

# **Agilent Technologies U3020AM23**

## **User's and Service Guide**

**Use this manual with the following documents:  
Application Note 1408-17 (5989-7265EN)  
PNA Series Network Analyzer On-line Help System**



**Agilent Technologies**

**Manufacturing Part Number: U3020-90001**

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The following safety notes are used throughout this document. Familiarize yourself with each of these notes and its meaning before performing any of the procedures in this document.

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**WARNING**      **Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.**

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**CAUTION**      Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

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## Definitions

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



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# **U3020AM23**

## Introduction

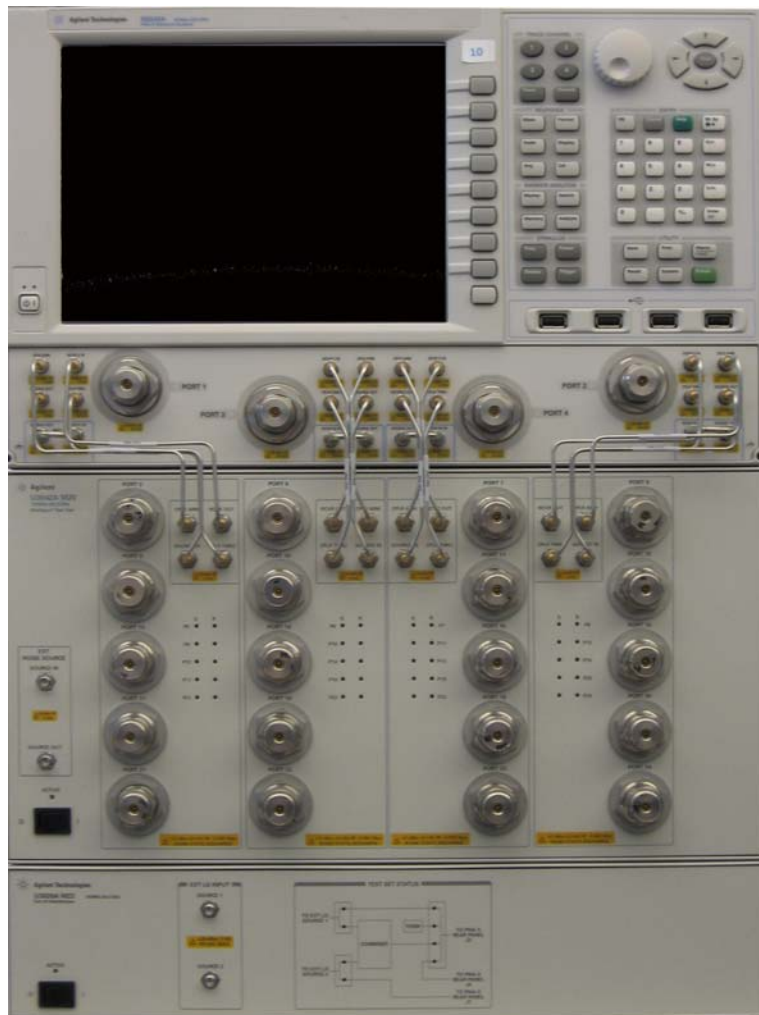
This document describes how to use and service the U3020AM23 Mechanical Switching Test Set for external LO distribution with the Agilent N5242A PNA-X.

**Figure 1 Front Panel N5242A with U3020AM23**





**Figure 2 Front Panel N5242A with U3020AM23 and U3042AM20 Test Sets**



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## Description

The Agilent U3020AM23 is a mechanical switching test set for external LO distribution to the N5242A (10 MHz to 26.5 GHz) PNA-X Network Analyzer. The U3020AM23 has a power combiner that can be selected to combine the External LO Source 1 and 2 front panel inputs to J3 on the rear panel. This provides the ability to create a two-tone, complex signal using external sources. Refer to Application Note 1408-17 for accurate intermodulation distortion measurements with the PNA-X.

The N5242A PNA-X Network Analyzers will be referred to throughout this document as the PNA-X. The U3020AM20 will be referred to as the Test Set.

## Network Analyzer Requirements

- N5242A Option 423 (4-Port with internal combiner and mechanical switches)

More PNA information is available on the following website:

- Documentation - <http://www.agilent.com/find/pna>

## 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 Agilent](#)” on page 47. Keep the damaged shipping materials (if any) for inspection by the carrier and an Agilent Technologies representative.

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## Available Options

### Cable Options

The Test Set available cable option:

- Option 042 (interface cable set)

### Mounting Kits

- U3021M Option 042 (Locking links for the Test Set to the N5242A, can be order separately but are not required).
- Front Handle Kit (5063-9226)
- Rack Mount Kit with Front Handles (5063-9232)

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## General Specifications

Specifications for the Test Set (10 MHz to 26.5 GHz) are characteristic. A functional certificate is only offered for the Test Set. There are no system specifications. The system performance of the PNA-X and the Test Set is dependent upon the input signal from the Ext LO Source 1 and 2. Actual performance of the system is based on the customer's PNA-X and options that are used with the Test Set.

The RF loss is 0.5 dB @ 10 MHz to 5 dB @ 26.5 GHz when the Test Set is in Standard Operating mode (J3 - J4). This will reduce the dynamic range by 4 dB @ 26.5 GHz.

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

- 87104A (87104-60001) Options 161 and 024
  - N1810UL (N1810-60075) Options 026, 115, 201, 302 and 403
- 

## Power Requirements

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

- 100/120/220/240 VAC (50/60Hz)
- The instrument can operate with mains supply voltage fluctuations up to  $\pm 10\%$  of the nominal voltage.
- Air conditioning equipment (or other motor-operated equipment) should not be placed on the same ac line that powers the Test Set and PNA-X.
- [Table 1](#) contains the maximum wattage for all instruments. This table can be use to determine the electrical and cooling requirements.

**Table 1 Power Requirements**

Standard Equipment	
Instrument	Maximum Wattage
N5242A	450
U3020AM23	350

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

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## Environmental Requirements

Refer to the PNA-X standard documentation for environmental requirements.

### Environmental Tests

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

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

### Equipment Heating and Cooling

If necessary, install air conditioning and heating to maintain the ambient temperature within the appropriate range. Air conditioning capacity must be consistent with the BTU ratings given in [Table 1](#).

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**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.

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### Required Conditions for Accuracy Enhanced Measurement

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

### Dimensions and Space Requirements

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

**Table 2 Instrument Dimensions**

Model	Weight	Height	Width	Depth
U3020AM23	7.5 kg (16.5 lb)	8.98 cm (3.5 in)	42.5 cm (16.75 in)	50 cm (19.7 in)

## Maximum Power Levels

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**CAUTION** It is recommended that you do not operate components near damage levels (+30 dBm). The power levels must be 3 dB below maximum level to ensure no damage, see [Table 3](#)

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**Table 3 Power Levels**

<b>Maximum U3020AM23 Test Port RF Power Levels:</b>	
Ext LO Input 1 and 2	+30 dBm 0 Vdc
<b>Maximum U3020AM23 Access Ports:</b>	
J3	+30 dBm 0 Vdc
J4	+30 dBm 0 Vdc
J7	+30 dBm 0 Vdc

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

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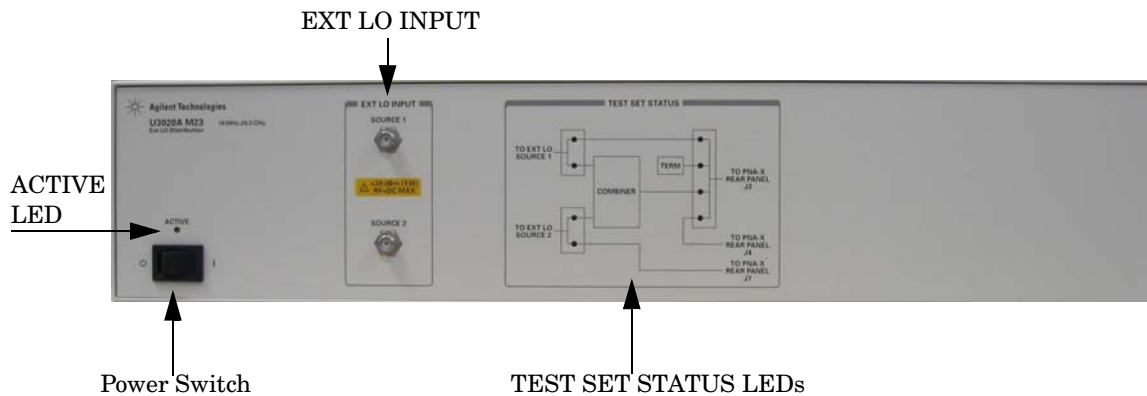
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**NOTE** Damage and maximum levels are not necessarily the optimum level.

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## Front and Rear Panel Features

Figure 3 U3020AM23 Front Panel



### EXT LO INPUT – 3.5 mm (female)

- SOURCE 1
- SOURCE 2

### TEST SET STATUS LEDs

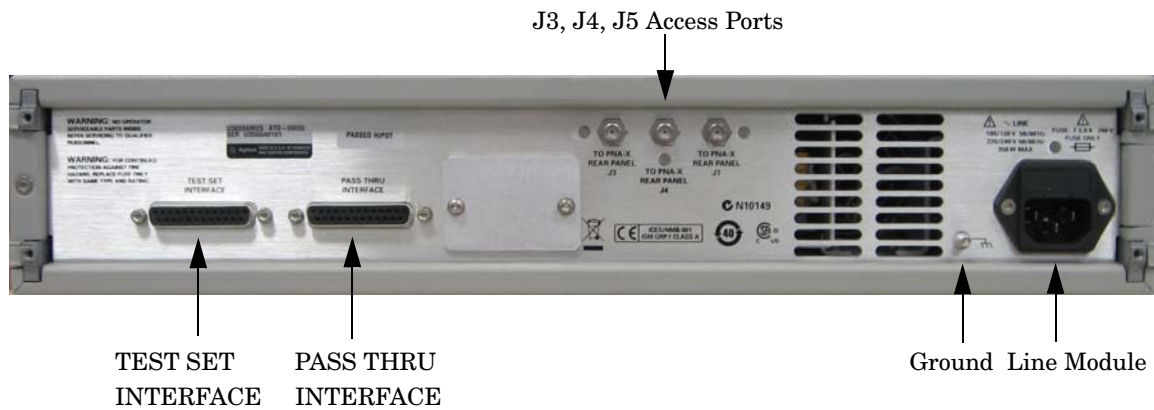
The LEDs in the Test Set Status panel indicates the RF path selected.

### ACTIVE LED

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

### Power Switch

- ☰ – Standby
- | – ON (Active LED On)

**Figure 4 U3020AM23 Rear Panel****ACCESS PORTS – 3.5 mm (female)**

- J3 (To PNA-X Rear Panel)
- J4 (To PNA-X Rear Panel)
- J5 (To PNA-X Rear Panel)

**TEST SET INTERFACE**

The Test Set Interface connector is used to send address and data to the Test Set from the PNA-X.

**PASS THRU INTERFACE**

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

**Ground**

Chassis ground that is provided for ESD and safety connection.

**Line Module**

The line fuse, as well as a spare, reside within the line module. [Figure 5](#) illustrates where the fuses are located and how to access them.

**Available Fuse**

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

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**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.

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**Figure 5** Line Fuse



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

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## System Setup with N5242A and U3020AM23

The U3020AM23 Test Set can be placed on top or below the PNA-X. The locking feet can be ordered separately, but are not required. The lock-link kit (5063-9252) is included with the U3020AM23 and is required if you are configuring the system with a U3042AM20 and a PNA-X.

### N5242A RF Interface Cable Connections

[Figure 6](#) illustrates the Test Set configuration and cable connections to the PNA-X. The cables have been supplied with Option 042.

**Table 4 N5242A RF Rear Panel Cable Connection**

RF Cables	From PNA-X	To Test Set
5061-9038	J3 (SW TSET IN Port 4)	J3
5061-9038	J4 (SW SRC OUT Port 4)	J4
5061-9038	J7 (SW TSET IN Port 3)	J7

1. Connect the RF interconnect cables from the PNA-X to the Test Set rear panel. As you are connecting each cable, torque to 8 in-lb. Refer to [Table 4](#) and [Figure 6 on page 12](#).

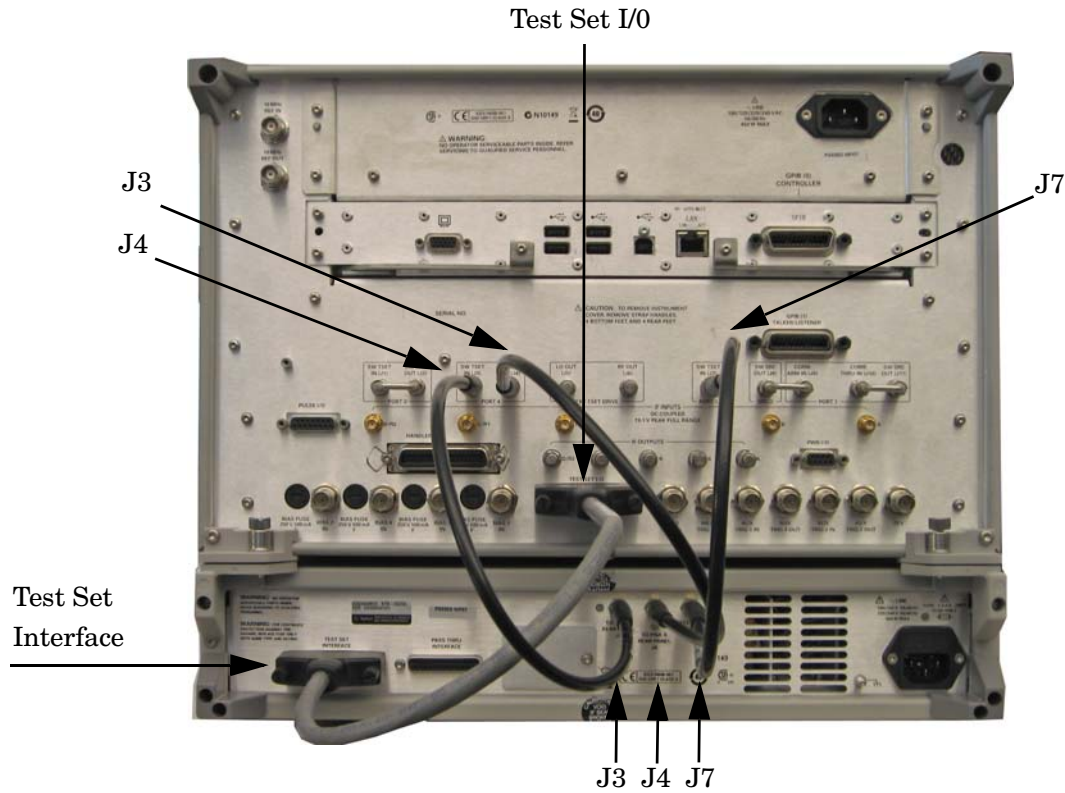
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**CAUTION** Over torque will cause damage to the Test Set and may cause connectors to spin or become loose.

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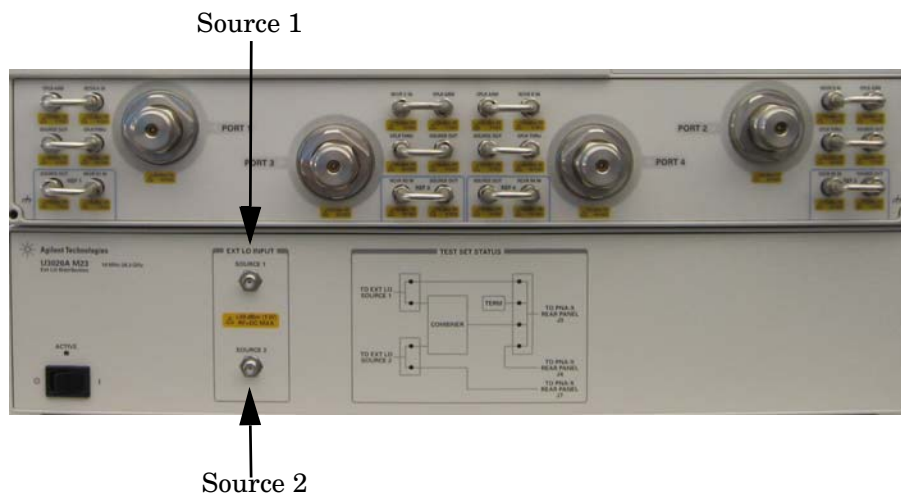
2. Connect the PNA-X Test Set I/O cable (8120-6818) to the Test Set Interface connector on the rear panel.

**Figure 6 U3020AM20 Rear Panel Connections**



3. Connect your Source to the Ext LO Input Source 1 or 2. A male SMA or 3.5 mm cables connectors are require (not included).

**Figure 7 U3020AM20 Front Panel Connections**



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## System Setup with N5242A, U3042AM20 and U3020AM23

If you are using the U3020AM23 only, locking feet are not necessary. Simply place the PNA-X on top of the U3020AM23.

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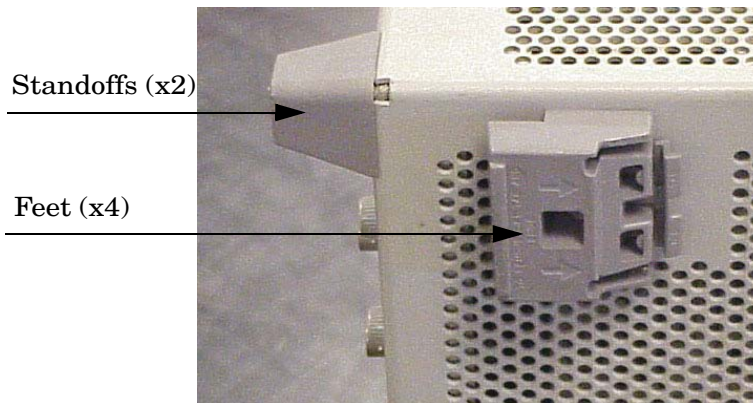
**WARNING**     **The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

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### Preparing the N5242A Network Analyzer

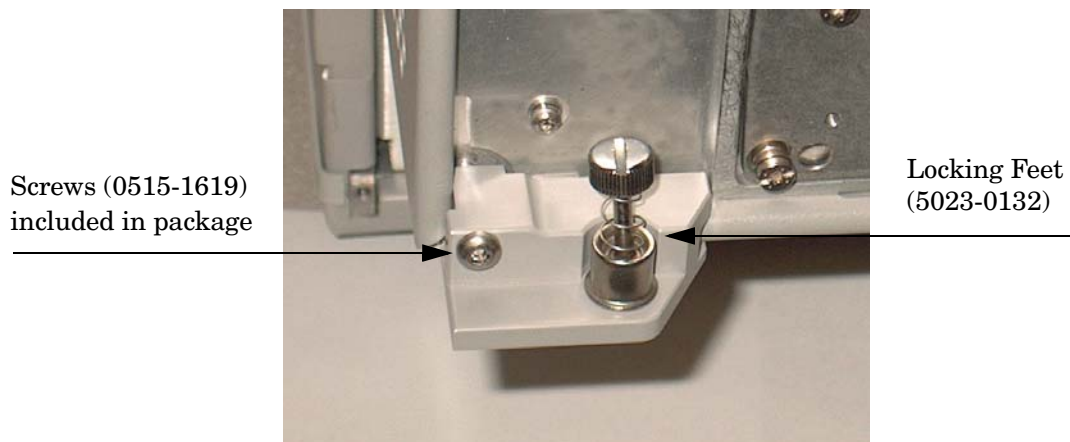
1. Remove the feet from the bottom of the network analyzer. Refer to [Figure 8](#).
2. Remove the 2 lower standoffs and screws (0515-1619) from the rear panel on the network analyzer.

**Figure 8**     **Rear Bottom Feet**



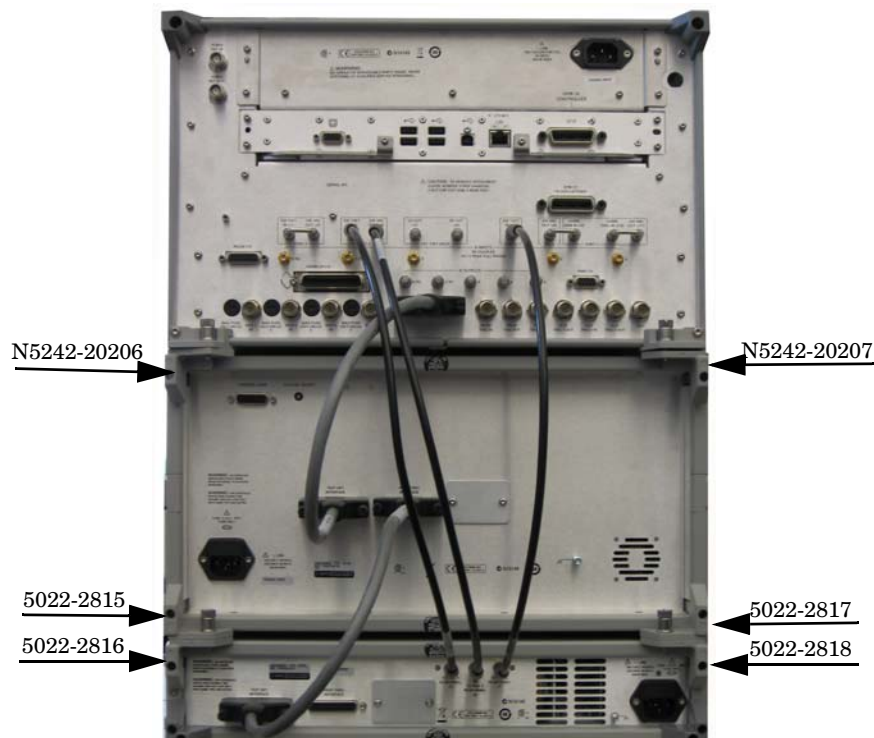
3. Install the two rear locking feet (5023-0132) onto the PNA-X, using the included screws (0515-1619), where the standoffs were removed. Refer to [Figure 9](#).

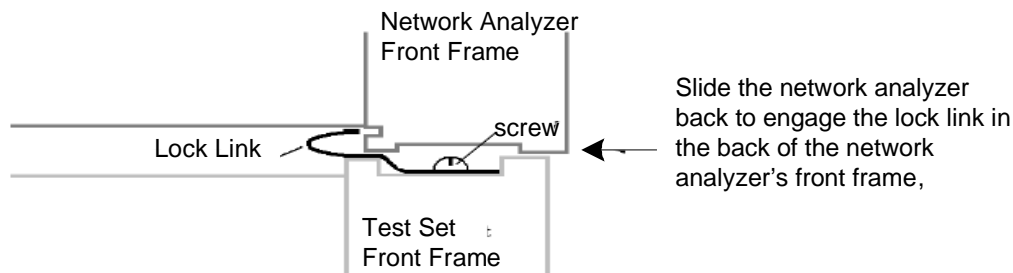
**Figure 9**     **Install Locking Feet on PNA-X**



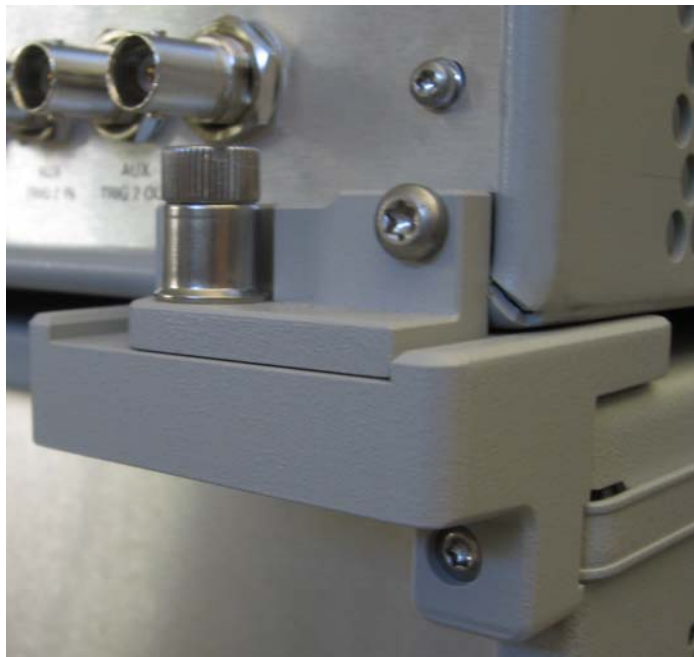
4. Remove the 4 feet from the bottom of the U3042AM20. Refer to [Figure 8](#).
5. Remove the two upper feet from the U3042AM20 and install the two locking feet N5242-20206 (right foot) and the N5242-20207 (left foot) using two screws (0515-2317) as shown in [Figure 10](#).
6. Remove the two lower feet from the U3042AM20 and install the two spring-loaded screw locking feet 5022-2815 and 5022-2817 (included in the kit 5063-9252).
7. Remove the upper top feet from the U3020AM23 and install the two locking feet 5022-2816 and 5022-2818 (included in the kit 5063-9252).
8. Remove the upper plastic strip from the top of the U3020AM23 front frame and install the four vertical lock-links 1600-1463 (included in the kit 5063-9252). See the U3042AM20 for positioning.
9. Place the U3042AM20 on the U3020AM23. Ensure that the front frame of the U3042AM20 is positioned slightly forward of the locks that are attached to the U3020AM23. Slide the U3042AM20 back so the locks engage the front frame of the U3020AM23 as shown in [Figure 11 on page 15](#).
10. Secure the U3042AM20 lower locking feet to the U3020AM23 upper locking feet, using the spring-loaded screws. If the U3042AM20 lower locking feet are not aligned with the screw holes in the U3020AM23 upper locking feet, loosen the screws securing the feet to the instrument slightly to align and tighten.
11. Place the PNA-X on top of the U3042AM20. Ensure that the front frame of the PNA-X is positioned slightly forward of the locks that are attached to the Test Set. Slide the PNA-X back so the locks engage the front frame of the analyzer.

**Figure 10 Rear Panel N5242A with U3020AM23 and U3042AM20 Test Sets**



**Figure 11 Locking the Analyzers**

12. Secure the PNA-X's lower locking feet to the U3042AM20 upper locking feet, using the spring-loaded screws. Refer to [Figure 12](#). If the network analyzer's lower locking feet are not aligned with the screw holes in the Test Set's upper locking feet, loosen the screws securing the feet to the instrument slightly to align and tighten.

**Figure 12 Locking Feet Screws****NOTE**

There are two Lock-Foot kits available. Refer to [“Contacting Agilent” on page 47](#) for ordering information.

- PNA-X – 5023-0132 (kit includes locking feet and screws)
- Test Set – 5063-9252 (kit includes locking feet and screws)
- N5242-20206 & N5242-20207 (See U3042AM20 User Guide)

## Controlling the U3020AM23 with N5242A

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

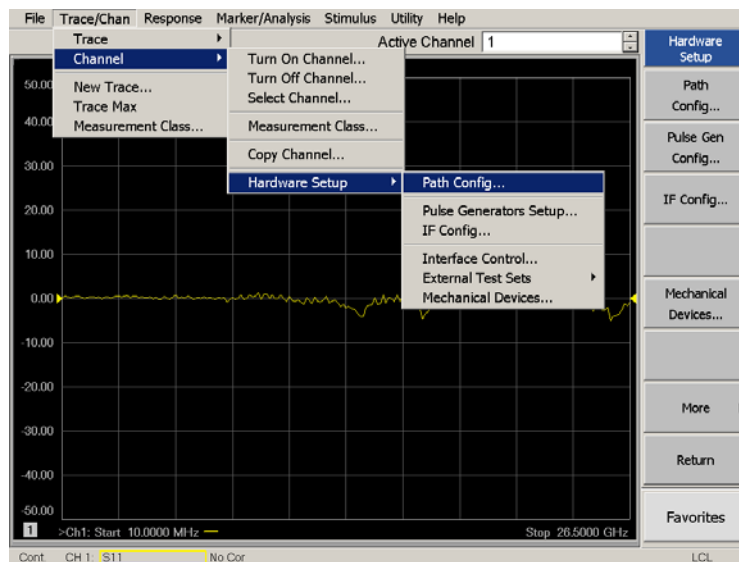
The Test Set is considered a “slave” instrument. A PNA-X must be used to control the Test Set through the Test Set I/O, using the Interface Control panel or GPIB commands.

The Test Set’s External Source Input signals can be sent through the Test Set to Port 3 or Port 4 on the PNA-X. They can also be combined in the Test Set, and sent to Port 4 for two-tone measurements. Refer to the following steps to setup the PNA-X and the Test Set.

### PNA-X Path Configurator Setting

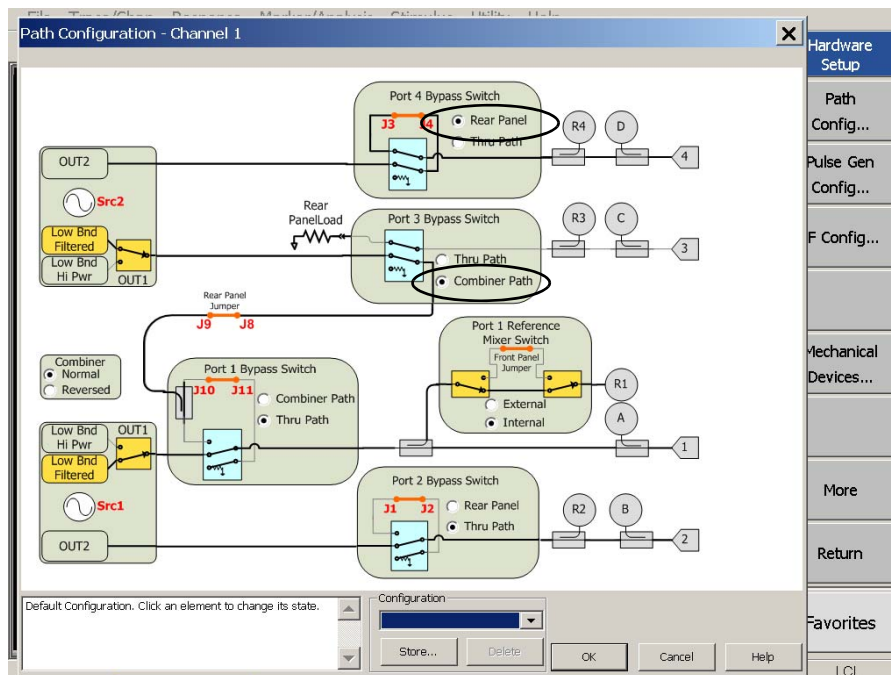
1. Select **Tran/Chan > Channel > Hardware Setup > Path Config.**

**Figure 13 Path Configuration**



2. Select **Rear Panel** in the Port 4 Bypass Switch panel to route the Ext LO Source 1 signal, or combined Ext LO Source 1 and 2 to Test Port 4.
3. Select **Combiner Path** in the Port 3 Bypass Switch panel to route the Ext LO Source 2 signal to Test Port 3. Select **OK**.

**Figure 14 Bypass Switch Select**



## Test Set Switch Path Settings

Refer to “N5242A Interface Control” on page 18 and Figure 17 on page 26.

- Standard PNA-X operation send command 0.1, which connects J3 to J4.
- To route Ext LO Source 1 to Port 4, send command 16.0 and 0.2.
- To connect Ext LO Source 2 to Port 3, send command 32.0.
- To connect both Ext LO Source 1 and Ext LO Source 2 to Port 4 (combined), send command 16.8, 32.8 and 0.3.

---

**IMPORTANT** If you are using a U3042AM20 with the U3020AM23, and the U3020AM23 is connected to the pass thru I/O connector of the U3042AM20 the addresses (listed above) must be incrementally increased by 1. Example 0 = 1, 16 = 17 and 32 = 33.

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## N5242A Interface Control

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

---

This section includes the interface control information for the Test Set. Applications and connectivity information can be found in the PNA-X Help menu.

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

### Overview of the Interface Control

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

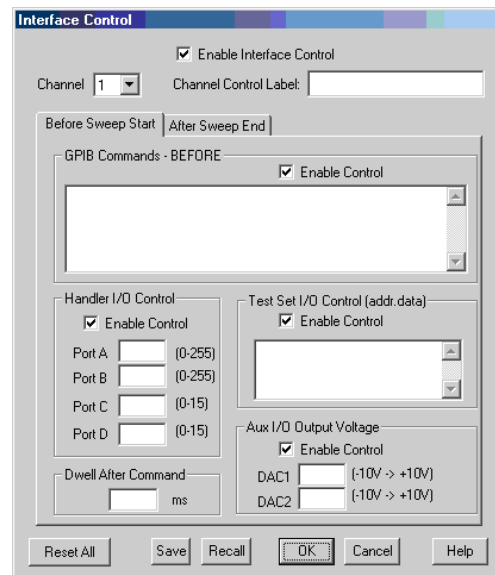
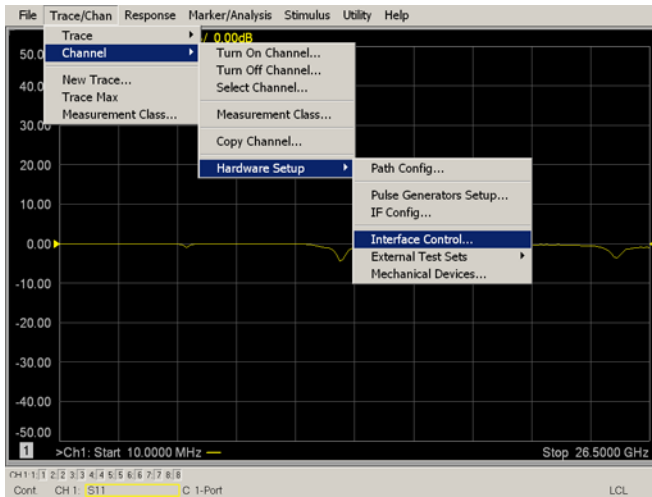
- A unique set of control data can be sent for each channel. In addition, a unique set of control data can be sent before the channel sweep starts and after the sweep ends.
- Interface Control settings can be saved and recalled from the Interface Control dialog box or with Instrument State Save and Recall.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



## How to Access Interface Control Settings

This section describes how to configure and operate the Test Set with the PNA-X. To access the Interface Control application select **Trace/Chan > Channel > Hardware Setup > Interface Control** in the drop-down menu, and click **Enable Interface Control**.

**NOTE** The PNA-X Series Network Analyzer comes with the Interface Control application. Please review this application before connecting the Test Set to the PNA-X. Information regarding this application can be found in the PNA-X Help menu, Interface Control. The application is shown below.



**NOTE** While using Interface Control, the PNA-X must be in GPIB System Controller mode. Once this is complete you must restart the PNA-X application to go back to Talker/Listener.

## Test Set I/O Address and Data using Control Interface with N5242A

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

---

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

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### Enable Interface Control:

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.

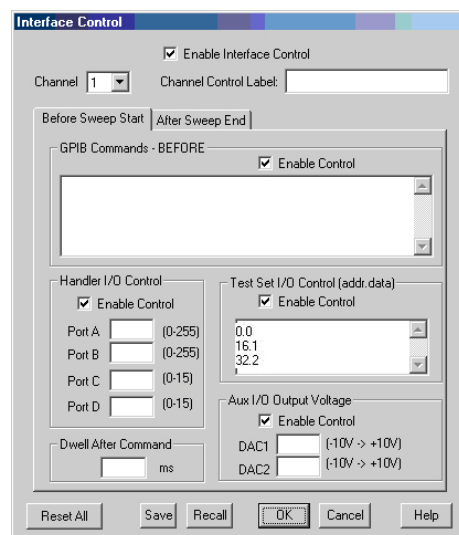
### Test Set I/O Control (address data):

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

Address and data are separated by a period. Entries should be separated by a new line, or carriage return. The front panel Enter key inserts a new line into the field. The number of Test Set I/O entries that can be entered is limited by the available memory of the PNA-X. See [“Test Set I/O Interface Commands” on page 25](#).

For example:

**0.0**  
**16.1**  
**32.2**



**Channel 1:**

Specifies the channel number for dialog settings. Each channel is configured individually. The list box illustrates the channels that currently have measurements. There must be at least one measurement present in order to make the settings.

**Channel Control Label:**

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

**Before Sweep Start – After Sweep End Tabs:**

Commands /data for all four interfaces can be sent Before Sweep Start and After Sweep End. However, they are configured and enabled on separate tabs of the Interface Control dialog box. For example; to send GPIB commands Before and After a PNA-X sweep, the Enable Control check box must be selected and commands entered on both the Before Sweep Start and After Sweep End tabs.

**Before Sweep Start:**

The data is sent before the first trace on the channel begins sweeping.

**After Sweep End:**

The data is sent after the last trace on the channel completes sweeping.

**Address:**

Positive integer is used to specify switch path to be controlled. Address also specifies output on specific ports. Refer to [“Test Set I/O Interface Commands” on page 25](#).

**Dwell After Command:**

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.

**Reset All:**

Sets all fields on all channels to their default values.

**Handler I/O Control and Aux I/O Output Voltage:**

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

**Save and Recall:**

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

**OK:**

Applies the settings and closes the dialog box.

**Cancel:**

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

---

**NOTE** Test Set I/O Commands can be found in [“Test Set I/O Interface Commands” on page 25](#). The Address and Data commands can be entered into the Test Set I/O control.

---

**N5242A GPIB Control**

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

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

**Overview of the GPIB Control**

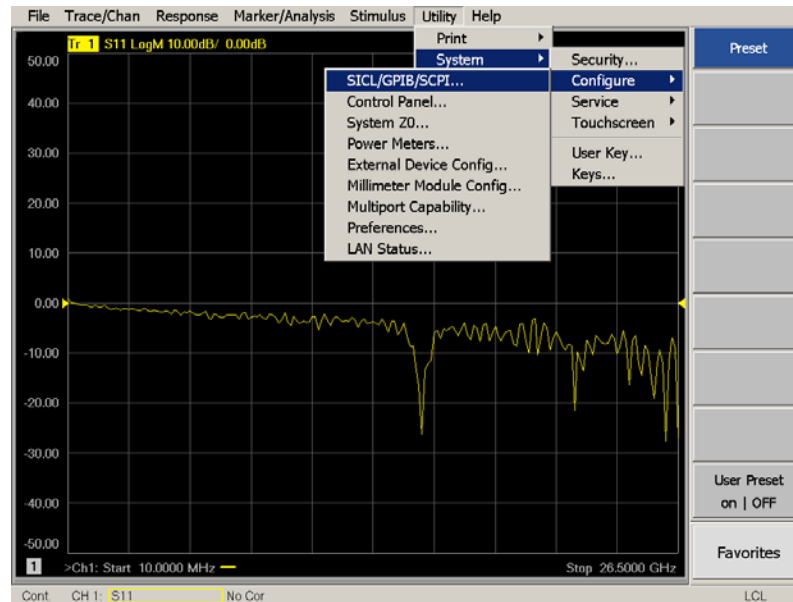
The GPIB Command Processor allows you to send address and data to control an external Test Set, without needing to create a remote program. The user is required to manually input address and data using the GPIB Command Processor Console in the PNA-X Series Network Analyzer system Help menu.

- 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

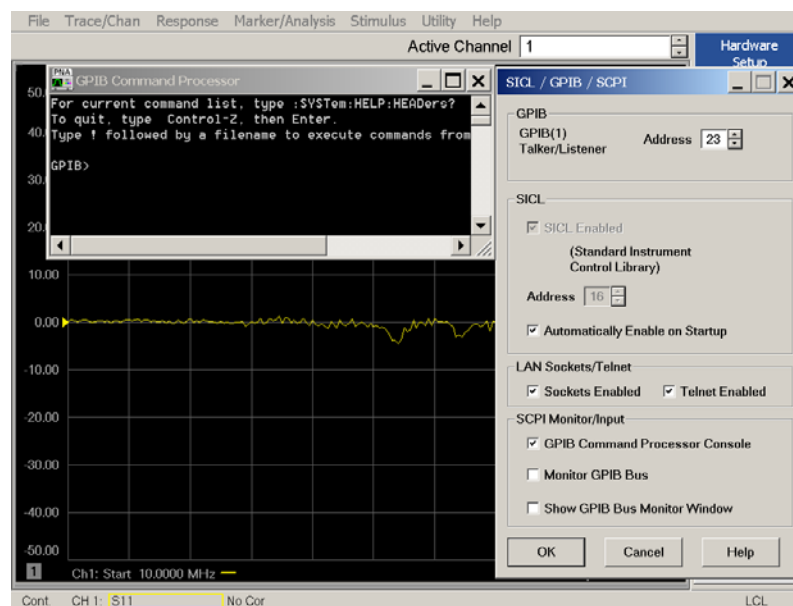
1. To access the GPIB Command Processor select **Utility > System > Configure > SICL/GPIB/SCPII**.

**Figure 15 Utility Configure**



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

**Figure 16 GPIB Command Processor**



## GPIB Command Processor Console

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

**address:** a integer number

**data:** a integer number

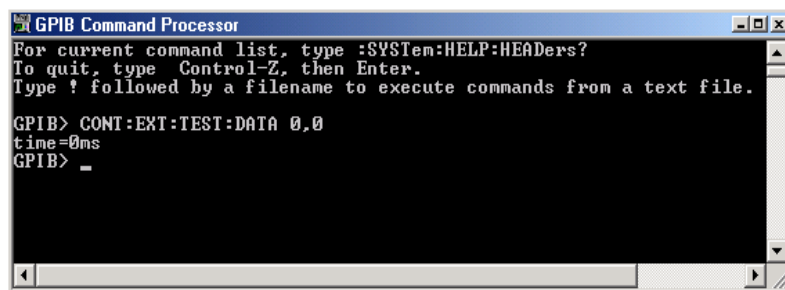
Address and data are separated by a comma. Commands should be separated by a new line, or carriage return.

For example:

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

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

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



```
GPIB Command Processor
For current command list, type :SYSTem:HELP:HEADers?
To quit, type Control-Z, then Enter.
Type ! followed by a filename to execute commands from a text file.

GPIB> CONT:EXT:TEST:DATA 0,0
time=0ms
GPIB> _
```

Refer to [“Test Set I/O Interface Commands” on page 25](#).

---

## Test Set I/O Interface Commands

### Switch Address and Data

Refer to [Table 5](#) and [Figure 17 on page 26](#) for information to set the internal switch paths of the Test Set. Additional information regarding the operation and descriptions for the internal switches can be found in [“Theory of Operation” on page 34](#).

Separate commands must to be sent to control Switch 1, 2, and 3. Refer to [“Controlling the U3020AM23 with N5242A” on page 16](#) to set the paths for PNA-X Test Ports 3 or 4.

**Table 5** U3020AM23 Path Value Select

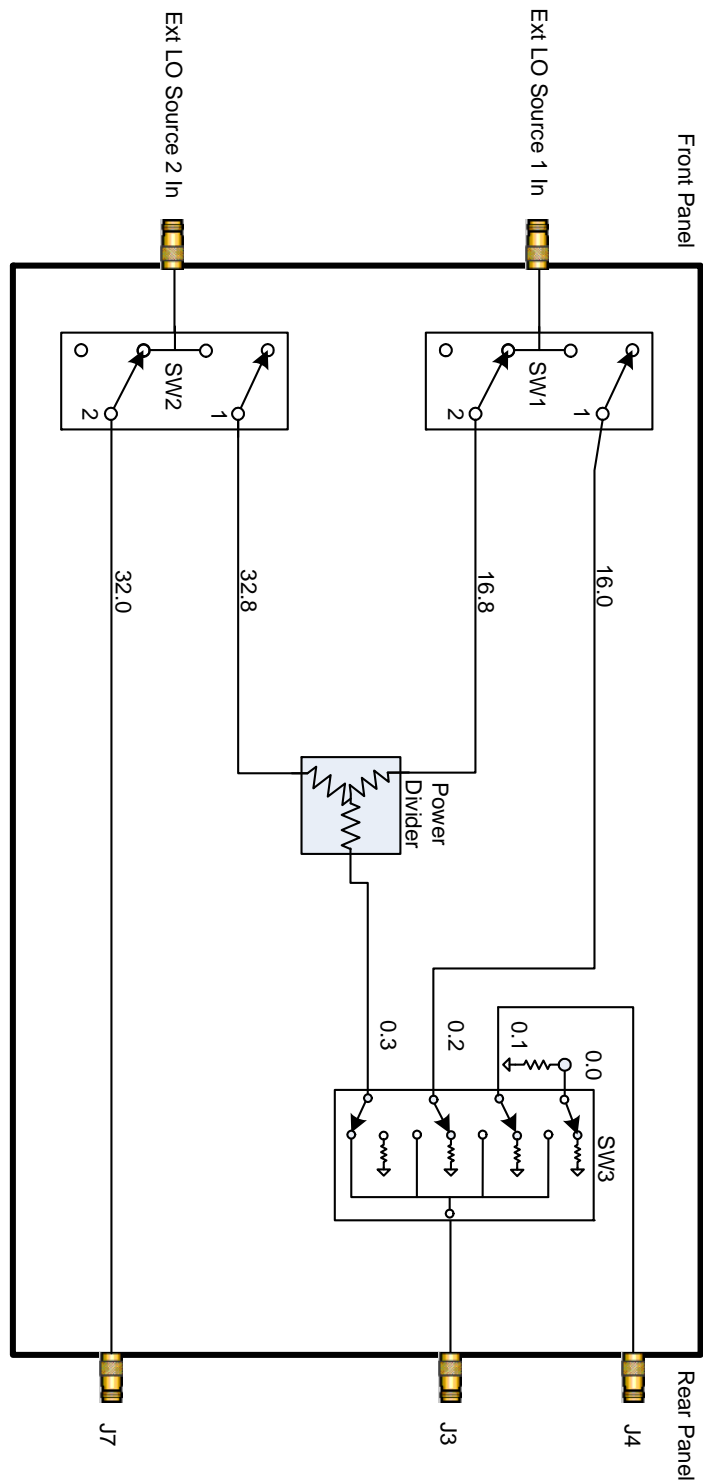
Address	Data	Source 1 (SW1)	Source 2/J7 (SW2)	J3/J4 (SW3)	Path
0	0			x	J3 Terminated
0	1			x	J3 to J4
0	2			x	SW1 to J3
0	3			x	Combiner to J3
16	0	x			Ext Source LO 1 to SW3
16	8	x			Ext Source LO 1 to Combiner
32	0		x		Ext Source LO 2 to J7
32	8		x		Ext Source LO 2 to Combiner

---

**IMPORTANT** If you are using a U3042AM20 with U3020AM23, and the U3020AM23 is connected to the pass thru I/O connector of the U3042AM20 the addresses must be incrementally increased by 1. Example 0 = 1, 16 = 17 and 32 = 33.

---

**Figure 17 U3020AM23 Standard Block Diagram**





## Operational Check

This operational check is to confirm the Test Set's operational performance. The operation verification limits provided ensure that your U3020AM23 is operating properly.

### Verification Limits

Specifications for the Test Set are typical. System performance for the Test Set is 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 Agilent Technologies for servicing or repair if the Test Set and PNA-X performance exceed the operational verification limits.

**Table 6 U3020AM23 Operation Verification Limit**

Connections	Loss
J3 to J4	< 4 dB
Source 1 to J3 (no combiner)	< 5 dB
Source 1 to combiner to J3	< 13 dB
Source 2 to combiner to J3	< 13 dB
Source 2 to J7	< 5 dB

### Equipment Required

The Agilent U3020AM23 requires that the user be familiar with the equipment and components listed in [Table 7](#).

This section provides an equipment list and configuration of the PNA-X and Test Set.

**Table 7 Equipment List**

Description	Qty
N5242A or E8362B Network Analyzer (or equivalent with Test Set I/O)	1
RF cables (5062-6696 or equivalent with SMA or 3.5 mm connectors)	2
3.5 mm adapter, female to female (1250-1666 or equivalent)	3
Test Set I/O Cable (8120-6818)	1
50 Ohm Load (1810-0118)	1

---

## Operational Check Procedure

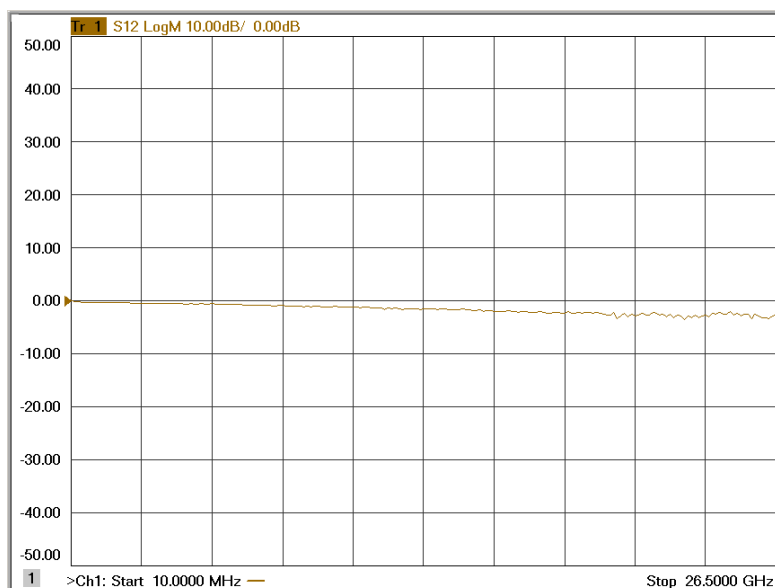
The sequence of this procedure is very important and must be followed or the performance accuracy and results may vary from the reference plots provided. Ensure that the Test Set is not connected to the PNA-X if you are performing a PNA-X Operator's Check. The PNA-X will indicate false failures if the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

### J3 to J4 Test

This test will verify the RF path insertion loss of J3 to J4.

1. Select [**Preset**] and verify the PNA-X in Standalone Mode.
2. Connect the RF cables to PNA-X Ports 1 and 2.
3. Connect two RF test cables together using an adapter.
4. Measure S12 trace. Select [**Meas**] > **S12**.
5. Perform a **Response Calibration** or normalize the S12 trace to remove the loss created by the test cables. Select [**Memory**] > **Normalize**.
6. Remove the adapter.
7. Connect the Port 1 cable to J3.
8. Connect the Port 2 cable to J4.
9. Send the Test Set I/O command 0.1. Verify that J4 front panel LEDs are On. Refer to [“How to Access Interface Control Settings”](#) on page 19.
10. Verify that the S12 trace loss is approximately < 4 dB @ 26.5 GHz and is sloped as shown in [Figure 18](#).

**Figure 18 J3 to J4**

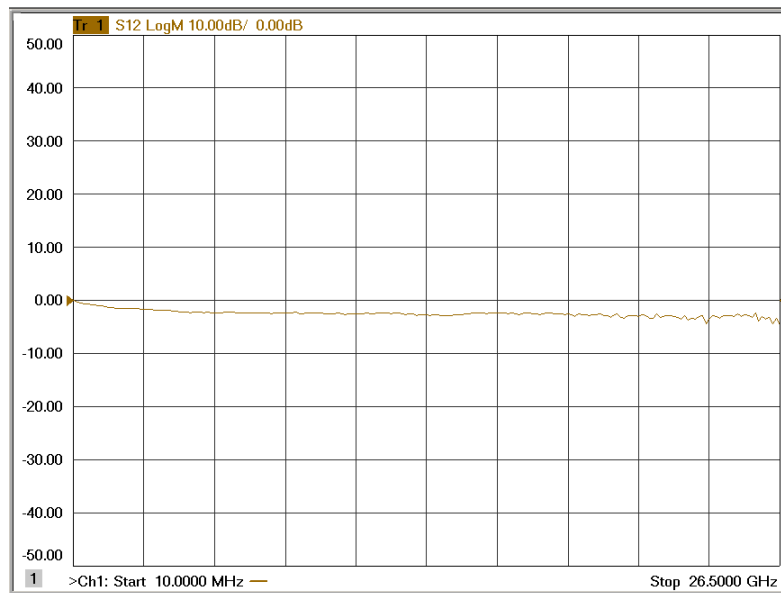


## Ext LO Source 1 to J3

This test will verify the RF paths insertion loss of Ext LO Source 1 to J3.

1. Select [**Preset**] and verify the PNA-X in Standalone Mode.
2. Connect the RF cables to PNA-X Ports 1 and 2.
3. Connect two RF test cables together using an adapter.
4. Measure S12 trace. Select [**Meas**] > **S12**.
5. Perform a **Response Calibration** or normalize the S12 trace to remove the loss created by the test cables. Select [**Memory**] > **Normalize**.
6. Remove the adapter.
7. Connect the Port 1 cable to J3.
8. Connect the Port 2 cable to Ext LO Source 1.
9. Send both Test Set I/O commands 16.0 and 0.2. Verify that Ext LO Source 1 and J3 front panel LEDs are On. Refer to [“How to Access Interface Control Settings” on page 19](#).
10. Verify that the S12 trace loss is approximately < 5 dB @ 26.5 GHz and is sloped as shown in [Figure 19](#).

**Figure 19 Ext LO Source 1 to J3**

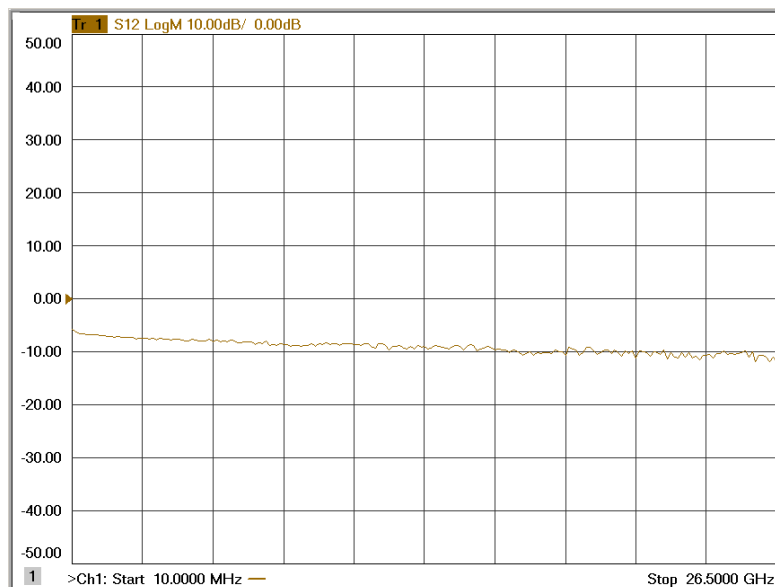


## Ext LO Source 1 to Combiner to J3

This test will verify the RF paths insertion loss of Ext LO Source 1 to Combiner to J3.

1. Select **[Preset]** and verify the PNA-X in Standalone Mode.
2. Connect the RF cables to PNA-X Ports 1 and 2.
3. Connect two RF test cables together using an adapter.
4. Measure S12 trace. Select **[Meas] > S12**.
5. Perform a **Response Calibration** or normalize the S12 trace to remove the loss created by the test cables. Select **[Memory] > Normalize**.
6. Remove the adapter.
7. Connect the Port 1 cable to J3.
8. Connect the Port 2 cable to Ext LO Source 1, and attach a 50 Ohm load to Ext LO Source 2.
9. Send Test Set I/O commands 32.8, 16.8 and 0.3. Verify that Ext LO Source 1 combiner and J3 combiner front panel LEDs are On.
10. Verify that the S12 trace loss is approximately  $< 13$  dB @ 26.5 GHz. Refer to [Figure 20 on page 30](#).

**Figure 20 Ext LO Source1 or 2 to Combiner to J3**



## Ext LO Source 2 to Combiner to J3

This test will verify the RF paths insertion loss of Ext LO Source 2 to Combiner to J3.

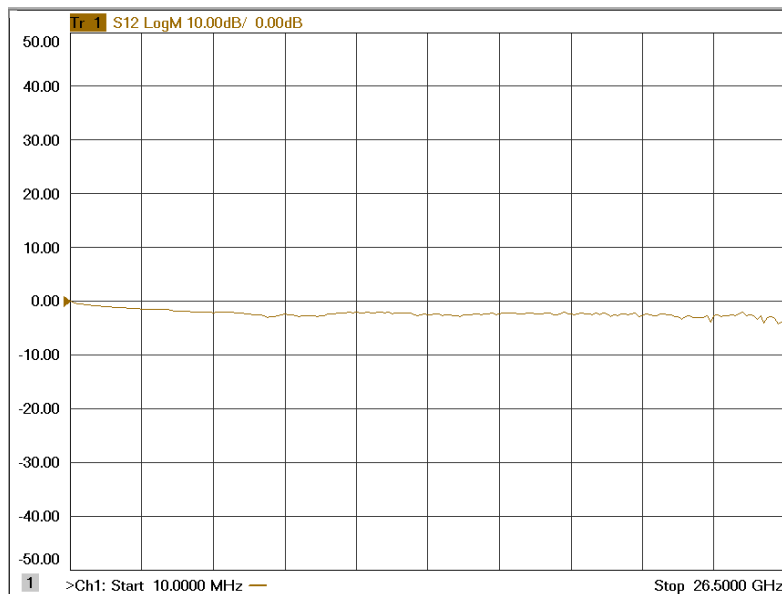
1. Select [**Preset**] and verify the PNA-X in Standalone Mode.
2. Connect the RF cables to PNA-X Ports 1 and 2.
3. Connect two RF test cables together using an adapter.
4. Measure S12 trace. Select [**Meas**] > **S12**.
5. Perform a **Response Calibration** or normalize the S12 trace to remove the loss created by the test cables. Select [**Memory**] > **Normalize**.
6. Remove the adapter.
7. Connect the Port 1 cable to J3.
8. Connect the Port 2 cable to Ext LO Source 2, and attach a 50 Ohm load to Ext LO Source 1.
9. Send both Test Set I/O commands 32.8 and 0.3. Verify that the Ext LO Source 1, Ext LO Source 2 and J3 Combiner LED's are on.
10. Verify that the S12 trace loss is approximately < 13 dB @ 26.5 GHz. Refer to [Figure 20 on page 30](#).

## Ext LO Source 2 to J7

This test will verify the RF paths insertion loss of Ext LO Source 2 to J7.

1. Select **[Preset]** and verify the PNA-X in Standalone Mode.
2. Connect the RF cables to PNA-X Ports 1 and 2.
3. Connect two RF test cables together using an adapter.
4. Measure S12 trace. Select **[Meas] > S12**.
5. Perform a **Response Calibration** or normalize the S12 trace to remove the loss created by the test cables. Select **[Memory] > Normalize**.
6. Remove the adapter.
7. Connect the Port 1 cable to J7.
8. Connect the Port 2 cable to Ext LO Source 2.
9. Send the Test Set I/O commands 32.0. Verify that J7 and Ext LO Source 2 front panel LEDs are On.
10. Verify that the S12 trace loss is approximately  $< 5$  dB @ 26.5 GHz.

**Figure 21 Ext LO Source 2 to J7**



---

## Service Information

Refer to [“Contacting Agilent”](#) on page 47.

---

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

---



---

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

---

## Replaceable Parts

Special options are built to order, so long lead times may be encountered when ordering replacement parts.

Description	Agilent Part Number
Switch, multiport (SW3) 87104A Opt 161 & 024	87104-60001
Switch, coaxial (SW1 and SW2) (Option 026, 115, 201, 302, and 403)	N1810-60075
SMA Interconnect Cable	5061-9038
Test Set I/O Interconnect Cable	8120-6818
Power Splitter	5086-7408
Power Supply	0950-4729
SW Interface Board, programmed	U3025-60062
10 LED Board (programmed)	N5261-60005
Test Set Control Board (programmed)	N5261-60006
PWR Supply (AC/DC SWG 650W 9-Output)	0950-4729
Fuse (8 A 250 V non-time delay 0.0146 Ohm)	2110-0342
Fuse (5 A 250 V non-time delay Socket)	2110-0709
Test Set I/O Cable	8120-6818
SMA Connector (female to female)	1250-1666
Kit-Front Handle	5063-9226
Kit-Front Mount	5063-9232
Termination, 50 Ohm	1810-0118
User's and Service Guide	U3020-90001

---

## Theory of Operation

The following is a description of the operation of the Test Set. Reference the Test Set block diagrams shown in [Figure 17 on page 26](#). This section assumes the user has a general understanding of couplers, switches, and network analyzers.

### RF Components

The Test Set uses three mechanical coaxial switches (SW1, SW2, and SW3) that are controlled by the Switch Interface and Controller boards. The switches select the Ext LO Source 1 and 2 RF paths and Test Set rear panel Source Outputs to the PNA-X. A Power Combiner is installed to enable mixing the Ext LO Source 1 and 2 signals.

### Switch Paths

#### SW1 - Ext LO Source 1 Switch

Switch 1 provides control of the Ext LO Source 1 path to the Power Combiner, or Switch 3. In the state shown in [“U3020AM23 Standard Block Diagram” on page 26](#), Ext LO Source 1 is routed to the Power Combiner.

#### SW2 -Ext LO Source 2 Switch

Switch 2 provides control of the Ext LO Source 2 path to the Power Combiner, or J7. In the state shown in the diagram, Switch 2 routes Ext LO Source 2 to J7.

#### SW3 - Rear Panel J3/J4 Switch

Switch 3 provides control of J3 and J4. In the state shown in the block diagram, Switch 3 routes the Power Divider Output to J3 and J4 is terminated.

### Test Set Control Board

The Test Set Control Board (N5261-60006) is a surface mount, printed circuit assembly (PCA). It provides a connection to the power supply, and the PNA Test Set I/O for control of the RF switch paths (through the Switch Interface board (U3025-60062)). The front panel “Active” and port LEDs are on only when the PNA has addressed the U3020AM23 Test Set. The rear panel fan is on when the controller board supplies are operational.

### Switch Interface Board

The Switch Interface board (U3025-60062) is installed on top of the Test Set Controller Board and provides connections to the RF switches. This board regulates the DC voltage supply (24 volts), and routes logic signals to the switches through ribbon cables connected to plugs P10, J26 and J36. See [Table 9 on page 39](#).



**Front Panel LED Boards**

Two LED board assemblies (N5261-60005) are mounted to the front panel. The LED's indicate the path shown on the front panel. The LED board assemblies are connected to the test set controller board by ribbon cables to J5 and J6. [Table 8 on page 39](#).

**Power Supply**

The power supply (0950-4729) converts the AC line voltages to DC. This is an automatic line voltage selecting power supply. The DC supplies are connected to the test set control board through four wire harness to J11, J12, J13 and J14. The AC line voltage (100 to 240 V @ 50/60 Hz) is provided from the line module on the rear panel.

---

## Troubleshooting

If the U3020AM23 is not operating properly, use the following procedures to isolate and repair the failure.

Refer to the Agilent PNA Series: Service & Support Home Page at:  
<http://na.tm.agilent.com/pna> for further information.

To request service, please contact your local service center. In the US, call 800-829-4444. For a listing of service centers worldwide, please visit us at [www.agilent.com/find/service](http://www.agilent.com/find/service). Refer to “[Shipping Your Instrument to Agilent for Service or Repair](#)” on page 47.

Refer to the following procedures for type of problem encountered. It is recommended that a qualified service technician perform the following procedures.

---

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

---

### Fan is not Operating in the Power Supply

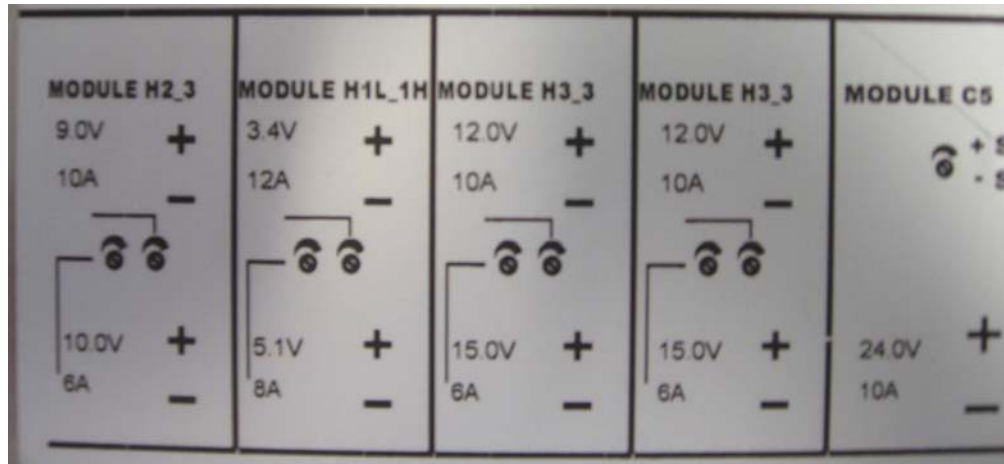
Suspect a power supply problem and perform the following:

---

**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 while it is being opened.**

---

1. Verify the front panel power switch (3101-4058) is operational.
2. Verify that the AC line voltage is correct (100 to 240 V @ 50/60 Hz) and that the power cord is not damaged.
  - a. If the power cord is damaged, replace it.
  - b. If the AC line voltage is incorrect, use another receptacle.
3. Verify that the fuse (2110-0709) in line module is not blown. There is a spare fuse in the line module. Refer to [Figure 5 on page 10](#). If the fuse is working, continue to step 4.
4. Remove the top cover. Verify that the supply LED indicators, on the test set control board (N5261-60006) are illuminated. The +9 and +10 V supplies will not be on. If the LED's are illuminated, replace the fan (87050-60027). Refer to [Figure 23 on page 40](#).
5. If the LED's are off, verify the voltages (+24, +5, +3, -15, -12, +15 and +12 Volt) on the Test Set Controller board. If the voltages are not correct, verify that J11 - J14 cables are connected correctly on both the power supply and controller board. Refer to [Figure 23 on page 40](#).
6. If the J11 to J14 cables are connected properly, measure the voltages on the power supply screw terminals. See the power supply voltages in [Figure 22 on page 37](#).

**Figure 22 Power Supply**

7. If power supply voltages are not present, verify and/or replace the two 8 amp fuses (2110-0342) in the line fuse assembly. Refer to [Figure 22 on page 37](#).
  - a. If the fuses are correct, replace power supply (0950-4729).

## Front Panel LEDs are not Illuminated

If the U3020AM23 power supplies are operating the following procedures can be used to verify the failure. Suspect the Test Set Controller Board (N5261-60006) or Front Panel LED Assembly (N5261-60005).

1. Verify the Test Set I/O cable (8120-6818) is installed correctly. See [Figure 10 on page 14](#).
2. Using multiport mode (Option 551), verify the PNA firmware is correct, and the test set file is loaded into the PNA, refer to [“Network Analyzer Requirements” on page 4](#).
3. Using the I/O command values, confirm the correct address and data values are used. Refer to [“Test Set I/O Interface Commands” on page 25](#).
4. Remove the top cover. Verify that the supply LED indicators, on the test set control board (N5261-60006), are illuminated. The +9 and +10 V supplies will not be on.
5. If the LED's are off, verify the voltages (+24, +5, +3, -15, -12, +15 and +12 Volt) on the Test Set Controller board. If the voltages are not correct, verify that J11 - J14 cables are connected correctly on both the power supply and controller board. Refer to [“Fan is not Operating in the Power Supply” on page 36](#).
6. Verify at least one of the status LEDs is on. If not, replace the controller board (N5261-60006).
7. If the controller board status LEDs are on, and the ACTIVE LED is on, suspect the Front Panel LED Boards (N5261-60005) or the ribbon cables (E4440-60078). If only one set of front panel LEDs are not working, connect the ribbon cable from one of the working front panel LED boards to the front panel LED Board assembly that is not working. Replace if necessary.

## Ext Source Paths are not Switching

If the Ext Source front panel inputs, or rear panel J3 or J4 are not switching, the following procedures can be used to verify the failure. The procedures assume power supplies, controller board and front panel LEDs are working. Suspect the switch interface board (U3025-60062), ribbon cable connection or coax switch (87104-60001) or (N1811T).

1. Inspect the ribbon cable connections from the test port switches to the Switch Interface board (U3025-60062).
2. Send a test set I/O command and verify that the mechanical switches are make a clicking sound. If there is no sound, replace the Switch Interface board (U3025-60062) or the suspected switch (87104-60001).
3. If the switches are operating, send a Test Set I/O command to verify the path for each port. See [Figure 17, “U3020AM23 Standard Block Diagram,” on page 26](#).
4. Substitute a known good switch, or connect a known good ribbon cable to a suspect switch and retest. Replace if necessary.

---

## Troubleshooting Diagrams and Tables

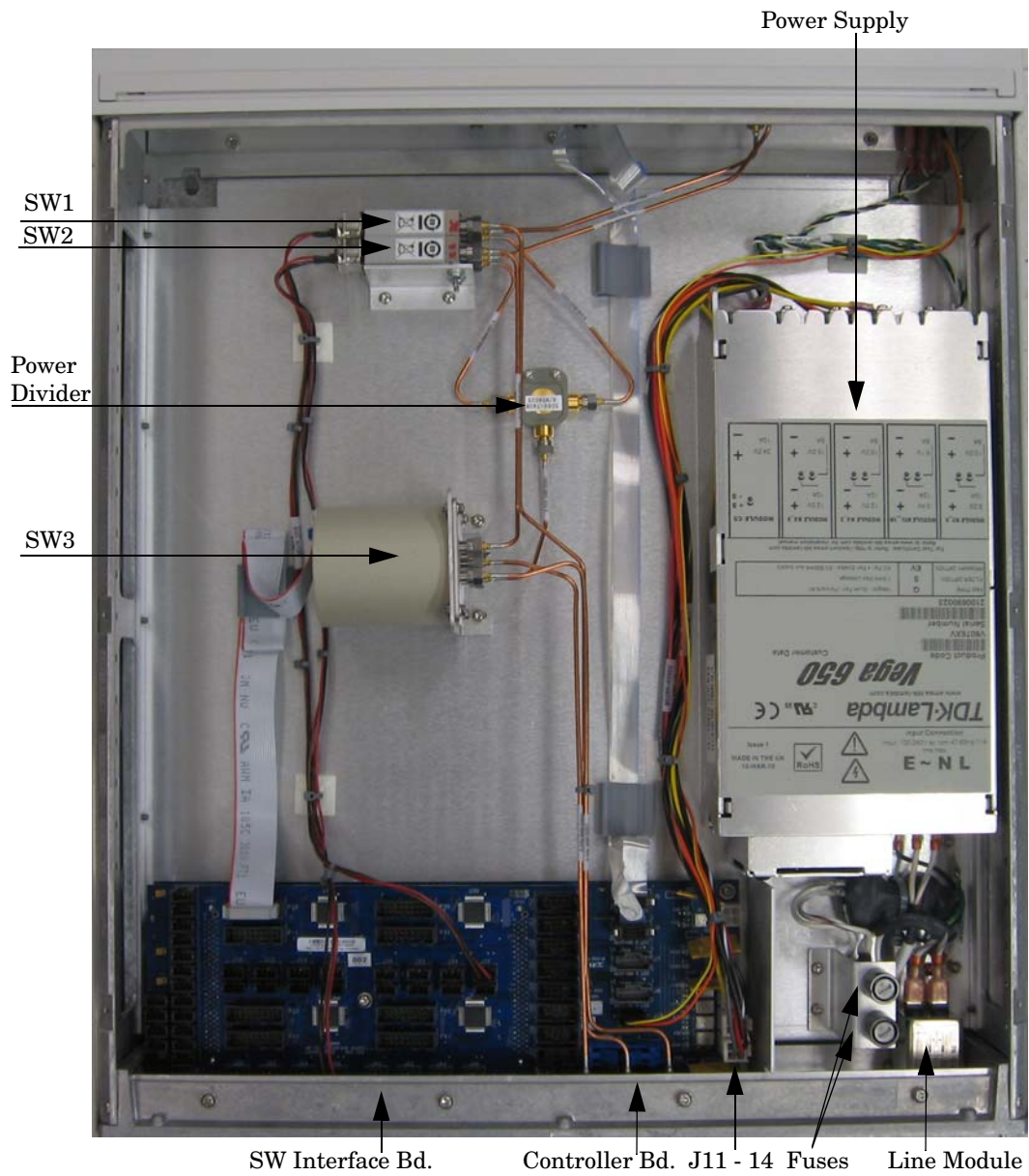
**Table 8      Controller Board Connections**

<b>Controller Board Connection</b>	<b>Connection</b>
LED Ribbon Cables From the LED Board:	
J5	Ext LO Source path LED
J6	Rear Panel path LED's (J3, J4 and J7)
Wire harness Active LED:	
P1	Active LED
Power Supply Wire Harness:	
J11- 14	Power Supply

**Table 9      Switch Interface Board**

<b>Switch Interface Board</b>	<b>Connection</b>
Switch Interface Board Connection:	
J36	Switch 1
J26	Switch 2
P10	Switch 3

**Figure 23 U3020AM23 Top View**



---

## Safety and Regulatory Information

### Introduction

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

### Before Applying Power

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

---

**WARNING** To prevent electrical shock, disconnect the **Agilent Technologies U3020AM23** from mains electrical supply before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

---

### Connector Care and Cleaning

If alcohol is used to clean the connectors, the power cord to the instrument must be removed. All cleaning should take place in a well ventilated area. Allow adequate time for the fumes to disperse and moist alcohol to evaporate prior to energizing the instrument.

---

**WARNING** Keep isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. It is extremely flammable. In case of fire, use alcohol foam, dry chemical, or carbon dioxide; water may be ineffective.

---

### Declaration of Conformity

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

### Statement of Compliance

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

## General Safety Considerations

### Cautions

Cautions applicable to this instrument.

---

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

---

---

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

---

---

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

---

---

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

---

---

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

---



## Servicing

Warnings applicable to this instrument.

- 
- |                |  |
|----------------|--|
| <b>WARNING</b> | <b>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.</b> |
|----------------|--|
- 
- |                |  |
|----------------|--|
| <b>WARNING</b> | <b>This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the product is likely to make the product dangerous. Intentional interruption is prohibited.</b> |
|----------------|--|
- 
- |                |   |
|----------------|---|
| <b>WARNING</b> | <b>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.</b> |
|----------------|---|
- 
- |                |   |
|----------------|---|
| <b>WARNING</b> | <b>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.</b> |
|----------------|---|
- 
- |                |   |
|----------------|---|
| <b>WARNING</b> | <b>This product is designed for use in Installation Category II and Pollution Degree 2.</b> |
|----------------|---|
- 
- |                |  |
|----------------|--|
| <b>WARNING</b> | <b>No operator serviceable parts inside. Refer servicing to qualified personnel.</b> |
|----------------|--|
- 
- |                |   |
|----------------|---|
| <b>WARNING</b> | <b>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.</b> |
|----------------|---|
-

## 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.



This symbol indicates that the instrument requires alternating current (ac) input.



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 instrument complies with Canada: CSA 22.2 No. 61010-1-04.



This is a symbol of an Industrial Scientific and Medical Group 1 Class A product.



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 ingress and operational environment.



This is a required mark signifying compliance with an EMC requirement. The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.



China RoHS regulations include requirements related to packaging, and require compliance to China standard GB18455-2001.



This symbol indicates compliance with the China RoHS regulations for paper/fiberboard packaging.

## Battery Collection

Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Agilent Technologies for disposal. Refer to [“Contacting Agilent” on page 47](#) for assistance.

## Compliance with German Noise Requirements

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

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

## EMC Information

Complies with European EMC Directive 2004/108/EC

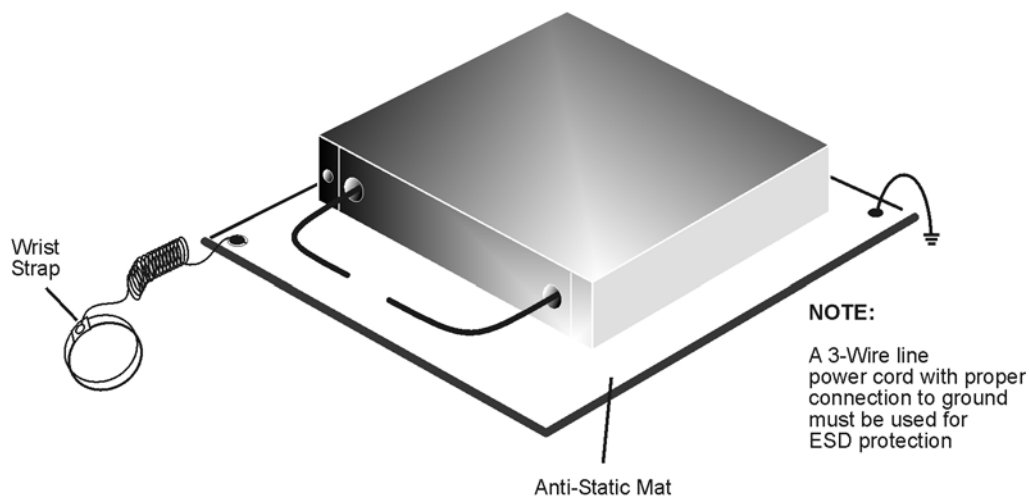
- IEC/EN 61326-1
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11
- This ISM device complies with Canadian ICES-001.  
Cet appareil ISM est conforme a la norme NMB du Canada.

## Electrostatic Discharge Protection

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

- *always* have a grounded, conductive table mat (9300-0797) in front of your test equipment.
- *always* wear a grounded wrist strap (9300-1367) with grounding cord (9300-0980), connected to a grounded conductive table mat, having a 1 M $\Omega$  resistor in series with it, when handling components and assemblies or when making connections.
- *always* wear a heel strap (9300-1126) when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.
- *always* ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port or cable connector briefly.
- *always* ground the center conductor of a test cable before making a connection to the analyzer test port or other static-sensitive device. This can be done as follows:
  1. Connect a short (from your calibration kit) to one end of the cable to short the center conductor to the outer conductor.
  2. While wearing a grounded wrist strap, grasp the outer shell of the cable connector.
  3. Connect the other end of the cable to the test port and remove the short from the cable.

**Figure 10 ESD Protection Setup**



ku310b

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## Agilent Support, Services, and Assistance

### Service and Support Options

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

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

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### Contacting Agilent

Assistance with test and measurements needs and information or finding a local Agilent office are available on the Web at:

*<http://www.agilent.com/find/assist>*

You can also purchase accessories or documentation items on the Internet at:

*<http://www.agilent.com/find>*

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

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

### Shipping Your Instrument to Agilent for Service or Repair

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**IMPORTANT** Agilent 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 Agilent for repair.

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

- Include a complete description of the service requested or of the failure and a description of any failed test and any error message.
- Ship the analyzer using the original or comparable antistatic packaging materials.
- Contact Agilent for instructions on where to ship your analyzer.<sup>6</sup>

