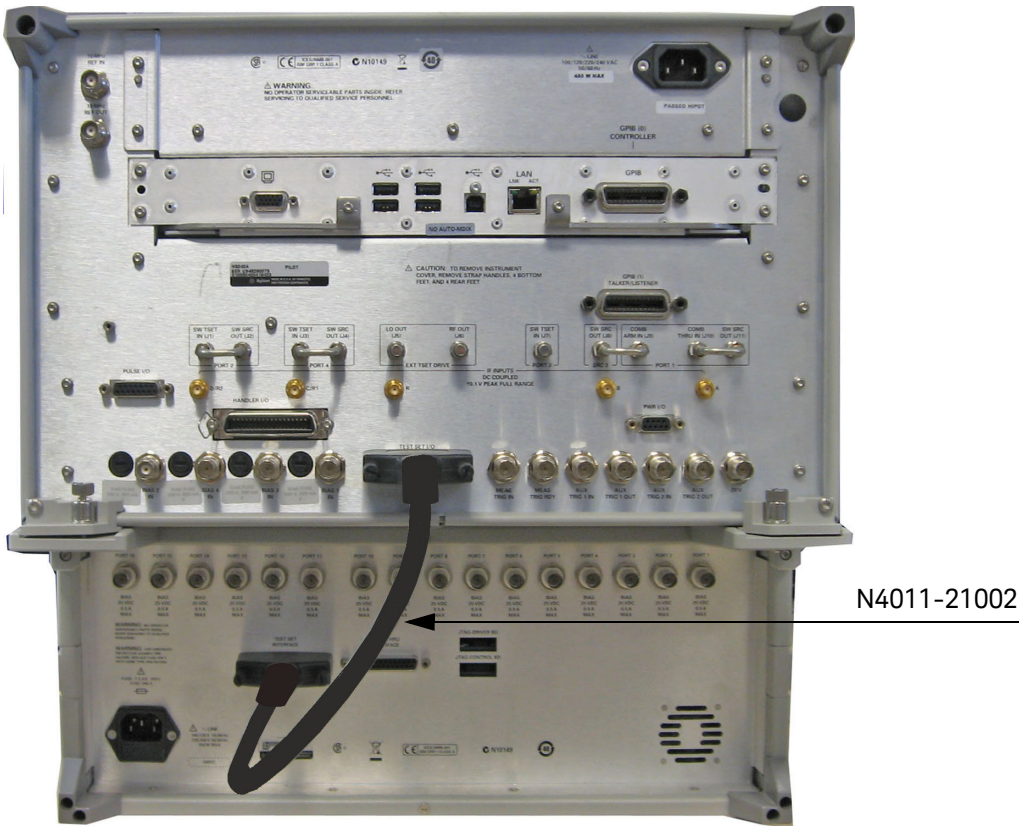
Figure 26 N5247A RF Interface Cable Connections



Test Set I/O Cable Installation

1. Connect the Analyzer's Test Set I/O cable (N4011-21002) to the Test Set Interface connector on the rear panel, similar to Figure 27.

Figure 27 PNA or PNA-X Test Set I/O Cable Connection



Interconnect Cable Verification

1. Perform the "System Operational Checks" on page 37.
2. If the problem still exists, perform the "RF Switching Failures" on page 82.
3. If a power hole or other failure still exist, refer to "Contacting Keysight" on page 96.

System Operational Checks

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

Before beginning this procedure you should complete the following steps:

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

Equipment Setup

- Turn *on* the Test Set and Network Analyzer.
- Preset the Analyzer and complete the following settings:
  - Set to Multi-Port Mode (refer to "Multiport Mode (Option 551)" on page 42)
  - Frequency range: 10 MHz to 26.5 GHz or highest frequency
  - Set the Analyzer to measure S11

Verify Results

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

Table 11 Reflection Response Results

Reflection Port	Response Trace	Cable Path Diagram
Ports 1-2	Figure 28 on page 38	Figure 29 on page 38
Ports 3-8	Figure 30 on page 39	Figure 31 on page 39
Ports 5-6	Figure 32 on page 40	Figure 32 on page 40
Ports 7-8	Figure 33 on page 40	Figure 33 on page 40

CAUTION The trace ripple (peak-peak variation) will be higher than when using an ECal Module due to variation in your Short's performance. If response is in question perform "Cal Kit Operational Check" on page 64.

Figure 28 Typical Reflection Response Ports 1-2 PNA and PNA-X, or 1-8 PNA-L (Standard)

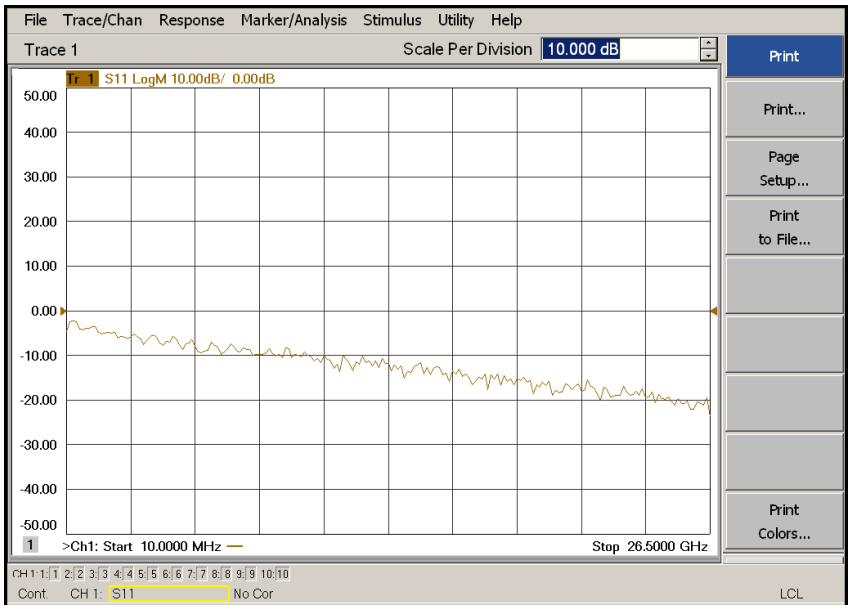


Figure 29 Reflection Response Signal Path Diagram Ports 1-2 (Standard)

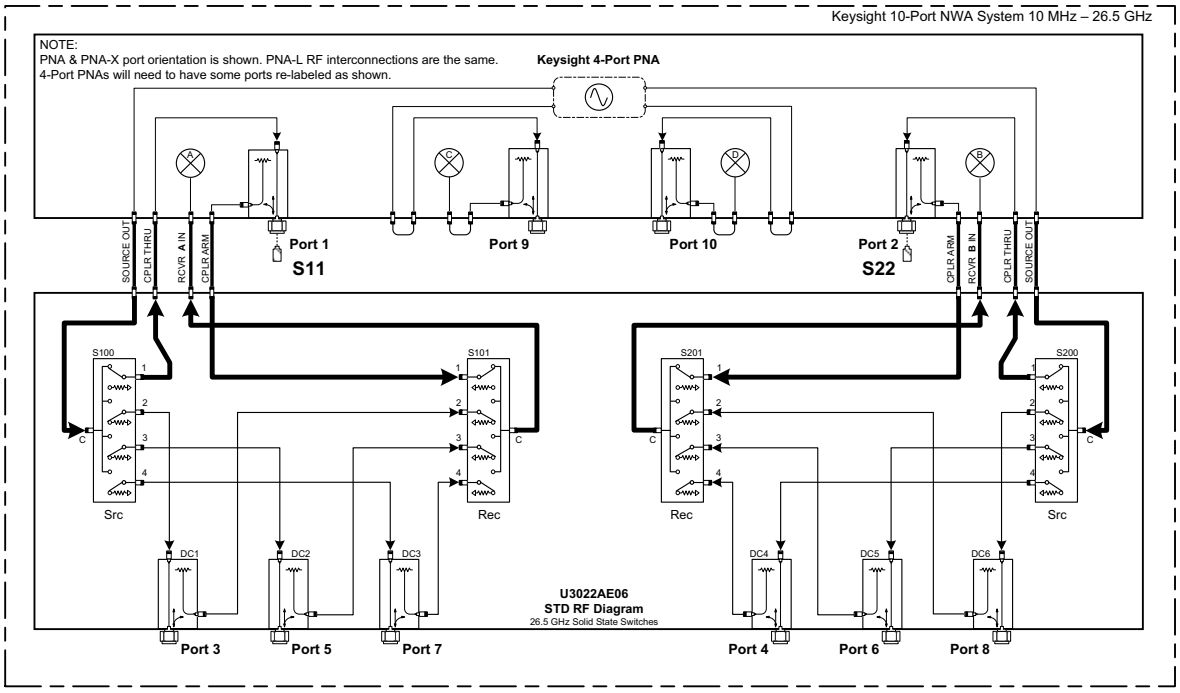


Figure 30 Typical Reflection Response Ports 3-8 PNA and PNA-X (Standard)

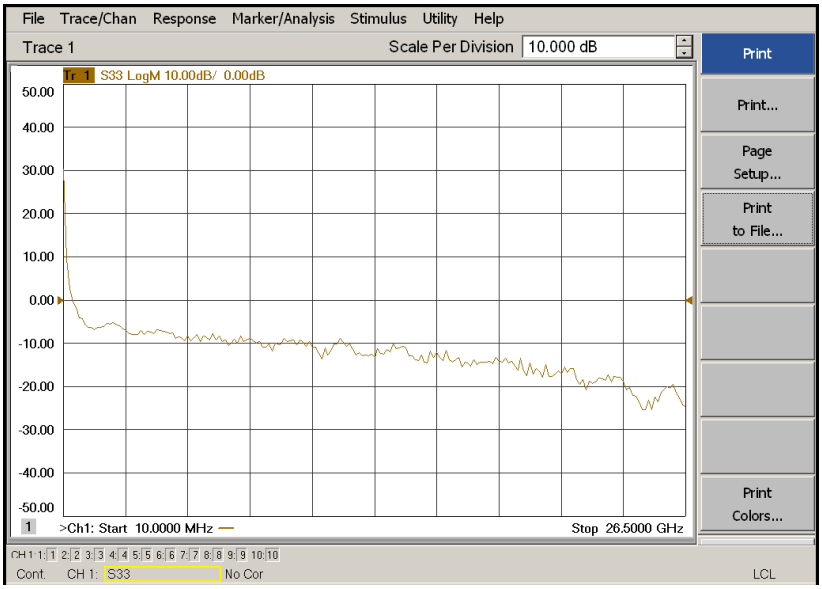


Figure 31 Reflection Response Signal Path Diagram Ports 3-8 (Standard)

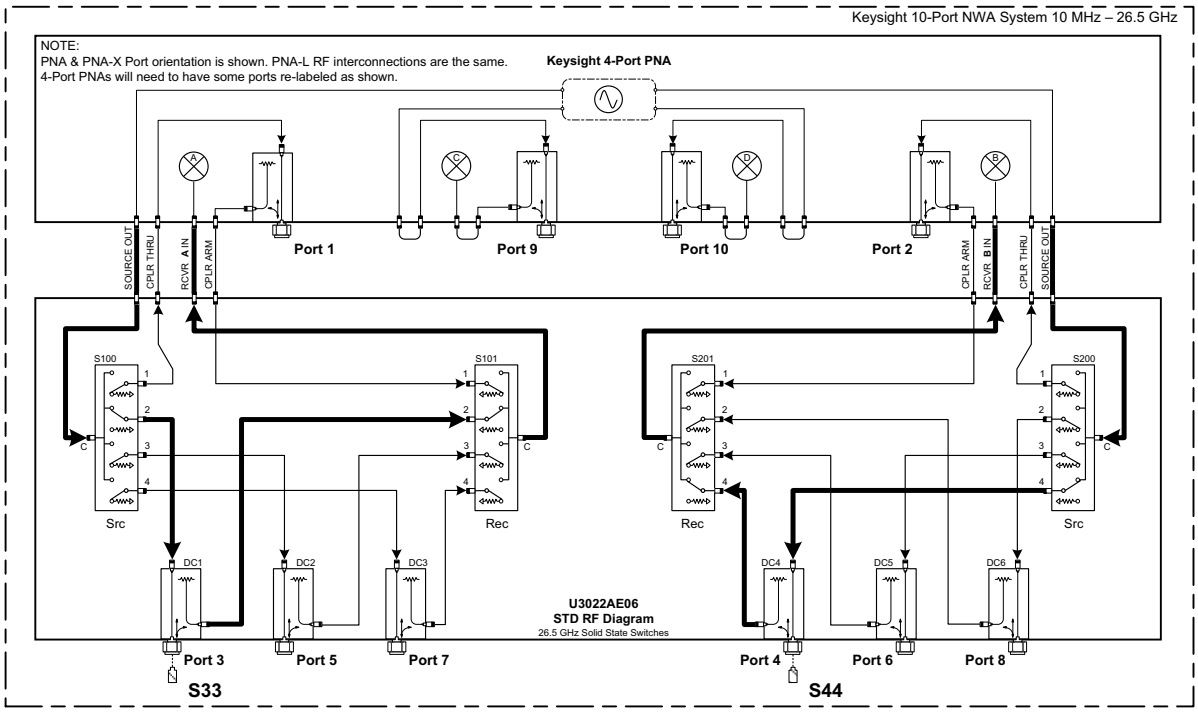


Figure 32 Reflection Response Signal Path Diagram Ports 5-6 (Standard)

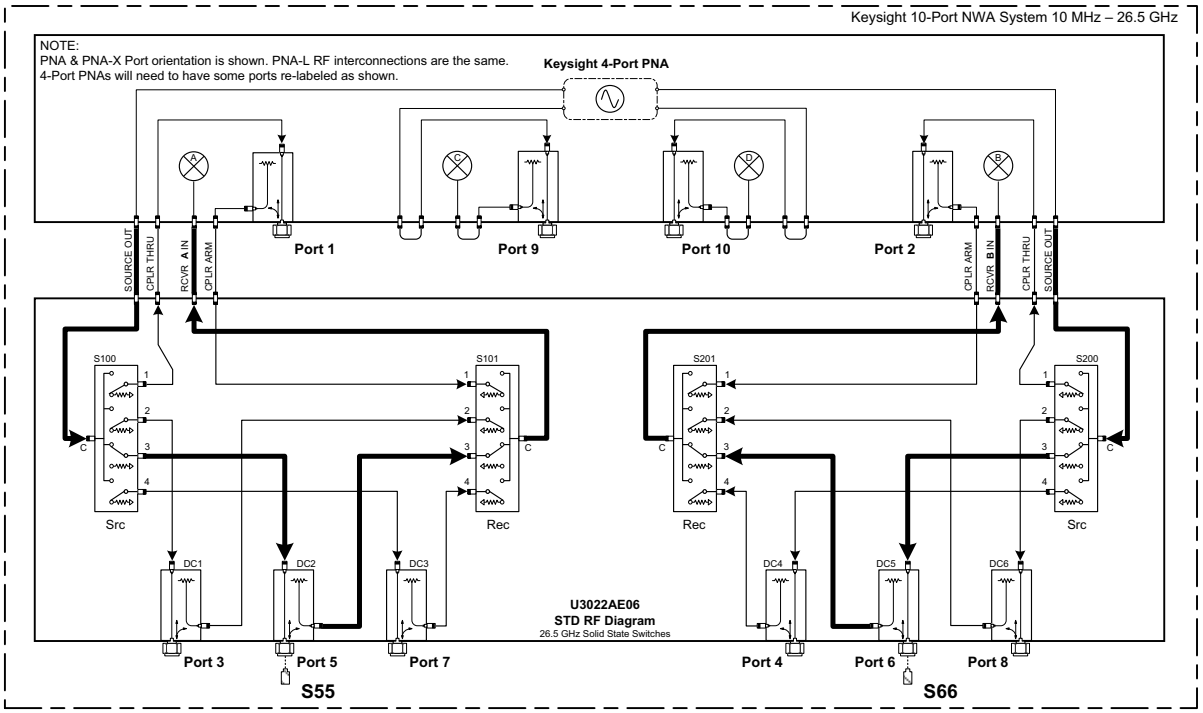
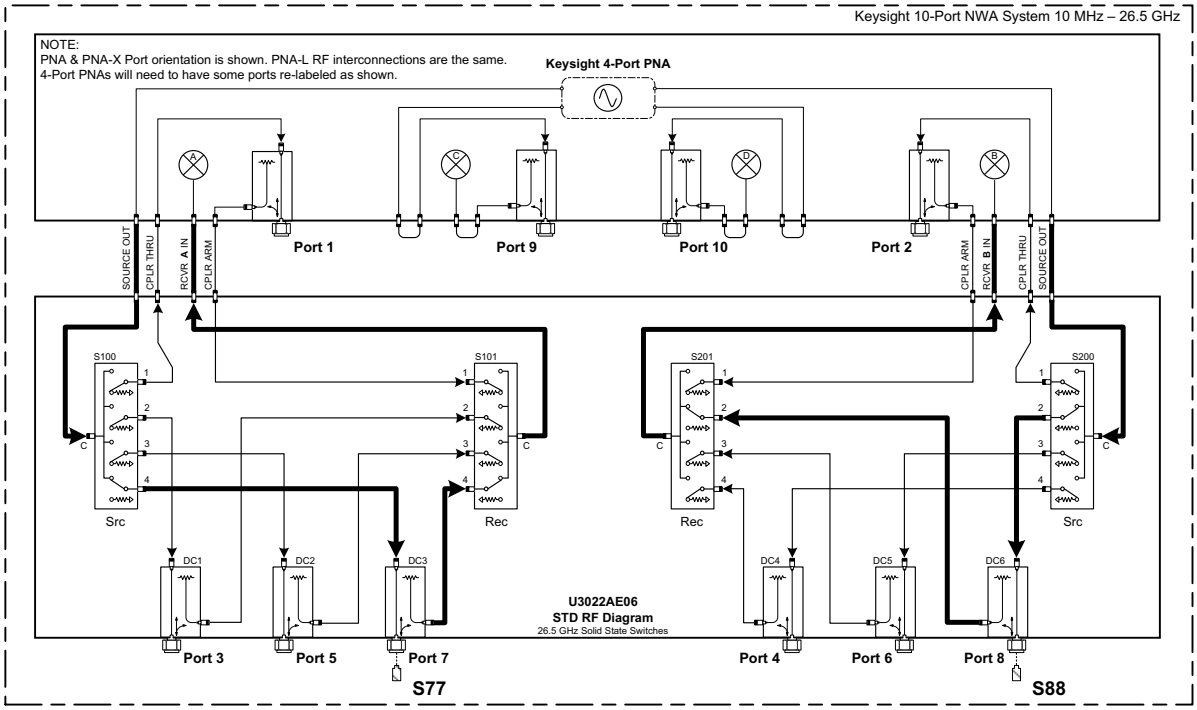


Figure 33 Reflection Response Signal Path Diagram Ports 7- 8 (Standard)



Controlling the Test Set

This section will describe how to configure and operate the Test Set with the Analyzer.

NOTE

The internal firmware of the Analyzer has not been modified for this Test Set option. Power levels may differ from those indicated on the Analyzer when the Test Set is connected.

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

- “Multiport Mode (Option 551)” on page 42
- “Interface Control Mode” on page 50
- “GPIB Control Mode” on page 54

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

Definitions for Specifications

Specifications describe the warranted performance of calibrated instruments that have been stored for a minimum of 2 hours within the operating temperature range of 0 to 55 °C, unless otherwise stated, and after a 45 minute warm-up period. Data represented in this document are specifications unless otherwise noted.

Characteristics describe product performance that is useful in the application of the product, but that is not covered by the product warranty. Characteristics are often referred to as Typical or Nominal values.

- **Nominal** describes representative performance that is useful in the application of the product when operated over a 20 to 30 °C temperature range. Nominal performance is not warranted.
- **Typical** describes characteristic performance, which 80% of instruments are expected to meet when operated over a 20 to 30 °C temperature range. Typical performance is not warranted.

Multiport Mode (Option 551)

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

Ensure the Test Set file needed for your analyzer are installed into network analyzer file directory: C:\Program Files\Agilent\Network Analyzer\testsets

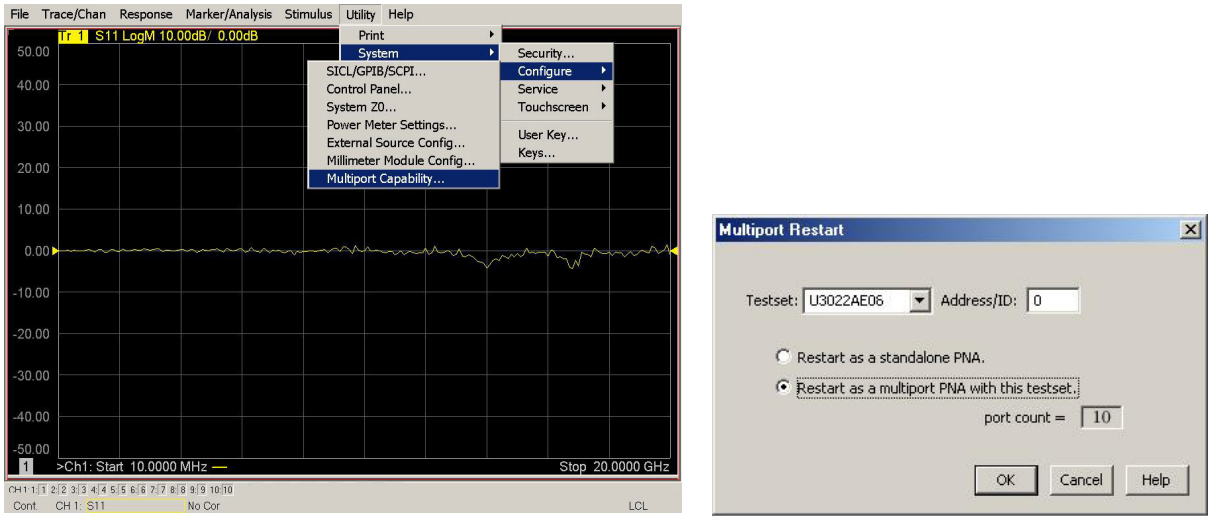
Refer to "Network Analyzer Requirements" on page 9.

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**.
2. Select **U3022AE06** (8 or 10-Port System) from the drop-down menu and select **Restart as a multiport PNA with this testset** > **OK**. The Analyzer will restart the network application with the Test Set interface features.

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

Figure 34 Selecting Multiport Mode

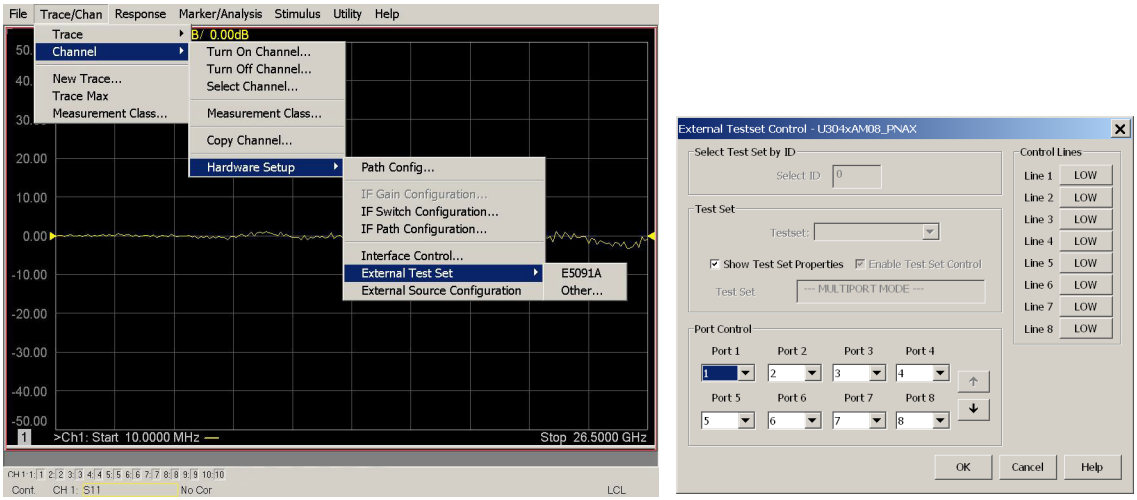


External Test Set Control Feature

NOTE If you are using a 2-Port Analyzer, Ports 9 and 10 are not available. The following graphics illustrate a 10-Port configuration.

To verify that the network application has the Test Set interface features, select **Trace/Chan** > **Channel** > **Hard ware Setup** > **External Test Set** > **Other**. The Test Set will be displayed as **External Test Set Control-U3022AE06**.

Figure 35 External Test Set Control



This menu will allow the physical Ports 1 thru 10 to be identified as any port for your convenience. For example; Port 5 can be named Port 2.

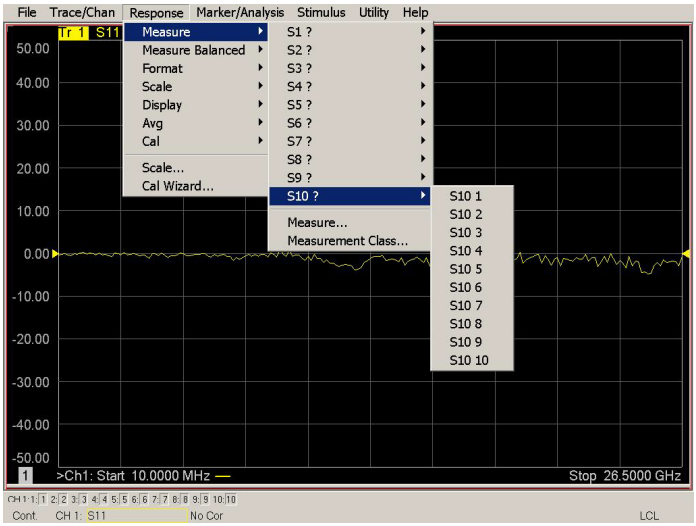
The **External Test Set Control-U3022AE06** also allows control of the DUT control lines, refer to “Control Lines” on page 58. To change the state from LOW to HIGH, select the graphical user interface (GUI) for the specific control (LINE 1 thru 8), then press **OK**. Each line can be controlled separately.

Select the **Port Control** down arrow for Ports 9 thru 10.

Trace Measure S-Parameter

S-Parameter selection can be accomplished using **Response** > **Measure**. Use the drop-down menus to select 1 of 100 S-Parameters for the 10-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 36 S-Parameter Measurement



New Trace Measure S-Parameter

S-Parameter Tab: Multiple S-Parameters can be made from the **New Trace** menu. In the drop-down menu select **Trace/Chan** > **Trace** > **New Trace**. The dialog box allows the selection of any of the 100 S-Parameters. Refer to Figure 37 and Figure 38 on page 45.

Figure 37 New S-Parameter Measurement

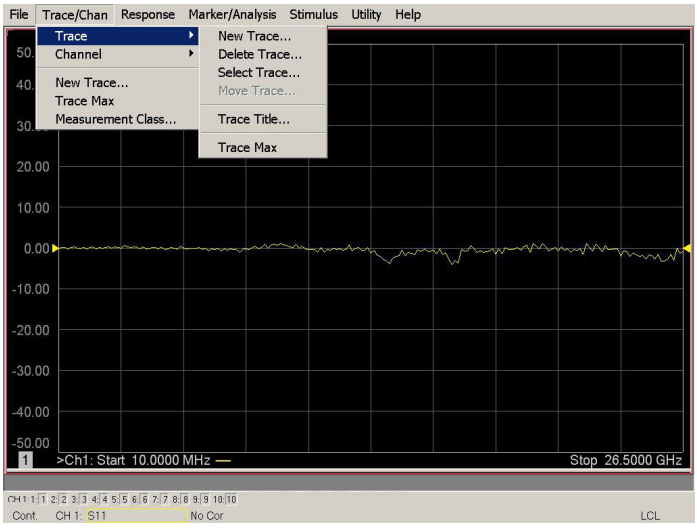


Figure 38 10-Port New Trace Measure (S11 - S55)

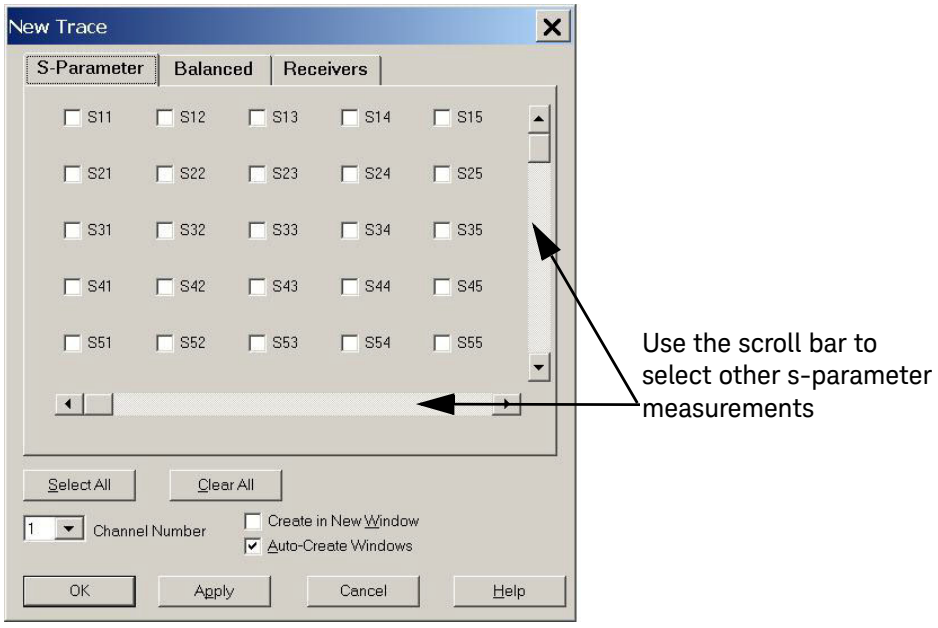
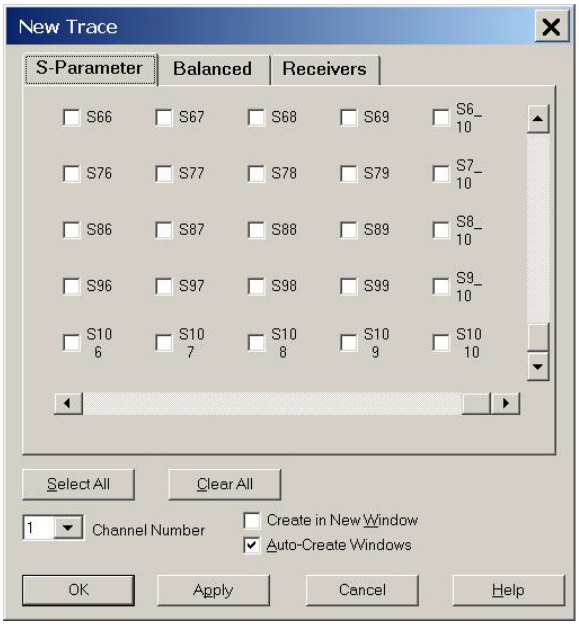


Figure 39 10-Port New Trace Measure (S88 - S1010)

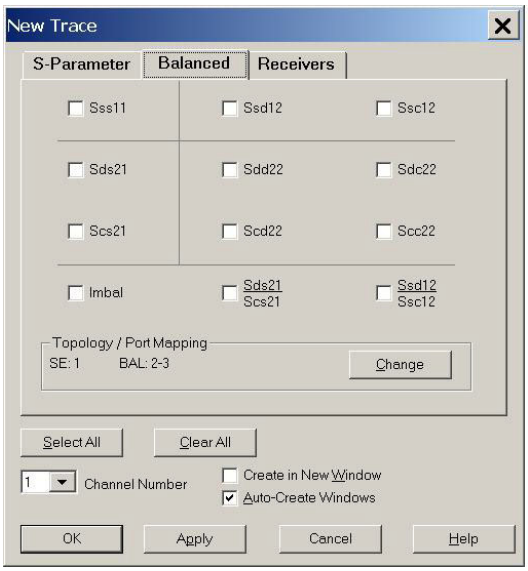


Balanced Tab

Balanced Measurements can be configured by selecting the Balance tab in the **New Measurement** menu.

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

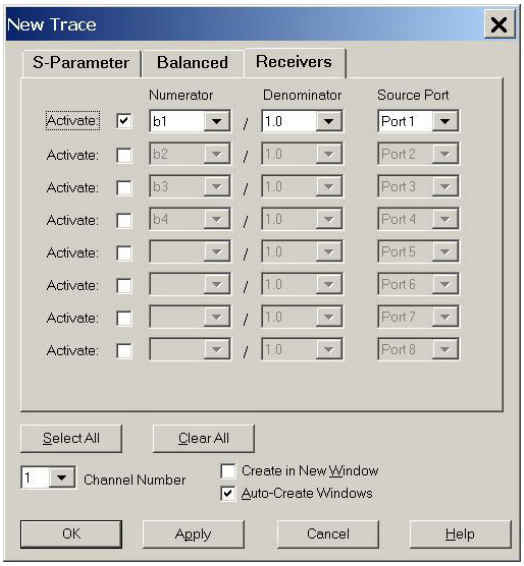
Figure 40 Selecting Balanced Measurements



Receivers Tab

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

Figure 41 Receiver Measurements

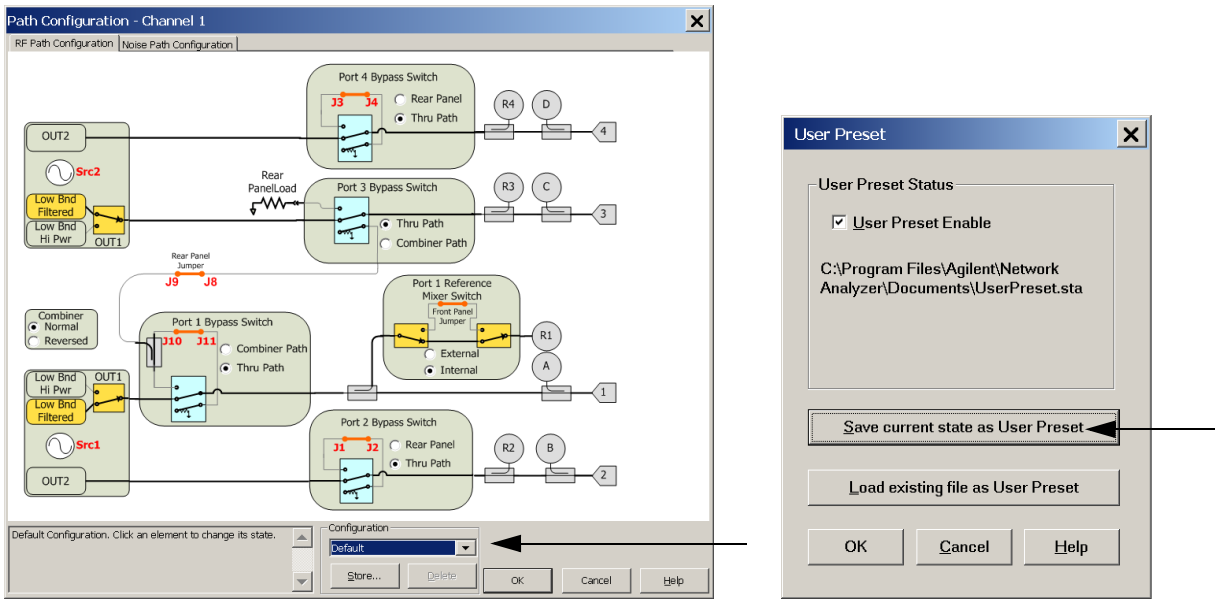


RF Path Configuration with Option 029

If the analyzer has Option 029 or H29 (noise figure capability) verify that the path configuration is set to Default. If it is not in Default configuration, Port 5 will not operate correctly.

1. 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 analyzer will return to Option 029 path configuration.
2. Verify that the Port 1 Noise Tuner Switch is set to external. Select **Utilities System**> **configure** > **Preferences**. If not, select **Meas: Port 1 Noise Tuner Switch is set to external**.

Figure 42 RF Path Configuration



N-Port Calibration

It is recommended that you perform an ECal characterization to minimize the connections required for multiple port calibration. The N4691B Option M0F is recommended with cable (85133F) if you are calibrating directly on the analyzer and Test Set ports.

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

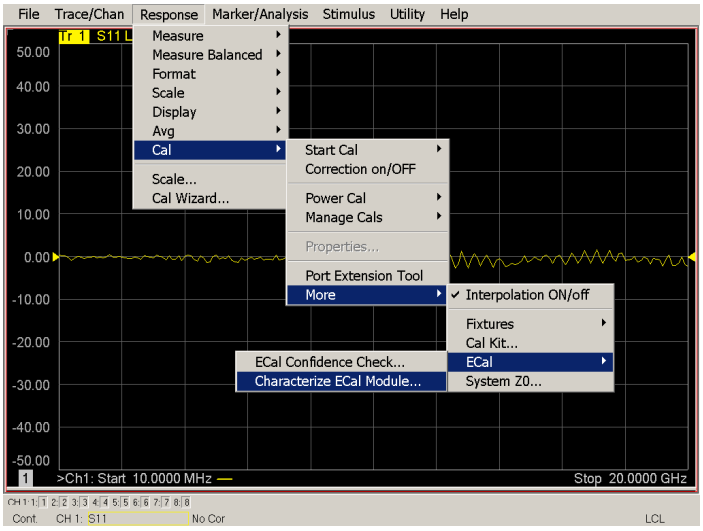
Calibrate at the end of the test port RF cables and any adapters that are used to connect the DUT. This removes the effect on the measurement of the DUT. Failure to do this will create ripple and other measurement errors.

NOTE

If measurement errors occur, ensure the newest version of firmware is installed on the 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 at http://na.support.keysight.com/pna/firmware/firmware.html

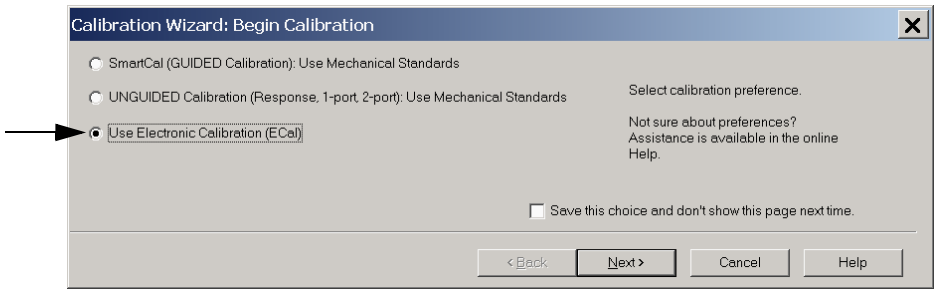
1. To perform an ECal characterization select **Response** > **Cal Wizard** > **Characterize ECal Module** and follow the prompts.
2. Save the ECal characterization file. Refer to the Help menu for characterizing information.

Figure 43 ECal Characterization and Calibration Wizard



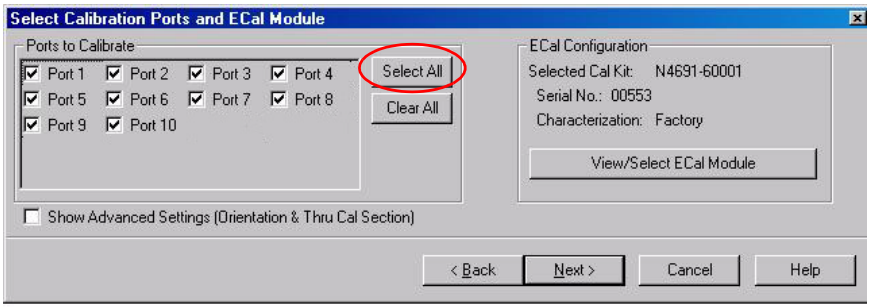
3. On the analyzer select **Response** > **Cal Wizard**.
   a. If using a mechanical cal kit, select **SmartCal (Guided Calibration)** > **Next**.
   b. If using an ECal module, connect the ECal to an available USB port and select **Use Electronic Calibration (ECal)** > **Next**.

Figure 44 Begin Calibration



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

Figure 45 8-Port Calibration



5. Connect the ECal or the mechanical cal kit to the ports you are calibrating following the Cal Wizard prompts and click **Measure** after each connection. The electrical delay value may be shown in the dialog box after the last measurement, click **OK**.
6. At the Calibration Completed prompt, select **Save As User Calset**, type the name and **Save**. See Figure 55 on page 67.
7. After calibrating Test Set ports, use a quality load and short to verify the calibration on each port or end of the test cable. Measure reflection and confirm the return loss is as expected. If the result is not as expected, repeat the calibration without the Test Set and ensure that the analyzer is in standard (non-multiport) mode.

NOTE

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

Interface Control Mode

NOTE

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

Overview of the Interface control

The Interface Control feature allows you to send data and remote commands to control external equipment using the GPIB, Handler I/O, Test Set I/O, Dwell After Command and Aux I/O without the need of an external computer. Refer to analyzer's Help menu, "Rear Panel Tour" and "Interface Control."

- A unique set of control data can be sent for each channel. In addition, a unique set of control data can be sent before the channel sweep starts and after the sweep ends.
- Interface Control settings can be saved and recalled from the "Interface Control" dialog box or with Instrument State Save and Recall.
- Interface Control settings can be copied to other channels using Copy Channels.
- Control data can only be WRITTEN to the interfaces, NOT READ from the interfaces.
- Control data is sent in the following order and this order cannot be changed: Refer to the Help menu.

1. GPIB Commands - BEFORE
2. Handler I/O Control
3. Test Set I/O Control (addr.data)
4. Dwell After Command
5. Aux I/O Output Voltage

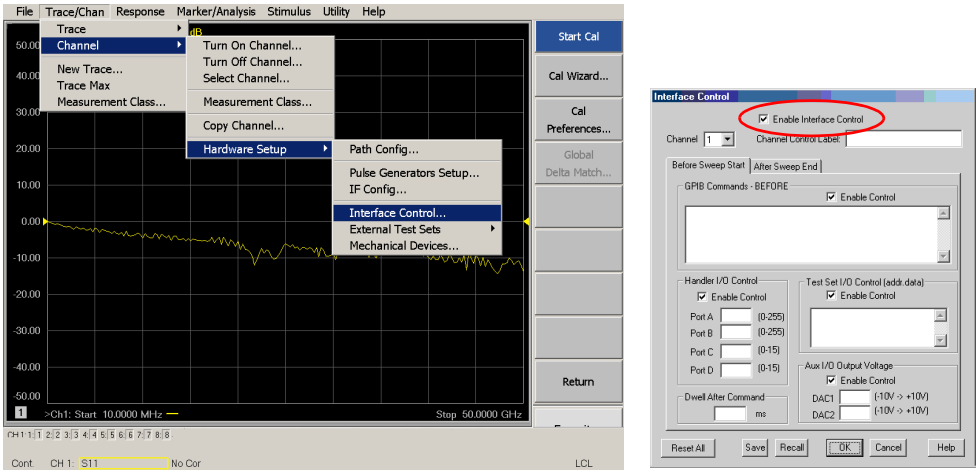
How to Access Interface Control Mode

1. To access the Interface Control mode, select **Trace/Chan** > **Channel** > **Hard ware Setup** > **Interface Control** in the drop-down menu, and select **Enable Interface Control**. If you are using an E8362B, select **Channel** > **Interface Control** in the drop-down menu, and select **Enable Interface Control**.

NOTE

The analyzer includes the Interface Control application and rear panel connection. Please review this application before connecting the Test Set to the Network Analyzer. Information regarding this application can be found in the Help menu, Interface Control.

Figure 46 Interface Control

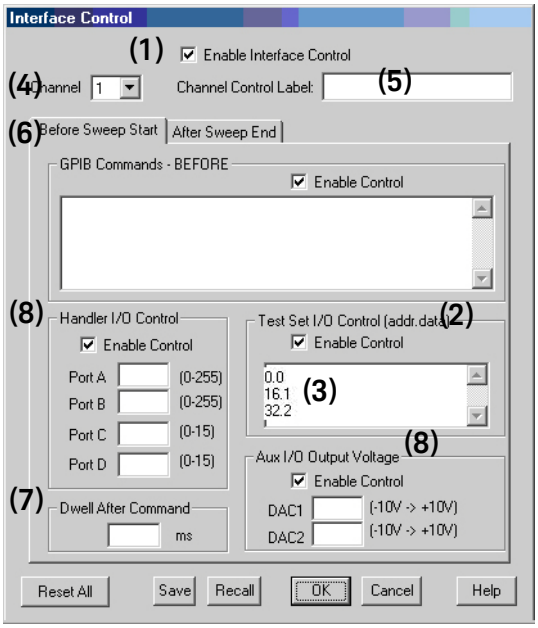


Using Interface Control Mode

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

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

Figure 47 Interface Control



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

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

Only positive integers are allowed to select switch positions or states of DUT control interface lines. Refer to "Address and Data Values" on page 56.

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

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

0.0
16.1
32.2

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

GPIB Control Mode

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

Overview of the GPIB Control

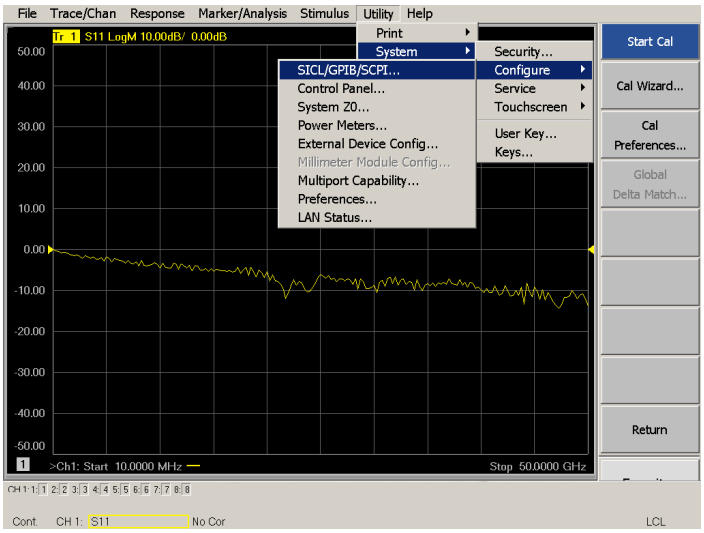
The GPIB Command Processor allows you to send address and data to control an external Test Set without creating a remote program. This allows you to control the Test Set without Option 551, or in non-standard measurement classes, such as Scalar Mixer/Converter, Swept IMD, Noise Figure Cold Source, etc. The user is required to manually input address and data using the GPIB Command Processor Console in the Help menu.

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

How to Access GPIB Command Processor

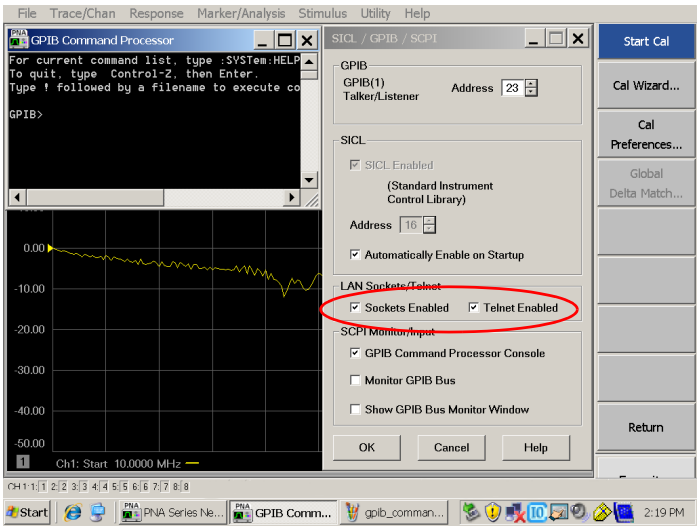
1. To access the GPIB Command Processor select **Utility** > **System** > **Configure** > **SICL/GPIB/SCPI**.

Figure 48 Utility Configure



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

Figure 49 GPIB command Processor



GPIB Command Processor Console

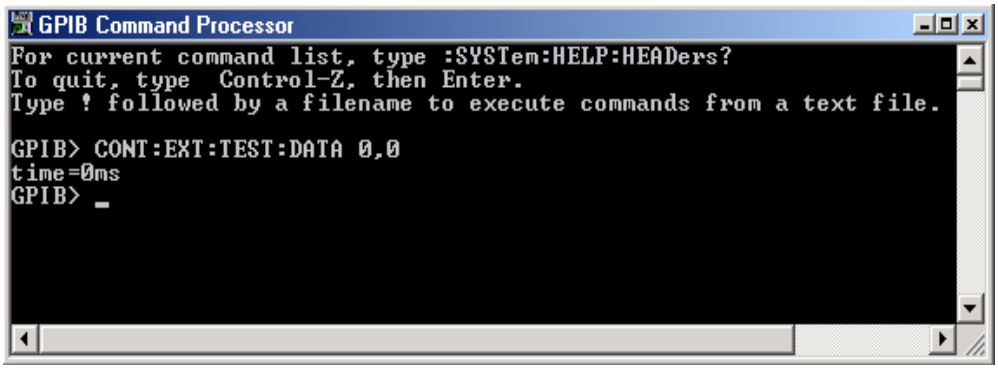
Write Commands: Once the GPIB Processor console is open, commands can remotely control the external Test Set I/O connector by sending the following:

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 56.

Address and Data Values

Setting the Test Port Paths with Address and Data

Refer to Table 12 and Figure 50 on page 57 for information to set the internal switch paths of the Test Set.

The address is the first value in the Test Set I/O control or GPIB data command. The second value controls the source and receiver paths of the ports. To select a Test Set port configuration both switches must be set to complete the source and receiver paths. To do this you must add the data values together to determine the data command value for each port, which is the second number in the Test Set I/O or GPIB command. Refer to "Interface Control Mode" on page 50 and in "GPIB Control Mode" on page 54.

Example 1: Refer to Figure 50 on page 57.

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

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

Source Port 3 = address 0, data 2 and Receiver Port 7 = address 0, data 128. The data values are added together, the entry will be 0.130.

Example 2: If the ports have two different addresses data commands, two separate commands must to be sent, you may use the same dialog box.

Port 1 is the Source and Ports 4 is the Receiver.

Source Port 1 = address 0, data 1 and Receiver Port 4 = address 16, data 32. The data entry will be 0.1 in one command line, and 16.32 in the second line.

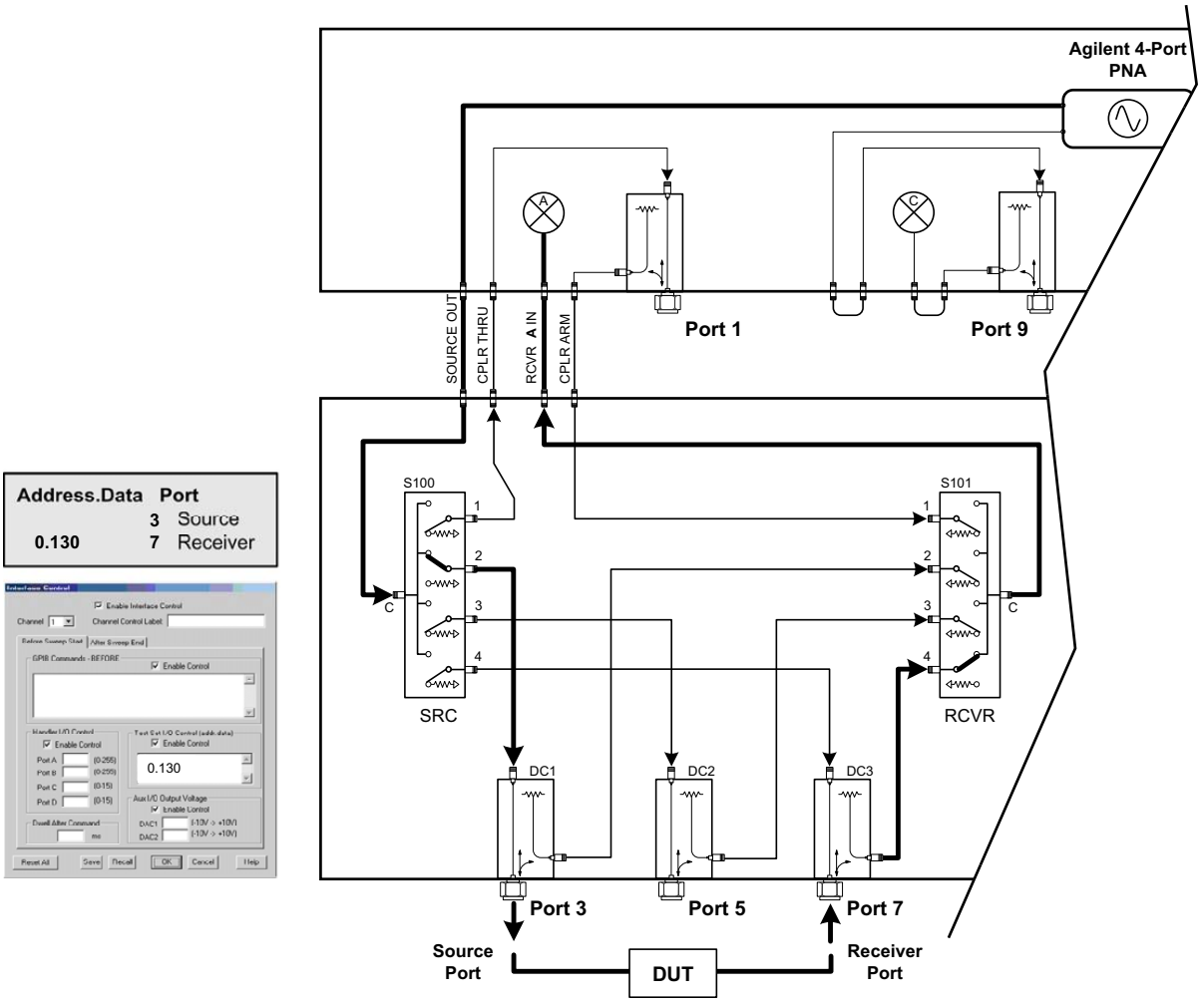
Table 12 Test Port Address and Data Values[a]

Address		Source Path				Receiver Path			
	Data	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**
0	Ports	1	3	5	7	1	3	5	7
16	Ports	2	4	6	8	2	4	6	8

a. 4-Port network analyzers provide Ports 9 and 10. These ports do not utilize the Test Set switch paths, therefore they do not have address data values.

Refer to "System Block Diagram" on page 75 for in-depth RF path information.

Figure 50 Example 1; Address and Data (Port 3 and 7)



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 Feature” on page 43 and “Setting the Control Lines with Address and Data Values” on page 62. See Table 13 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 52 on page 60 and Table 14 on page 59 for control line pin location and description. Refer to “Internal Voltage Supply Configuration” on page 60 and “External Voltage Supply Configuration” on page 61 for configurations.

Table 13 DUT Control Specifications

Item	Specifications
Connector Type	15–pin female D–Sub
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 51 DUT control Line Pin Assignment (rear panel view)

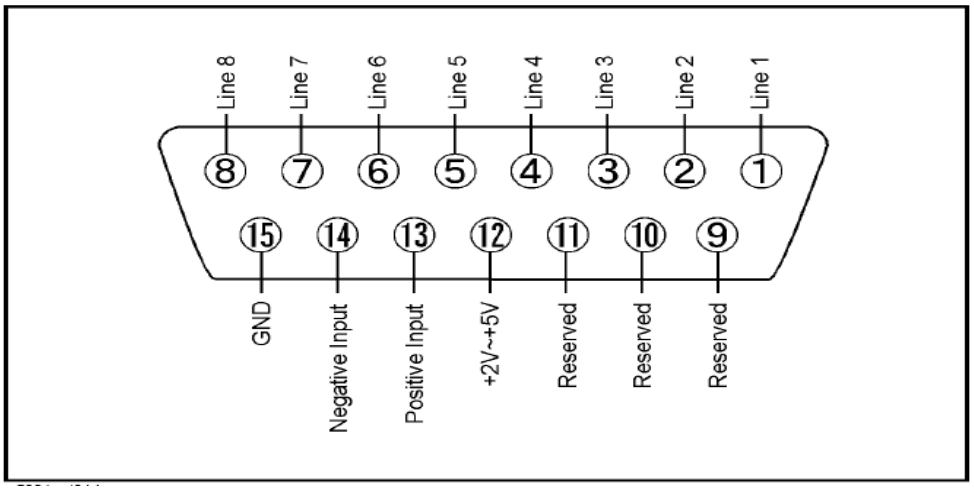


Table 14 DUT Control specifications

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

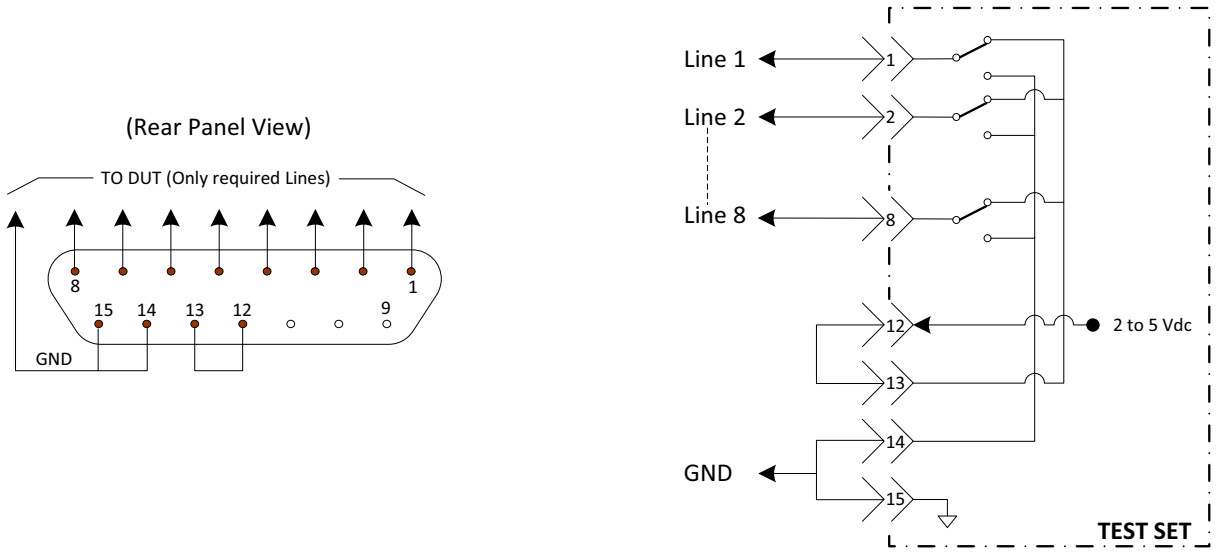
The output voltage of pin 12 can be adjusted from +2 to +5 V. Perform the following procedure to set the voltage:

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 52 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 52 Internal DC Power Configuration (rear panel view)



External Voltage Supply Configuration

Figure 53 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.

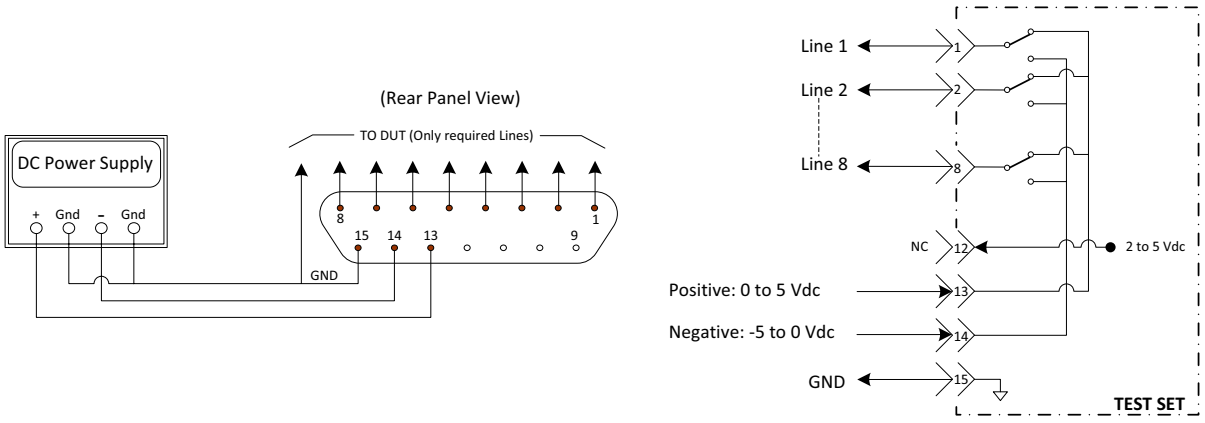
Turning On the Test Set using an External Power Supply.

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

Turning On 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 53 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 analyzer is in Standalone Mode.

Setting the Network Analyzer 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 56, the <address>.<data> values are determined in a similar manor, with the following exceptions:

- Table 15 will be used.
- The <address> value is always = 112

Table 15 Test Set DUT Control Address and Data Logic Table

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

After a power reset all DUT control lines are initially configured to a logic high state or connected to Pin 13, refer to Figure 52 on page 60. To reset all control lines to logic high, without having to reset the power switch on the Test Set, make the following analyzer entry:

Front panel 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 51 on page 59 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 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 analyzer Interface Control Mode line entry = 112.6 > OK.

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

Cal Kit Operational Check

The following procedure can be used to confirm that the Test Set and analyzer are operational. The operation verification limits provided ensure that your Test Set and analyzer are operating properly within the limits. Refer to "General Specifications" on page 12.

Equipment Required

The Test Set requires that the user be familiar with the equipment and components listed in Table 16.

This section provides an equipment list and setup of the analyzer and Test Set.

Table 16 Equipment Required

Description	Qty
N4691A 3.5 mm ECal Module 10 MHz to 26.5 GHz (Option 00F or M0F) *or* N4691B 3.5 mm ECal Module 300 kHz to 26.5 GHz (Option 00F or M0F) *or* Mechanical cal kit 85052B or 85052D	1
N5230C 4-Port Network Analyzer (Option 245 and 551) *or* N5222A, N5232A or N5242A Option 400 and 551 *or* E8362B/C 2-Port Network Analyzer (Option 014 and 551)	1
Set of interconnect cables (analyzer and test set), see "RF Interface Cable Connections (U3021-60043)" on page 30, "RF Interface Cable Connections (U3021-60045)" on page 28, "RF Interface Cable Connection (U3021-60046 or U3021-60047)" on page 32 or "RF Interface Cable Connection (U3021-60050)" on page 34	1

Verification Limits

Typical performance is based on 1 to 2 units, refer to Table 17. 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.

Table 17 Reflection Tracking Limits[a]

Frequency	Standard Port 1- 8[b]	Option 001 or 002 Port 1-8
10 MHz to 4 GHz	-10 dB	0 dB
4 GHz to 6 GHz	-13 dB	-2.5 dB
6 GHz to 10 GHz	-16 dB	-5.0 dB
10 GHz to 15 GHz	-17 dB	-7.5 dB
15 GHz to 20 GHz	-25 dB	-15 dB
20 GHz to 26.5 GHz	-30 dB	-40.0 dB

a. Reflection Tracking takes into account Source Loss, Receiver Loss, Margin, and analyzer Mixer Cal.
b. A standard unit is one without Options 001 or 002.

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 analyzer if you are performing an Operator's Check. The analyzer will indicate false failures if the Test Set is connected.

NOTE On a 10-Port configuration Ports 9 and 10 are not connected to the Test Set; therefore, only Ports 1 thru 8 are tested.

NOTE If you suspect that your 8 or 10-Port configuration is not operating properly, ensure that all front RF jumper interconnect cables are correctly attached.

Preparing the Network Analyzer

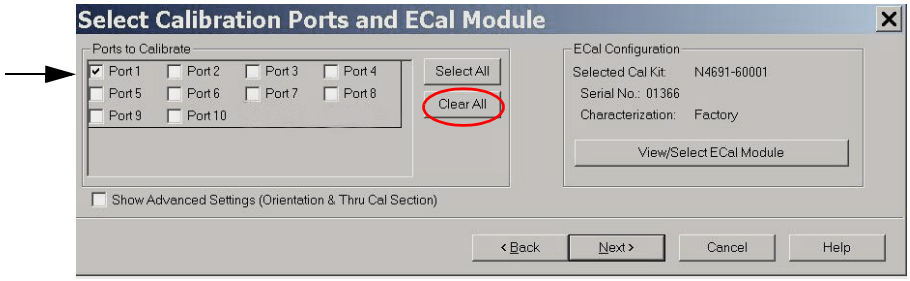
1. Connect the Test Set to the analyzer using the interconnect cables as shown in "Hardware Lock-link Kit Installation (U3021-60001)" on page 19 and "Hardware Lock-link Installation (U3021-60002)" on page 22.
2. Turn *on* the Test Set.
3. Select **Response** > **Cal** > **Manage Cals** > **Cal Set**. Delete or rename any Cal Sets titled "999.1" thru "999.8" (8-Port), although it is unlikely that you will find Cal Sets with these names.
4. Verify that the 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**. Select **Restart as multiport PNA with this testset** and select **U3022AE06** (8-Port) from the drop-down menu > **OK**. Refer to Figure 34 on page 42.
5. Press **[Preset]**.
6. Verify that the **[Start Frequency]** is set to **[10 MHz]**.
7. Set the **[Stop Frequency]** is set to **[26.5 GHz] or [UpperFreq]** limit for your analyzer.
8. Select **[Power]** > **Power Level** and enter **[0 dBm]**.
9. Select **Response** > **Avg** > **IF Bandwidth** > **100 Hz** > **OK**. If you are using an E8362B, select **[Sweep Setup]** > **Bandwidth** > **[100 Hz]** > **[Enter]**.
10. Select **Stimulus** > **Sweep** > **Number of Points** > **401**. If you are using an E8362B, select **[Sweep Setup]** > **Points** > **[401]** > **[Enter]**.
11. Connect the ECal module to an available USB port on the front or rear panel of the analyzer. This procedure assumes you are using a ECal. If you are not, see "1-Port Calibration and Verification Procedure" on page 67, step 2.

Allow the ECal module, Test Set and analyzer to warm up for a minimum of 30 minutes.

1-Port Calibration and Verification Procedure

1. Connect the ECal or the mechanical cal kit to Port 1 or the port you are testing. Torque to 8 in-lb. For further information refer to the Help menu.
2. Perform a 1-Port Calibration on Port 1. On the analyzer, select **Response** > **Cal** > **Start Cal** > **Calibration Wizard**.
   a. If using a mechanical cal kit, select **SmartCal (Guided Calibration)** > **Next**.
   b. If using an ECal module, connect the ECal to a analyzer's USB port. Select **Use Electronic Calibration (ECal)** > **Next**.
3. Continue following the Cal Wizard prompts. In the Select Calibration Ports and ECal Module dialog box click **Clear All**, then select **Port 1** > **Next** > **Measure**.
4. Ensure the Cal Kit you are using is indicated on the right side of the dialog box.

Figure 54 1-Port Calibration

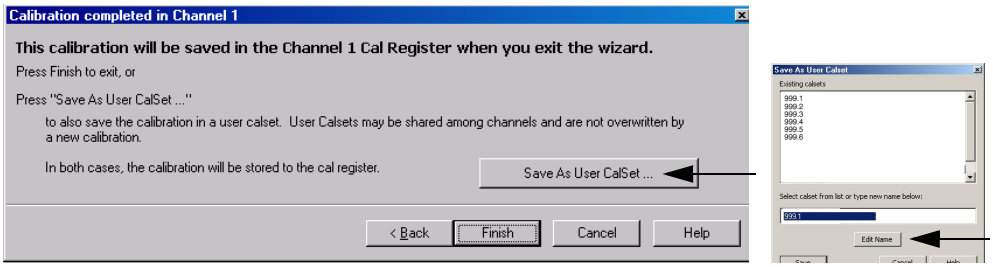


5. Continue to follow the prompts. At the Calibration Completed dialog box, select **Save As User Calset**, type the name **999.1**. Overwrite the Calset if it already exists and **Save**.

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

6. Repeat step 1 thru step 5 for Ports 2 thru 8. When finished, there should be 8 Cal Sets saved with the titles "999.1" thru "999.8" (8-Port).
   If you are using an ECal module you can verify the individual port calibration by selecting **Response** > **CAL** > **More** > **ECAL** > **ECAL Confidence Check**. Select **Change Measurement** and select the test port S-Parameter > **Apply** > **OK** > **Read Module Data**. For further information refer to "ECal Confidence Check" on page 73.

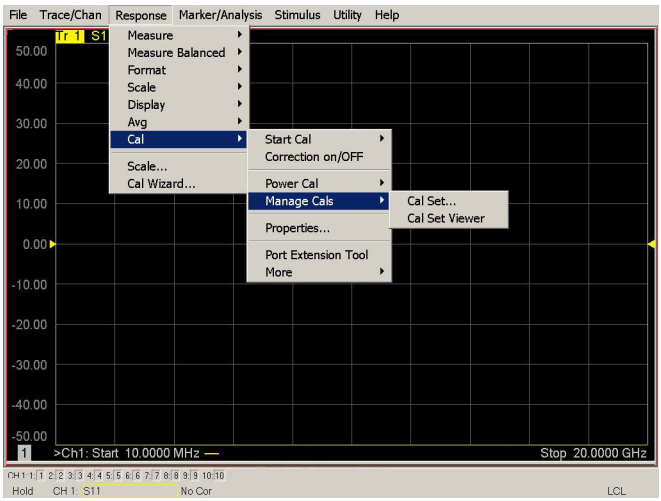
Figure 55 Calibration Complete



Cal Set Verification

1. Select **Trace/Chan > Trace > Delete Trace**. There should be no traces on the display.
2. To launch the Cal Set Viewer toolbar. Select **Response > Cal > Manage Cals > Cal Set Viewer**.

Figure 56 Calibration, Cal Set Viewer



3. From the Cal Sets drop-down menu, select **999.1** and select **Enable**. Select the **Reflection Tracking(x,x),** where x,x is the port being tested. Ensure that the **Enable** and **Error Terms** check boxes are selected.
4. Compare the Reflection Tracking (1,1) trace to the appropriate limits in Table 17 on page 65. The trace should be above the limit.
5. Repeat step 3 and step 4 for Cal Sets "999.1" thru "999.8" (8-Port).

Figure 57 Standard Reflection Tracking with PNA or PNA-X (Ports 1 and 2)

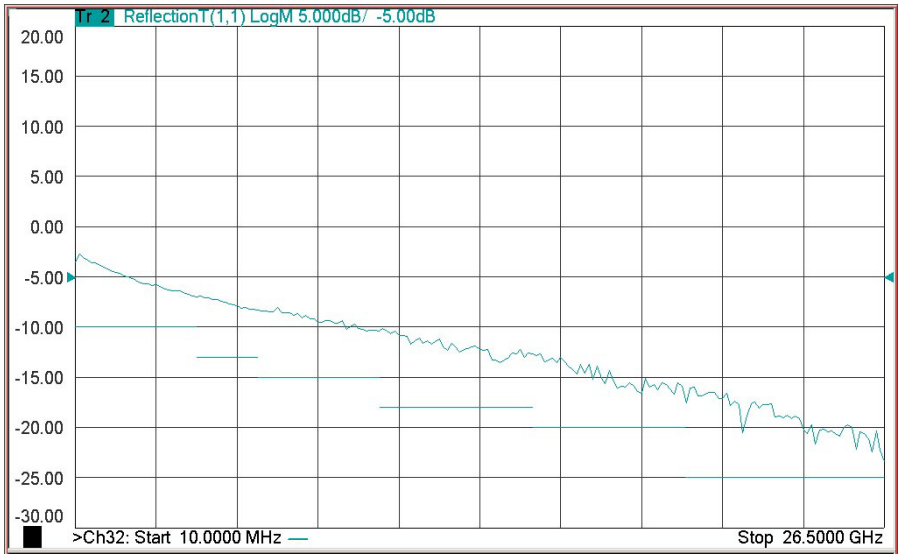
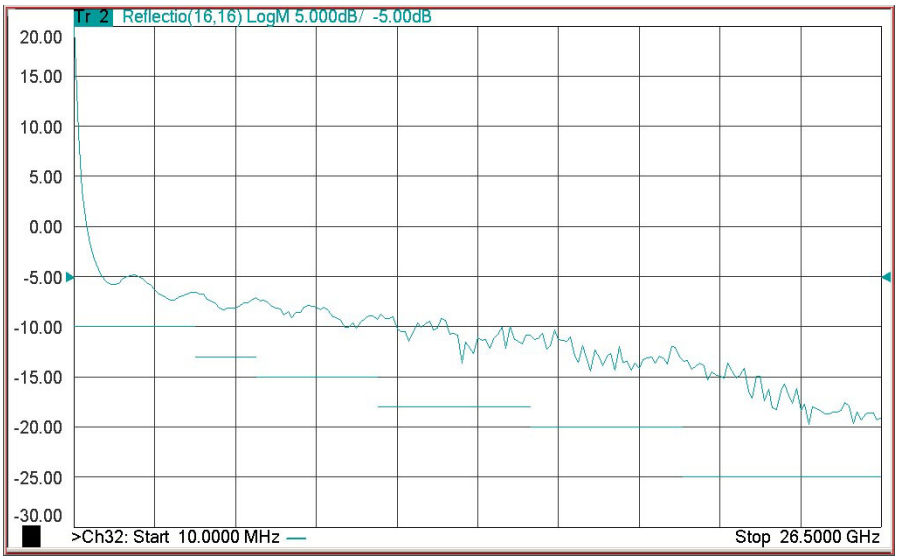


Figure 58 Standard Reflection Tracking with PNA or PNA-X (Ports 3 to 8)



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

Figure 59 Standard Reflection Tracking Trace with PNA-L (Ports 1 to 8)

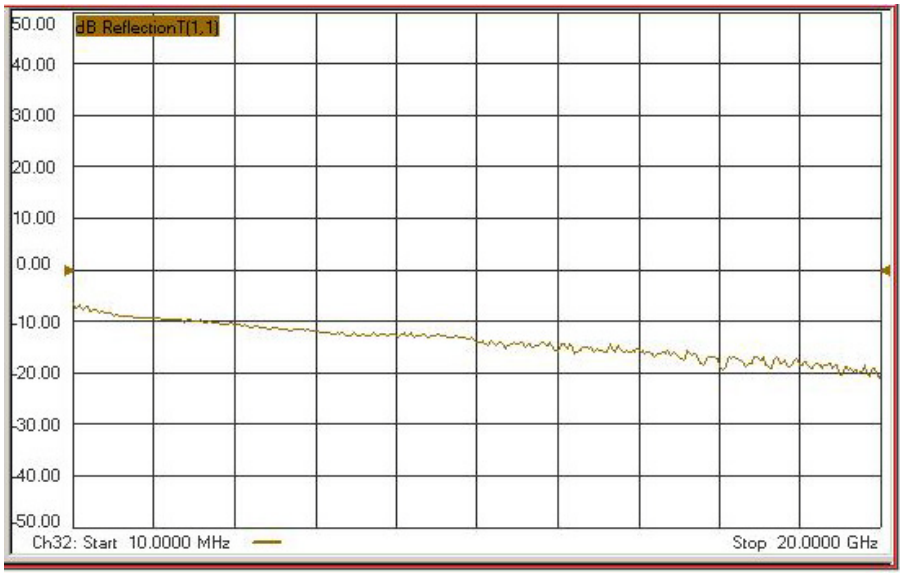
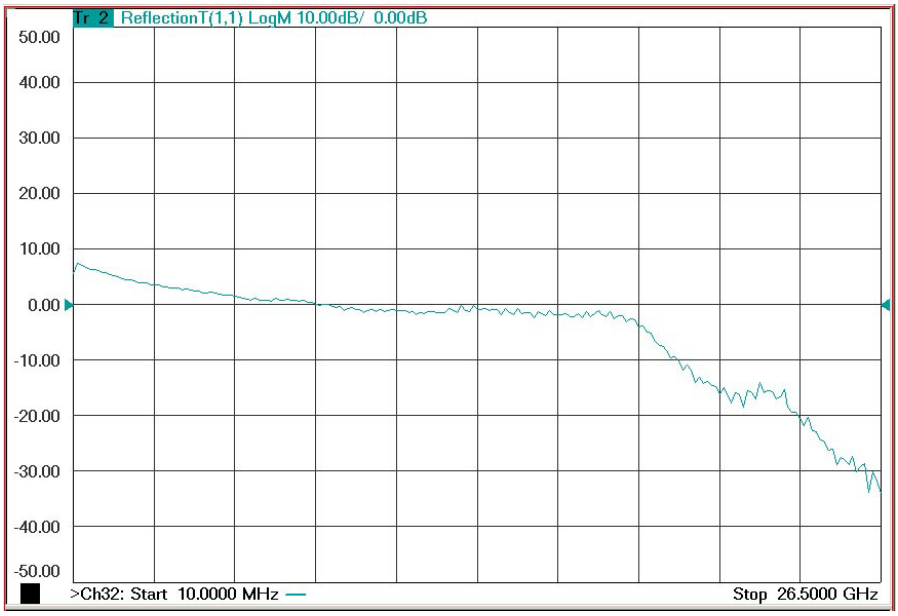


Figure 60 Option 001 or 002 Reflection Tracking Trace with PNA or PNA-X (Ports 1 and 2)



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

Figure 61 Option 001 or 002 Reflection Tracking with PNA or PNA-X (Ports 3 to 8)

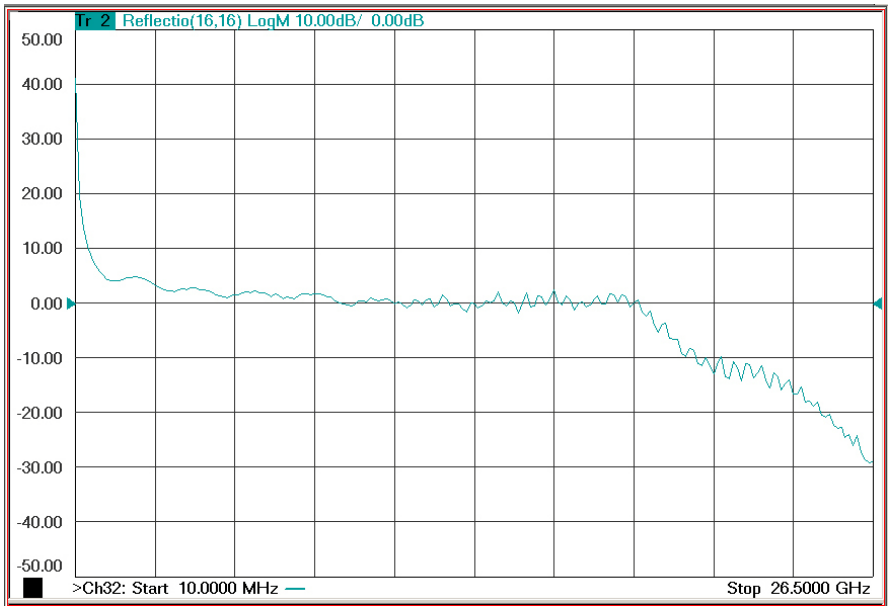


Figure 62 Standard Reflection Tracking with PNA-L (Ports 1 to 8)

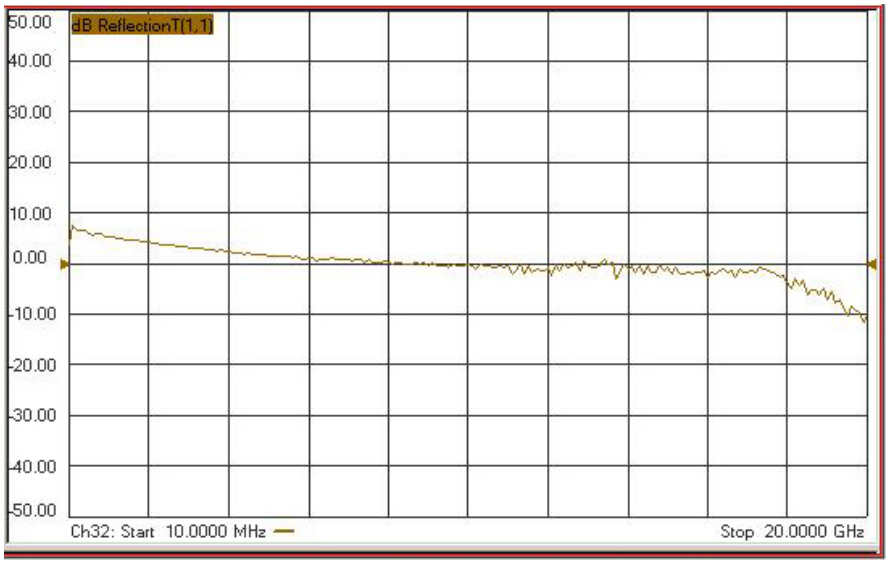


Figure 63 E8362A Standard Reflection Tracking (Ports 1 and 2)

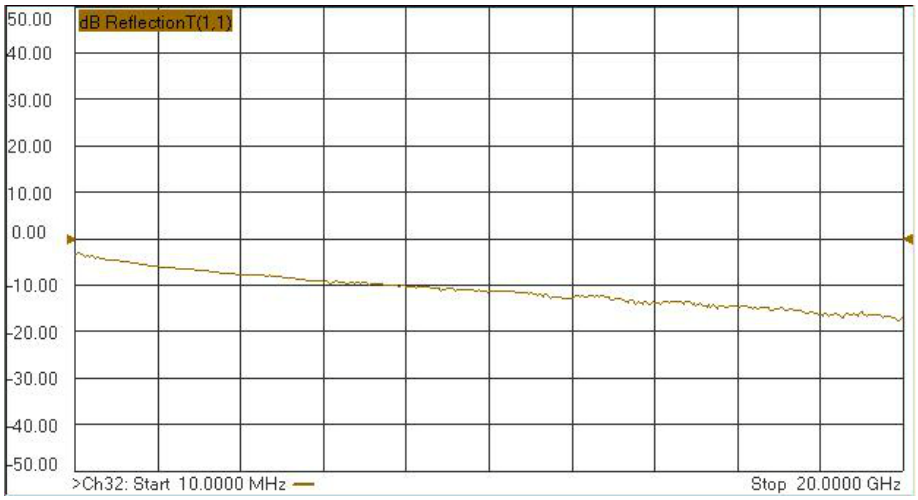
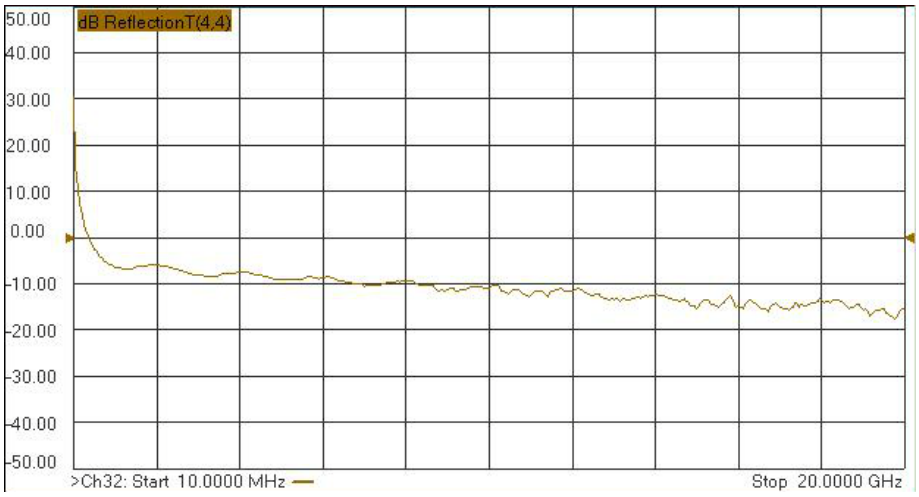


Figure 64 E8362A Standard Reflection Tracking (Ports 3 to 8)



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

Verifying Cal Kit Operational Check Failure

If your test results fail the Cal Kit Operational Check limits, see Table 5 and Table 6 on page 15 and verify the following:

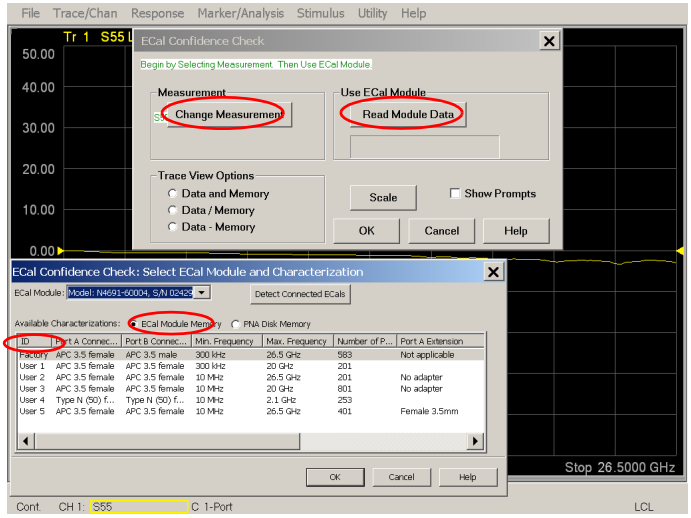
1. Ensure that the Test Set is turned On and connected to the analyzer.
2. Check all appropriate analyzer and Test Set connectors for damage, cleanliness, and proper torque.
3. Repeat the relevant 1-Port calibrations using another ECal or mechanical standard.
4. Verify that the analyzer is operating properly and meeting its published specifications. If the analyzer is connected to the Test Set it will fail the Operational Check. Refer to "Network Analyzer Requirements" on page 9.

ECal Confidence Check

The following procedure 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, **[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. ECal Confidence Check dialog box: Click **Change Measurement** and select the test port S-parameter > **Apply > OK**. Click **Read Module Data**.
6. Select **ECal Module** dialog box: Select the ECal Module you are using, and select the **ECal Module Memory and Factor ID > OK**.

Figure 65 ECal Confidence Check



Service Information

This section provides information to troubleshoot and repair the U3022AE06 Test Set. Refer to "Keysight Support, Services, and Assistance" on page 96 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.**

Replaceable Parts

The following replaceable parts are available from Keysight Technologies.

Table 18 Available Replacement Parts (SPO)

Description	Keysight Part Number
Test Set Locking Feet for a PNA-L	5063-9253
Test Set I/O Cable	N4011-21002
DUT control Board	E5091-66503 *or* U3020-63223 (RoHS)
Fan (rear panel)	87050-60027
Fan (Deck)	87075-60021

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 19 Replacement Parts (E06)

Description	Keysight Part Number
Label (Port 2)	U3022-80002
Label (Port 9)	U3022-80006
Label (Port 10)	U3022-80007
U3022AE06 User's and Service Guide	U3022-90004
LED Status Board	N5261-63005
LED Status Ribbon Cable	N5261-60001
Switch Interface Board	Z5623-63647 *or* Z5623-63998 (RoHS)
Controller Board	N5261-63006
Power Switch and LED	Z5623-60221

System Block Diagram

Figure 66 U3022AE06 Standard Configuration

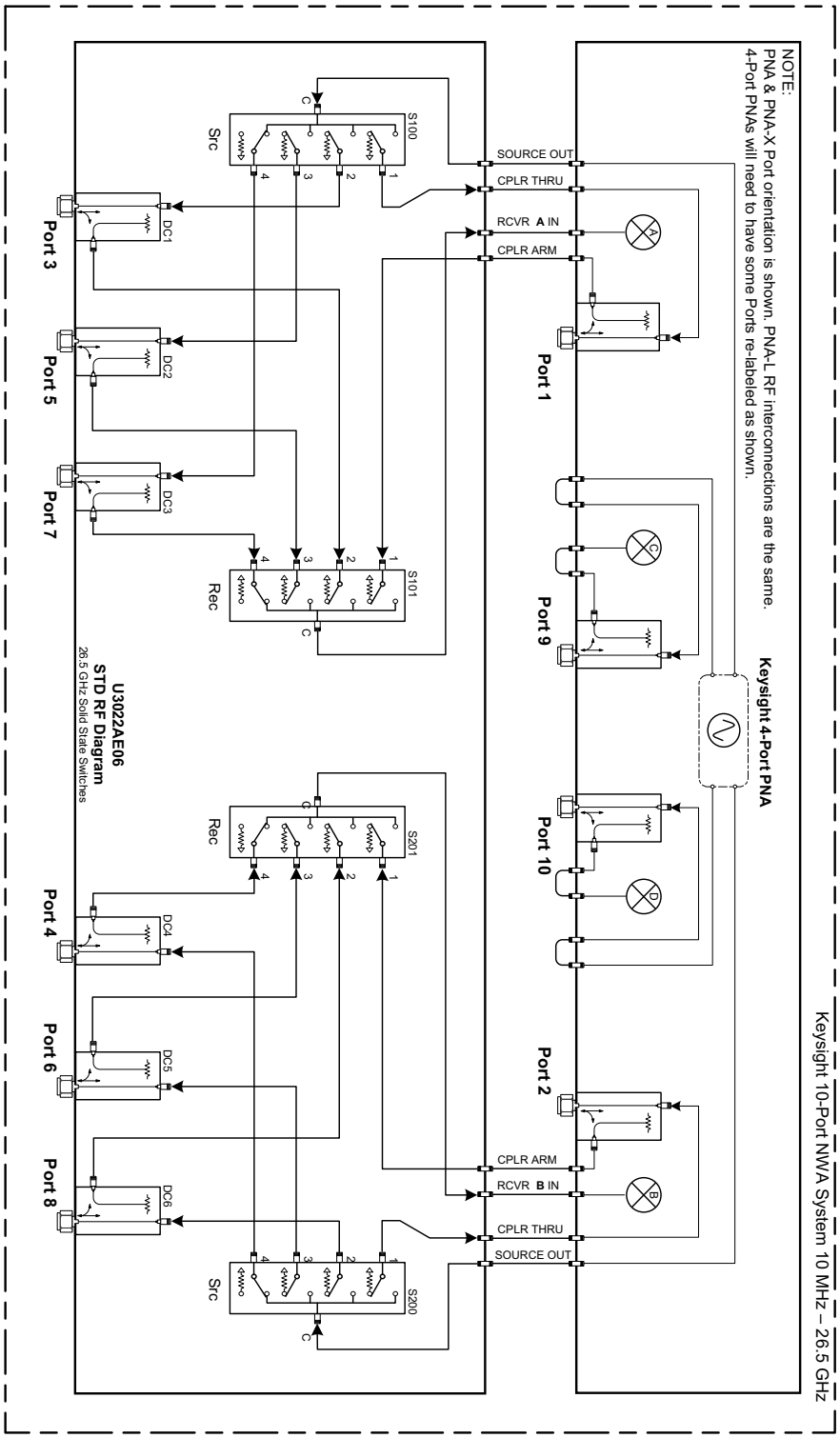


Figure 67 U3022AE06 Option 001 Configuration

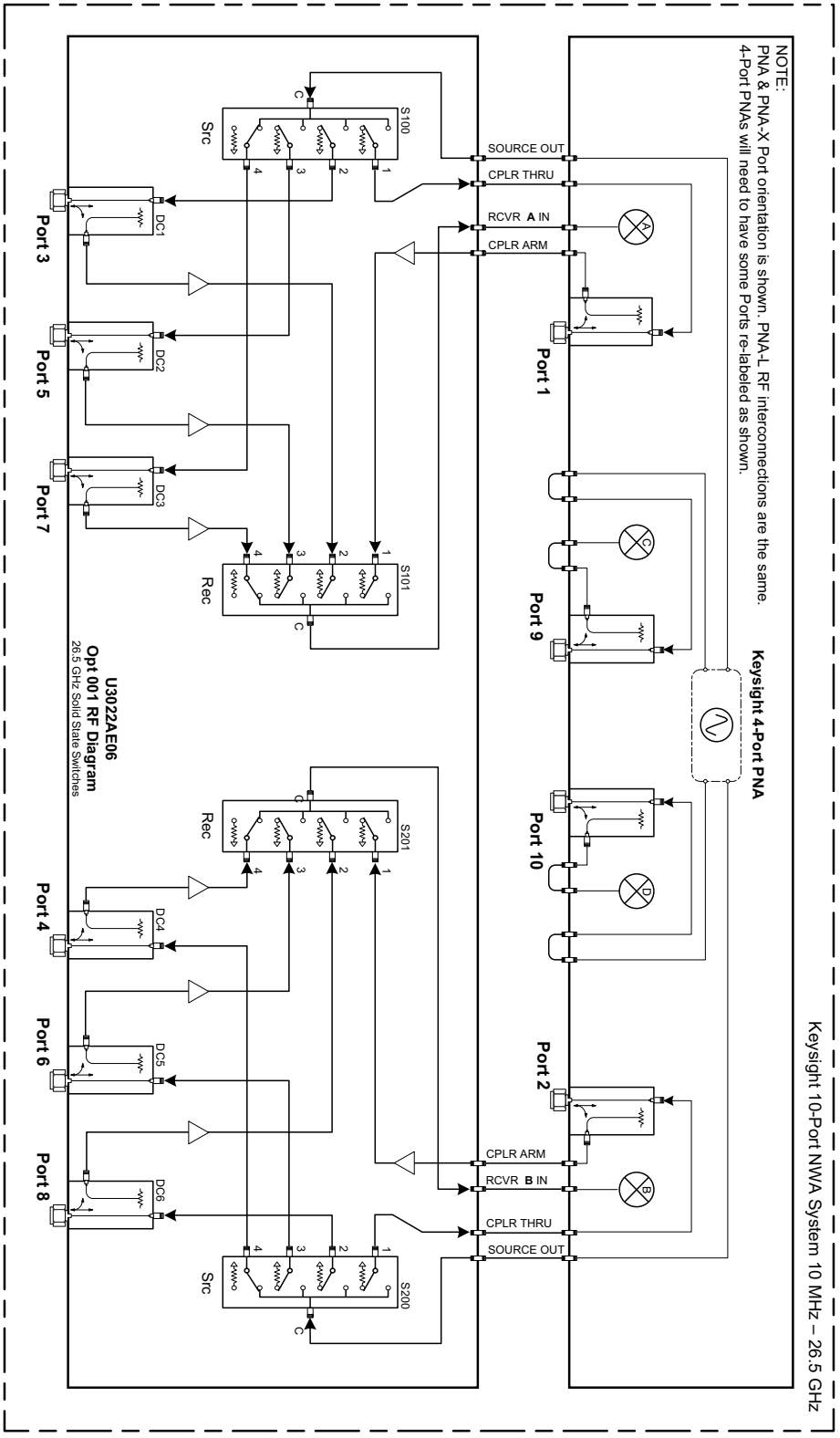
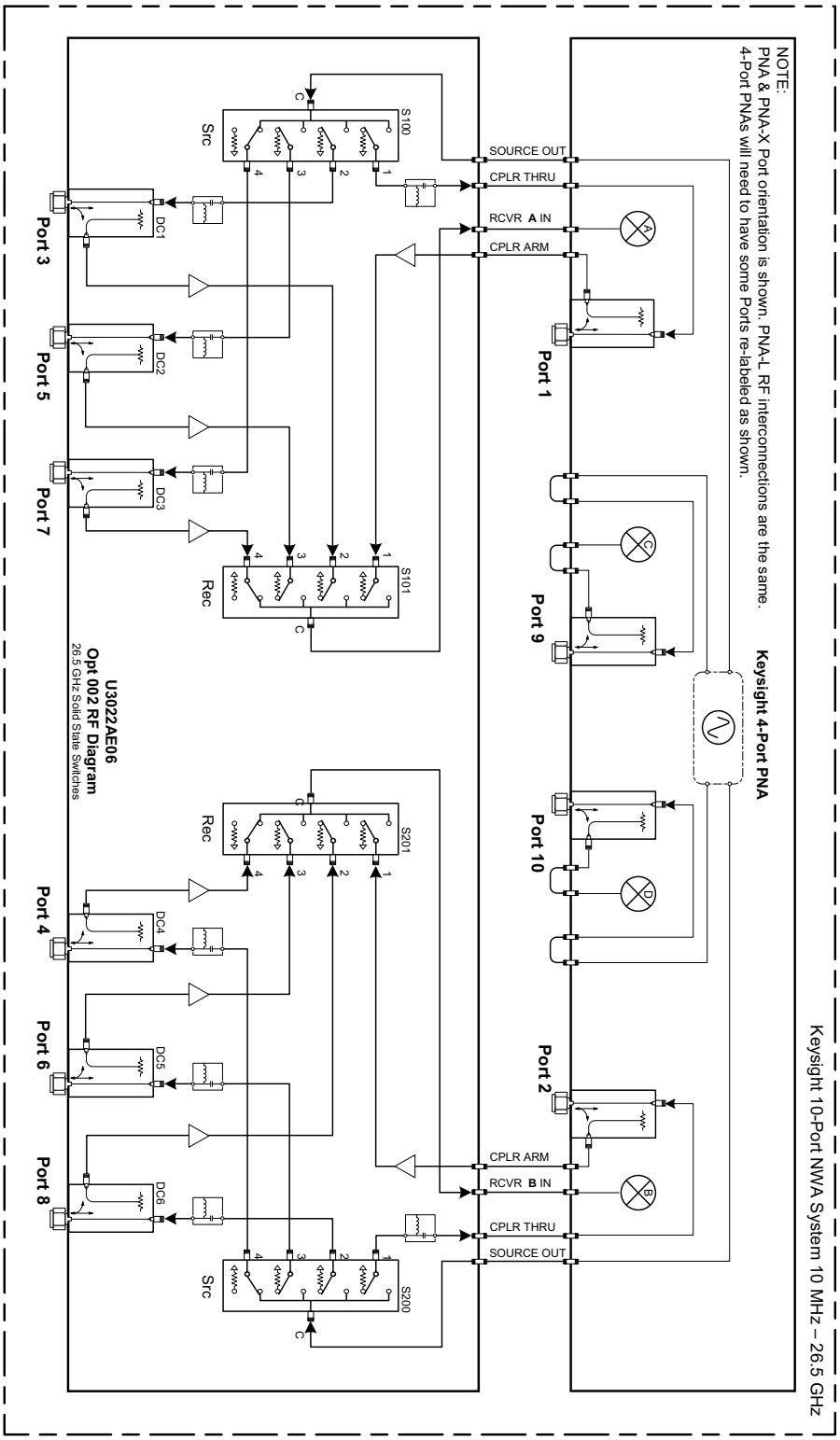


Figure 68 U3022AE06 Option 002 Configuration



Theory of Operation

The following is a description of the operation of the Test Set. Reference the Test Set block diagrams shown in “System Block Diagram” on page 75. This section assumes the user has a general understanding of couplers, switches, and network analyzers.

RF Coupler/Bridges

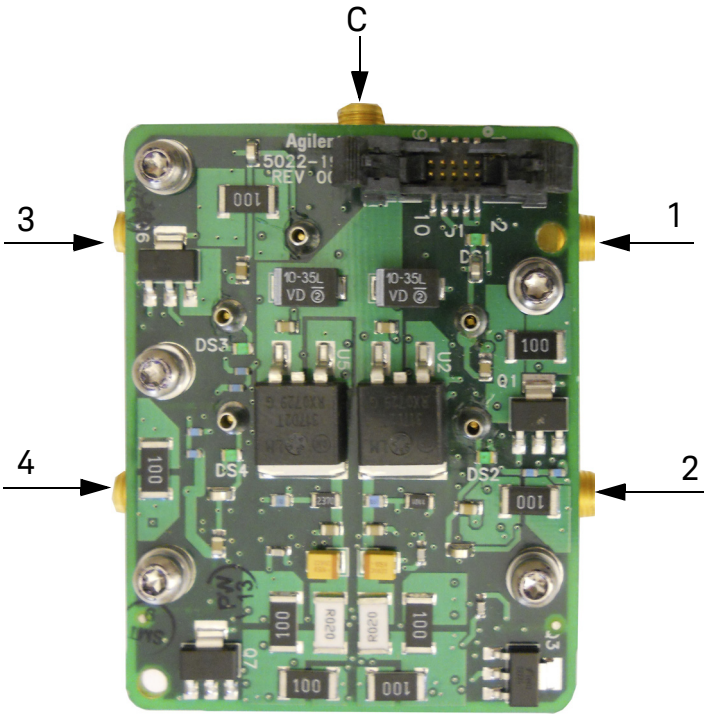
The Test Set uses four coupler/bridges (5087-7716 or RoHS compliant 5087-7752) on the front panel for RF Test Ports 3 to 8. The coupler/bridges provide the signal separation of the source and receiver paths, using resistor networks. The Test Set ports can receive from or stimulate a signal to the DUT.

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

RF Switch Components

The Test Set uses eight solid-state switches (5087-7306 or RoHS compliant 5087-7751) that have internal 50 Ohm termination for each path. The switches select the RF paths from the analyzer’s source and receiver through interconnect cables to the Test Set. Network analyzer Ports 1 thru 2 and Test Set ports paths 3 thru 8.

Figure 69 Switch



Switch Paths

S100 - Source Output to Ports (1, 3, 5 and 7) Switch 100 provides control of the Source Output path to analyze Port 1, 3, 5 and 7 to the Test Set. In the state shown in the block diagram, switch 100 routes the RF Source back to the analyzer Port 1, and the Test Set Source path to Ports 3, 5 and 7 are terminated.

S200 - Source to Ports (2, 4, 6, and 8) Switch 200 provides control of the Source Output path to analyze Ports 2, 4, 6, and 8 to the Test Set. In the state shown in the block diagram, switch 200 routes the RF Source back to the analyze Port 2, and the Test Set Source Output path to Port 4, 6 and 8 are terminated.

S101 - Source to Ports (1, 3, 5 and 7) Switch 101 provides control of the A Receiver path to analyze Ports 1, 3, 5 and 7 to the Test Set. In the state shown in the block diagram, switch 101 routes the Coupler ARM from Port 1 to the A Receiver and all unused Test Set Ports (3, 5 and 7) Coupler ARM path are terminated.

S201 - Receiver to Ports (2, 4, 6 and 8) Switch 201 provides control of the B Receiver path to analyze Ports 2, 4, 6, and 8 to the Test Set. In the state shown in the block diagram, switch 201 routes the Coupler ARM from analyze Port 2 to the B Receiver and all unused Test Set Ports (4, 6 and 8) Coupler ARM paths are terminated.

Troubleshooting the Test Set

If the Test Set is not operating properly, use the following procedures to isolate the problem. It is recommended that a qualified service technician perform the following procedures.

Refer to the Keysight PNA Series: Service & Support Home Page at: http://na.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://keysight.com/find/service.

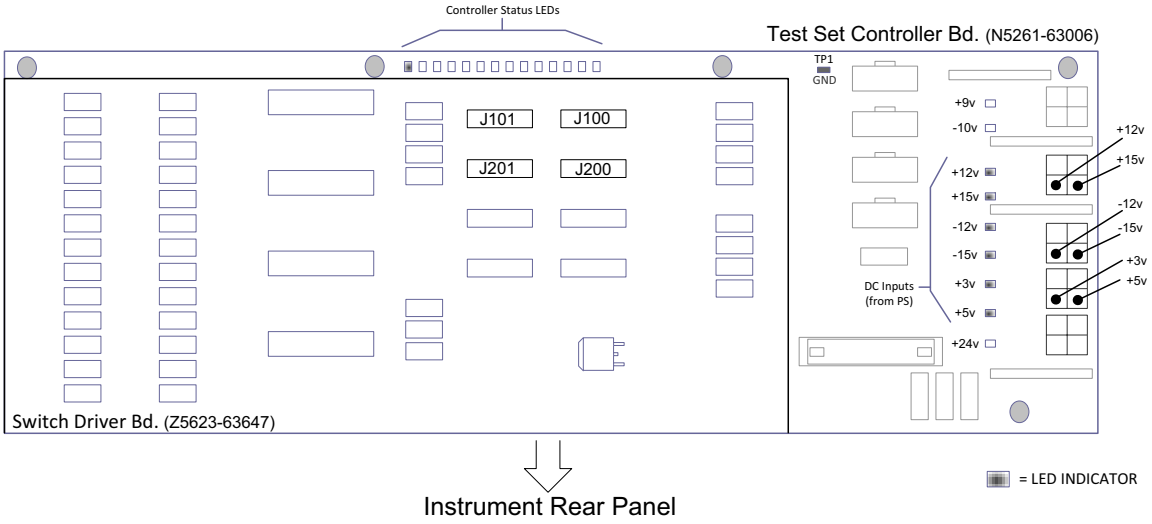
WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

Non-RF Failures

Non RF failures are; Power Supply, Fans, Control Lines, Status LEDs or Interface not operating. Refer to Figure 75 on page 87.

1. Verify that the front panel Power Switch is operational.The front panel Active LED will be *off* unless the Test Set interface cable is connected and the Test Set is addressed by the network analyzer.
2. Turn *on* the Test Set and the analyzer.The rear panel Deck and Internal power supply fans should be operational. If not continue with step 3.
3. AC Line voltage checks (remove AC power from the instrument).
   a. Ensure the proper AC Line voltage is present at the instrument line cord.
   b. Remove the AC power cord from the instrument. Verify the instrument AC Line Module fuse (2119-0709) and replace if necessary. Refer to Figure 7 on page 18.
   c. Verify the Internal AC lines fuse (2110-0342). Remove the instrument bottom cover. Near the rear panel are two fuse holders, verify the fuses and replace if necessary. See Figure 77 on page 89.
4. Internal DC Power checks.
   a. Set the front panel switch to the Standby position. No fans or indicator lights should be operational
   b. Remove the top cover.
   c. Set the Standby switch to the *on* position. Both the rear panel and internal power supply fans should be operational. Verify that the DC indicator LEDs are *on* as shown in Figure 70 on page 81.

Figure 70 DC Power Status LEDs



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

e. If the rear panel or deck fans is not operating and the DC Indicator LEDs are on; replace fan.

5. Front Panel R and S indicator LED Check.
   Verify the Test Set's Controller board Controller Status LEDs, shown in Figure 70 on page 81.

   a. If none are on remove the Switch Driver board and recheck, if still no indication, replace the Controller board.

   b. If the Controller Status LEDs are on and the front panel Active LED is on, suspect the front panel LED boards or the ribbon cables. Replace as needed.

6. Control Lines are not working.

   a. Verify that the control voltage pin connections to the DUT control lines are connected properly. Refer to "Control Lines" on page 58.

   b. Verify that the rear panel DC voltage control adjustment can be set to 5 Vdc. Refer to Figure 6 on page 17.

RF Switching Failures

If the Test Set's RF signal functionality is not operating properly, use the following procedure to aid in isolating the source of problem. The internal RF solid state switches used in this instrument are biased with the +15 Vdc supply voltage and controlled logic signals coming from the Test Set Controller board and Switch Interface board.

1. Place the network analyzer and Test Set side by side (not stacked) and connect the I/O cable (N4011-21002). See Figure 6 on page 17.
2. Ensure that the network analyzer is *not* in Multiport Mode.
3. Using the Test Set I/O Data command values, confirm the correct address and data values are used, refer to "Address and Data Values" on page 56.
4. Verify the solid state switch LEDs.
   a. Each RF solid state switch has a Bias/Logic control board. This board has four port status LEDs. When a switch control signal is created, the switch port status LED will indicate which switch port is being selected. Refer to "RF Switching Path Test" on page 82.
   b. If the LEDs *on* the Switch are *off* when that switch is selected, verify that the ribbon cable is installed on the correct connector on the Switch Interface board. If the connection is correct, substitute a working switch or ribbon cable. Swapping can be performed in this situation.

RF Switching Path Test

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

- Install the Test Set I/O cable from the analyzer to the Test Set's rear panel.
- Remove the front panel RF interface cables and reinstall the analyzer's front panel jumper cables.

Equipment Required

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

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

Equipment Setup

1. Turn *on* the Test Set and the analyzer.
2. **[Preset]** the analyzer and set it to **Standalone Mode**. Select **Utility** > **System** > **Configure** > **Multiport Capability**. In the dialog box select **Restart as a standalone PNA** > **OK**.
3. Confirm the frequency range is set to 10 MHz to 26.5 GHz.
4. Connect the RF flexible cables to Port 1 and 2. Connect the cables together using a 3.5 mm adapter.
5. Configure the analyzer to measure S21 and normalize the response trace.
6. Set the analyzer to **Interface Control Mode**: Select **Channel** > **Hardware Setup** > **More** > **Interface Control**... and click **Enable Interface Control** box.

NOTE

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

Source and Receiver Path Tests

Refer to Table 21 for measuring the S21 response of the Source and Receiver signal paths. The tables indicates RF cable connections as well as Address and Data command for each path test.

Connect the RF cables as indicated in the tables. The expected results should be similar to Figure 71 and Figure 72 on page 85.

Table 20 RF Signal Path Insertion Loss (S21)

RF Path	Signal	Insertion Loss (typical)
Source In to Ports 3-8	Source	Figure 71 on page 85
Source In to CPLR THRU	Source	Figure 72 on page 85
RCVR OUT to Ports 3-8	Receiver	Figure 73 on page 86
RCVR to CPLR ARM	Receiver	Figure 74 on page 86

Table 21 Signal Path Connections and Commands

Path #	RF Path Description	<Addr>.<Data>	Path Components	Response (typical)
Ports 1, 3, 5, & 7				
1	Source IN to Port 3	0.2	P3 CPLR, S100	Figure 71 on page 85
2	Source IN to Port 5	0.4	P5 CPLR, S100	
3	Source IN to Port 7	0.8	P7 CPLR, S100	
4	Source IN to CPLR THRU	0.1	S100	Figure 72 on page 85
5	RCVR OUT to Port 3	0.32	P3 CPLR, S101	Figure 73 on page 86
6	RCVR OUT to Port 5	0.64	P5 CPLR, S101	
7	RCVR OUT to Port 7	0.128	P7 CPLR, S101	
8	RCVR OUT to CPLR ARM	0.16	S101	Figure 74 on page 86
Ports 2, 4, 6, & 8				
1	Source IN to Port 4	16.2	P4 CPLR, S200	Figure 71 on page 85
2	Source IN to Port 6	16.4	P6 CPLR, S200	
3	Source IN to Port 8	16.8	P8 CPLR, S200	
4	Source IN to CPLR THRU	16.1	S200	Figure 72 on page 85
5	RCVR OUT to Port 4	16.32	P4 CPLR, S201	Figure 73 on page 86
6	RCVR OUT to Port 6	16.64	P6 CPLR, S201	
7	RCVR OUT to Port 8	16.128	P8 CPLR, S201	
8	RCVR OUT to CPLR ARM	16.16	S201	Figure 74 on page 86

Figure 71 Source IN to Ports 3-8 Path Response (Std)

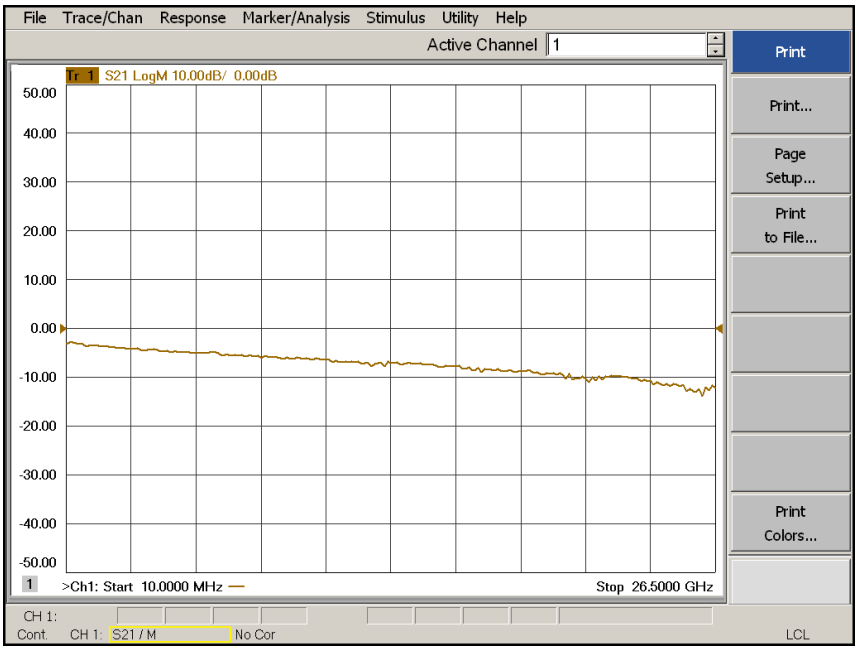


Figure 72 Source IN to CPLR THRU Path Response (Std)

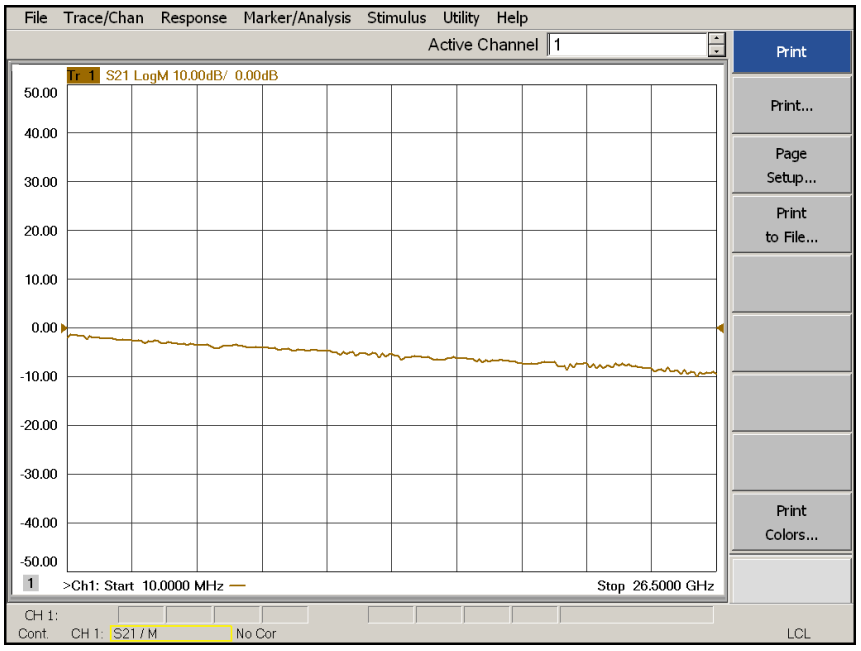


Figure 73 RCVR OUT to Ports 3-8 Path Response (Std)

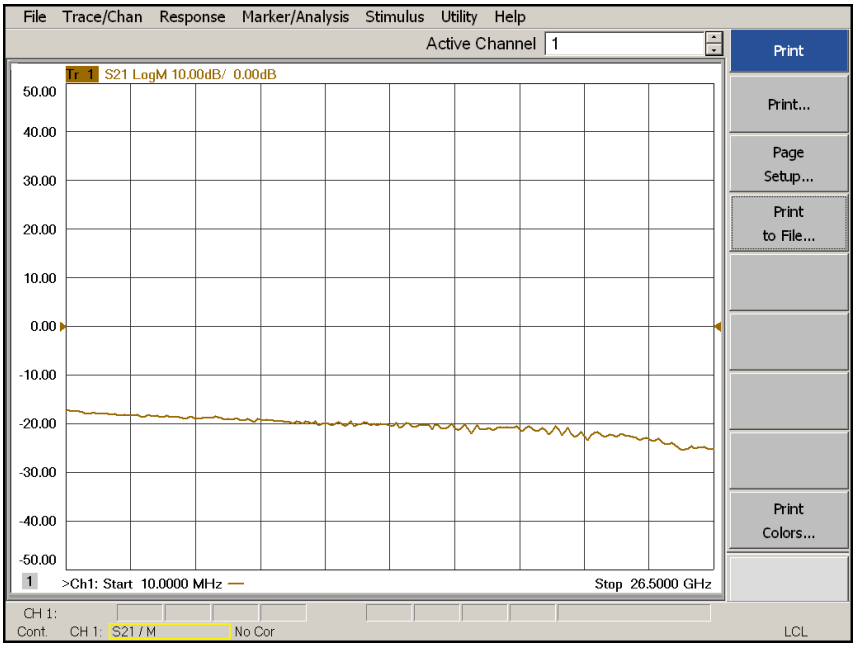


Figure 74 RCVR OUT to CPLR ARM Path Response (Std)

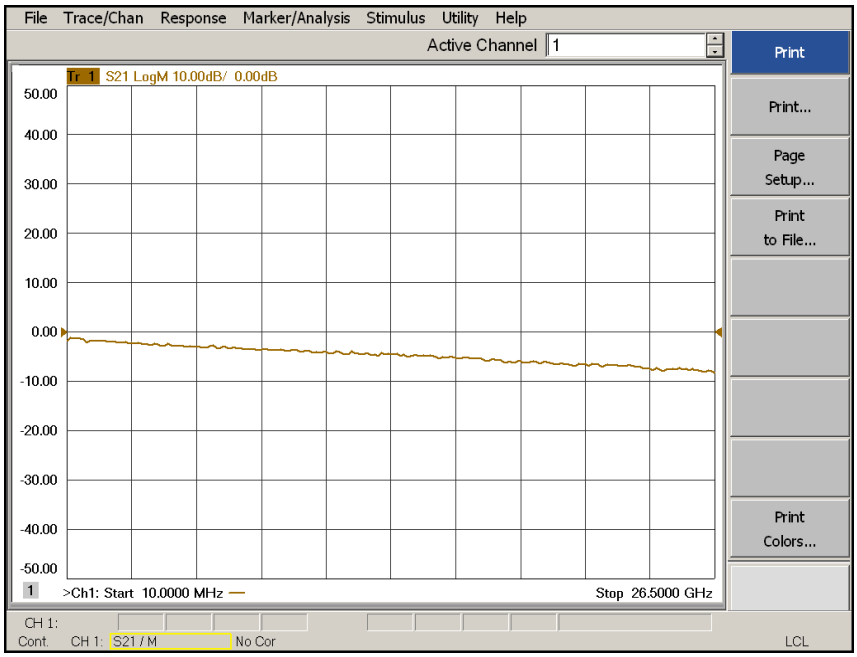


Figure 75 Test Set Diagram

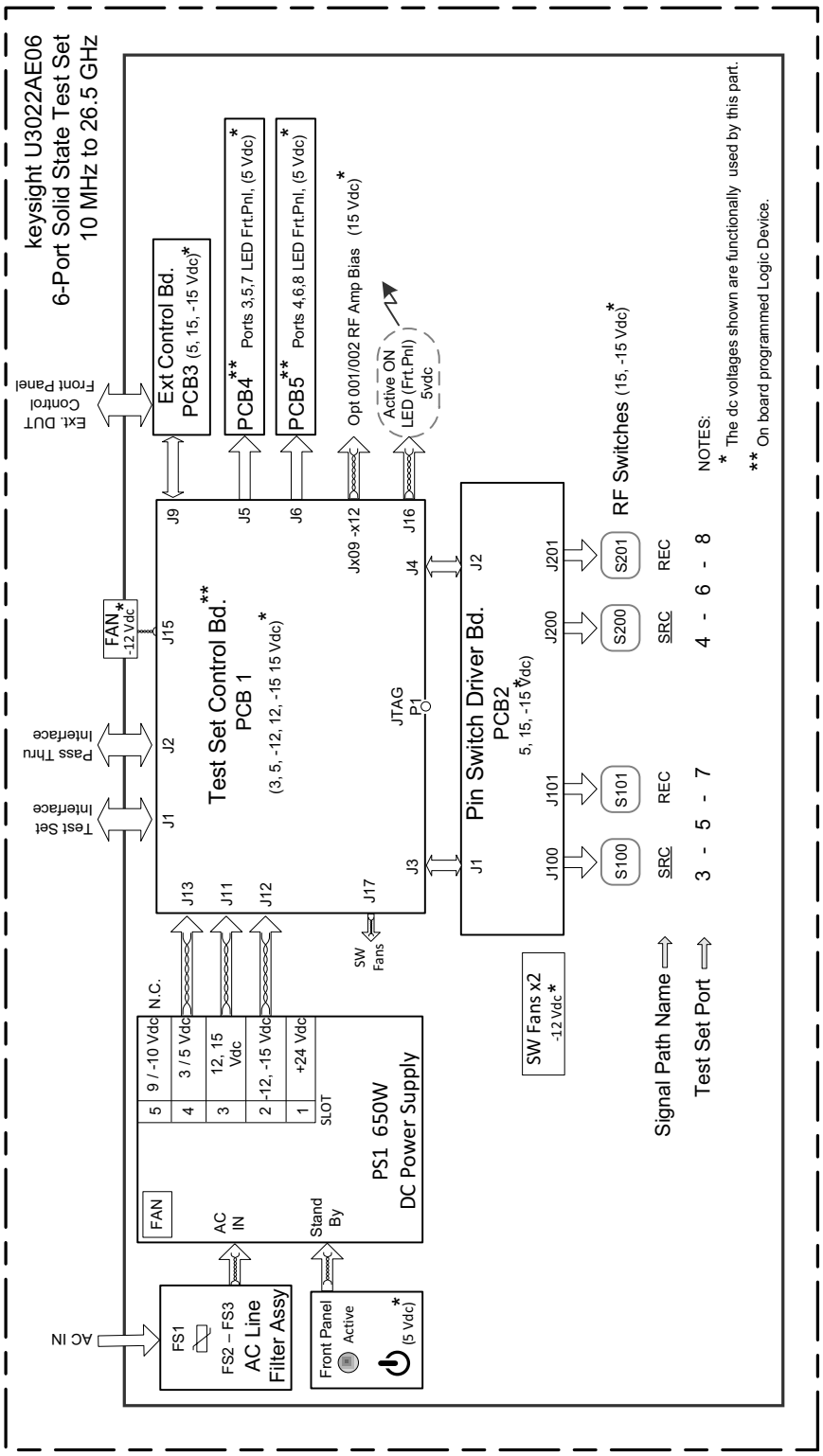


Figure 76 Top View (Std)

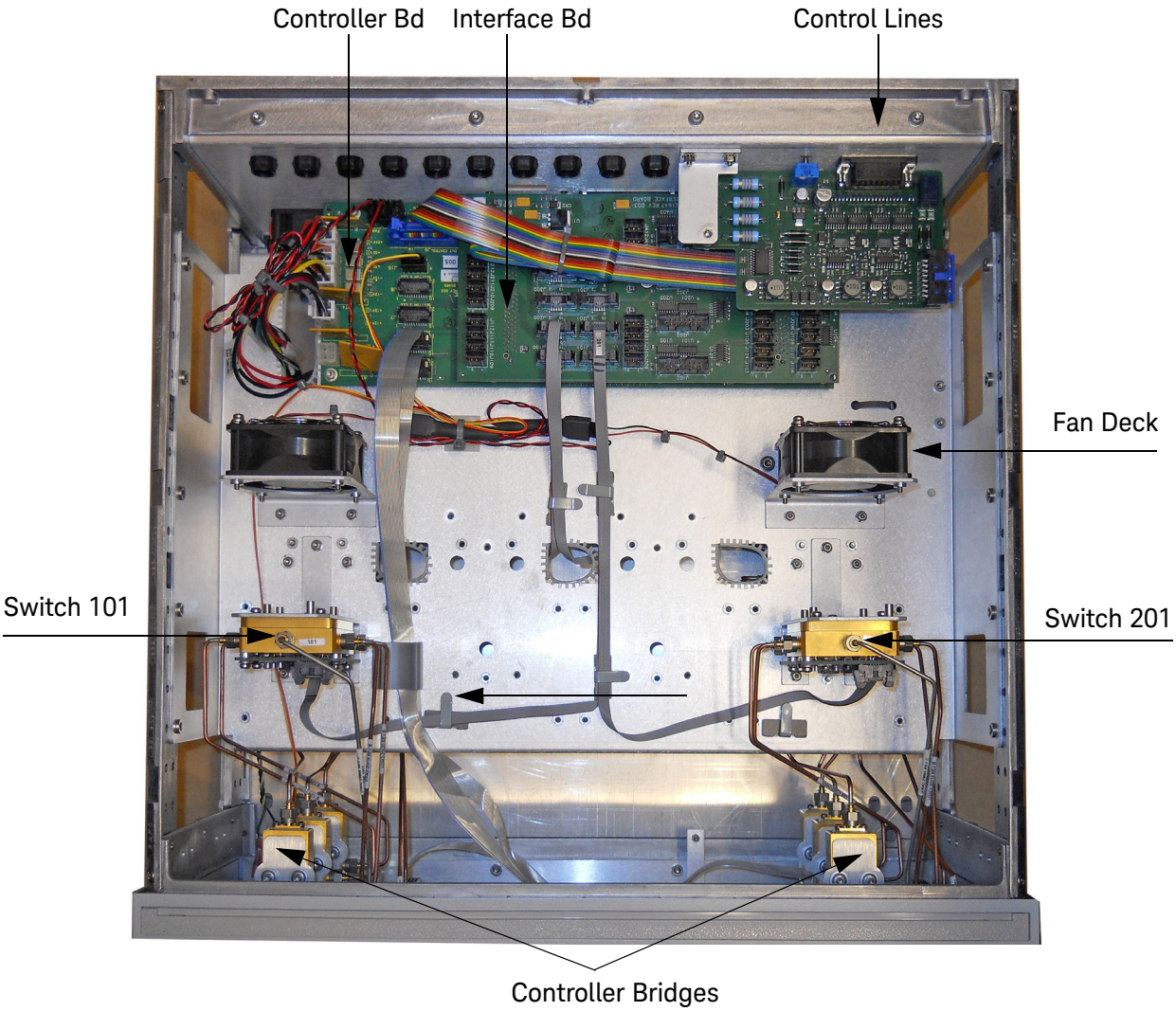
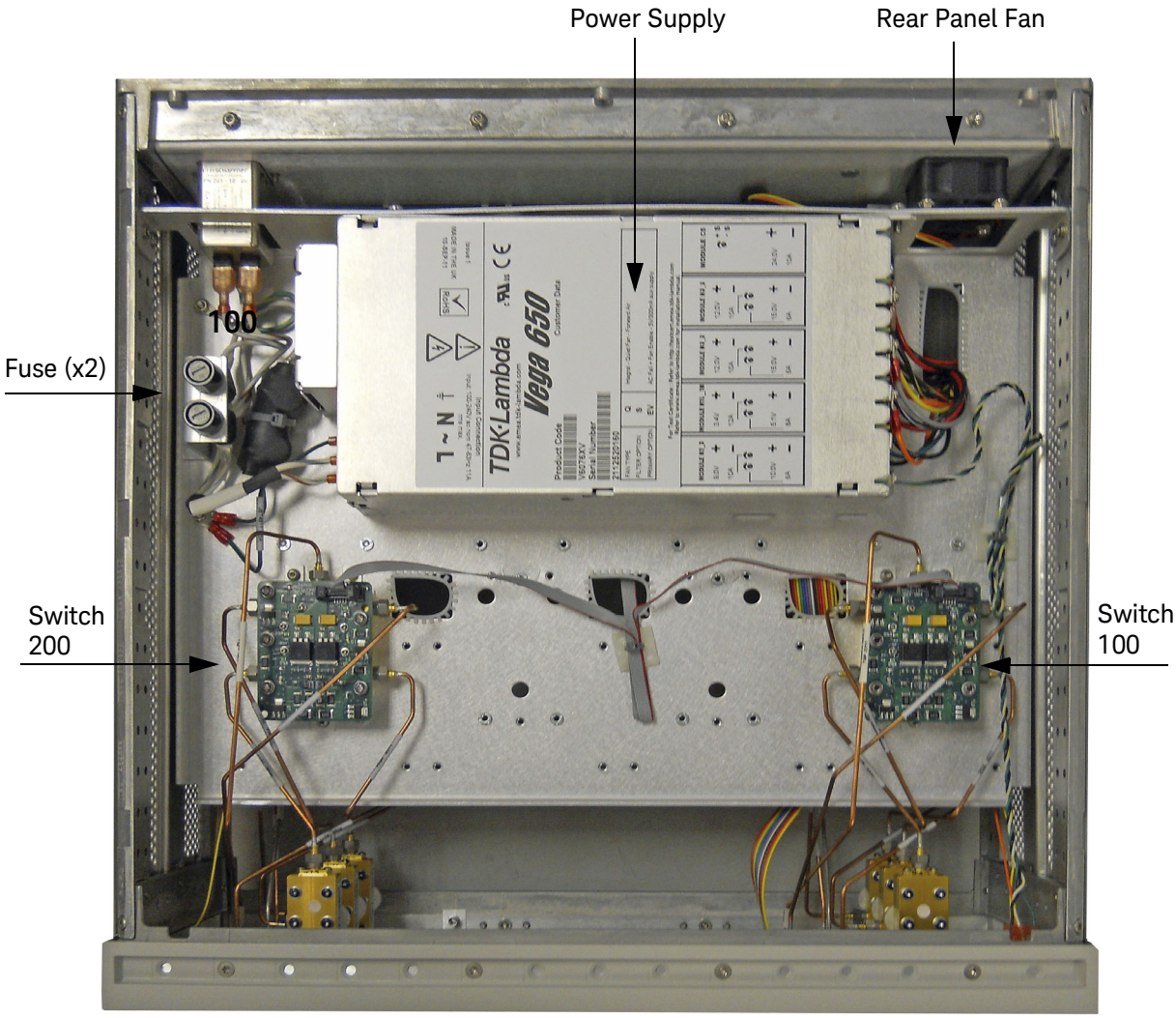


Figure 77 Bottom View



Safety and Regulatory Information

Introduction

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

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

Safety Earth Ground

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

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

Statement of Compliance

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

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 U3022AE06 from the main 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

Electrostatic discharge (ESD) can damage or destroy electronic components. The product is shipped in materials that prevent damage from static, and should only be removed from the packaging in an anti-static area ensuring that the correct anti-static precautions are taken.

Two types of ESD protection are listed below. Purchase acceptable ESD accessories from your local supplier.

- Conductive table-mat and wrist-strap combination
- Conductive floor-mat and heal-strap combination

Both types, when used together, provide a significant level of ESD protection. To ensure user safety, static-safe accessories must provide at least 1 MΩ of isolation from ground.

WARNING **These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**

Regulatory Information

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

Instrument Markings


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 as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).

This symbol indicates that the power line switch is ON.

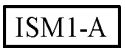

This symbol indicates that the power line switch is in the STANDBY position.


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. (If accompanied by a year, it is when the design was proven.)

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



This mark designates the product is an Industrial Scientific and Medical Group 1 Class A product (reference CISPR 11, Clause 5)

This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001).


Direct Current.

The instrument has been designed to meet the requirements of IP 2 0 for egress and operational environment.


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

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


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


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

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 Korea Class A EMC Declaration

This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

A 급 기기 (업무용 방송통신기자재) 이 기기는 업무용 (A 급) 전자파적합기기로서 판 매자 또는 사 용자는 이 점을 주 의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으 로 합니다 .

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 int he 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):

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

Declaration of Conformity

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

Keysight Support, Services, and Assistance

Service and Support Options

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

Contacting Keysight

Assistance with test and measurements needs and information or finding a local Keysight office are available at: http://www.keysight.com/find/assist

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

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

Shipping Your Product to Keysight for Service or Repair

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

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

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

Edition 3, December 2020
Supersedes May 2015

U3022-90004

www.keysight.com