PNA Series 2-Port and 4-Port Microwave Network Analyzer System - Banded Self-Configuration - Operation & Installation Guide

110 GHz and 120 GHz

Use this manual in conjunction with the following documents:
- PNA Series Network Analyzer Embedded Help System
(Online at: http://mktwww.srs.is.keysight.com/field/service/network/pna/)
- PNA Series Network Analyzer Installation and Quick Start Guide Part Number E8356-90001
- N5227A PNA Series Microwave Network Analyzer Service Guide Part Number N5227-90026
- N5290/1A Millimeter-Wave System Service Guide N5292-90026

KEYSIGHT

OPERATION AND INSTALLATION GUIDE

Notices

Trademark Acknowledgments

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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.

3. System Installation

4. Performance Verification

5. Maintenance and Support

1 Safety and Regulatory Information

NOTE

This document is applicable to non-LFE broadband millimeter-wave systems and banded millimeter-wave systems. Where the text applies to both types of systems, “millimeter-wave system” is used. Where the content is specific to one or the other types of systems, “non-LFE broadband millimeter-wave system” or “banded millimeter-wave system” is used. For N5290/91A LFE broadband millimeter-wave system information refer to

https://www.keysight.com/us/en/assets/9018-04581/installation-guides/9018-04581.pdf

Information in This Chapter

This chapter provides safety information that will help protect you and your system’s equipment. It also contains information that is required by various government regulatory agencies.

Chapter One at-a-Glance

Section Title	Summary of Content
“Safety Symbols” on page 3	Descriptions of CAUTION and WARNING symbols used throughout this manual.
“General Safety Considerations” on page 4	A list of safety points to consider when servicing your network analyzer.
“Electrostatic Discharge Protection” on page 6	A discussion of electrostatic discharge (ESD) and related recommendations and requirements for ESD protection. Also, includes a table of ESD equipment part numbers.
“Regulatory Information” on page 8	Definitions of instrument markings. Instructions for disposing of the analyzer’s lithium battery.
“N5292A Test Set Equipment Ratings” on page 12	Describes the voltage, frequency, and power ratings of your N5292A test controller
“Environmental Requirements” on page 13	Descriptions of the environmental requirements that are characteristic for a system based on the limitations of the PNA network analyzer
“Site Preparation” on page 14	Describes power requirement-related information for your millimeter-wave system System.

Safety Symbols

The following safety symbols are used throughout this manual. Familiarize yourself with each of the symbols and its meaning before operating this instrument.

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 note until the indicated conditions are fully understood and met.

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.

General Safety Considerations

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 instrument, will make the instrument dangerous. Intentional interruption is prohibited.

WARNING **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 grounding by not using this cord may cause product damage.

Before Applying Power

WARNING 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.

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.

WARNING If an instrument handle is damaged, you should replace it immediately. Damaged handles can break while you are moving or lifting the instrument and cause personal injury or damage to the instrument.

WARNING Supply voltages which oscillate between the two normal input ranges of the autoranging line voltage input will damage the power supply. In rare cases, this damage has become a user safety concern. If unstable power levels are expected, the analyzer input power must be buffered by a line conditioner.

WARNING Safety of any system incorporating the equipment is the responsibility of the assembler of the system.

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

CAUTION Before switching on this instrument, make sure

- the correct rating service breaker.
- the supply voltage is in the specified range

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.

CAUTION Do not operate the analyzer with the outer cover removed for more than 30 minutes, as this could cause the analyzer to overheat which could result in costly damage.

CAUTION Ventilation Requirements: 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 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, then forced convection must be used.

Servicing

NOTE All of the service information for the banded and non-LFE broadband millimeter self-configurations can be found in the Service Guide. Refer to http://literature.cdn.keysight.com/litweb/pdf/N5292-90026.

Electrostatic Discharge Protection

This is important. If not properly protected against, electrostatic discharge can seriously damage your analyzer, resulting in costly repair.

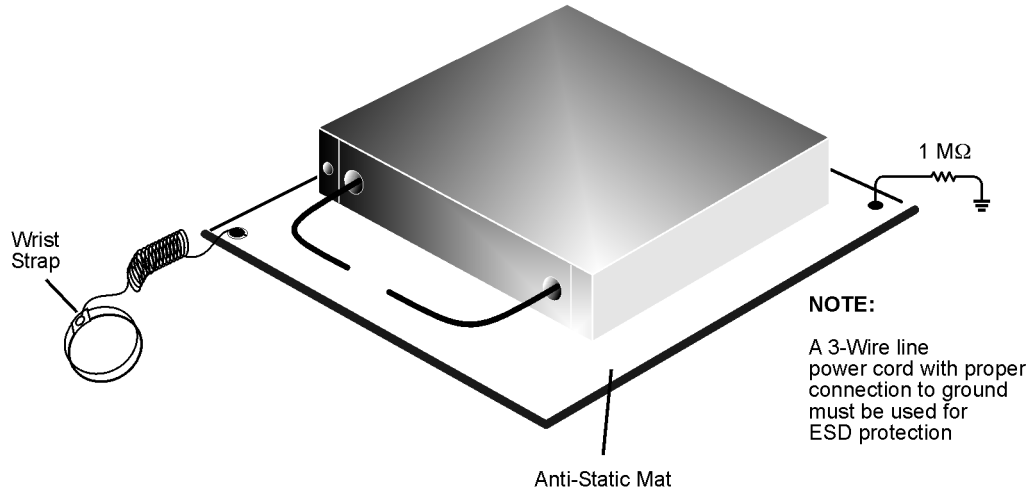
Protection against electrostatic discharge (ESD) is essential while removing assemblies from or connecting cables to the network analyzer. Static electricity can build up on your body and can easily damage sensitive internal circuit elements when discharged. Static discharges too small to be felt can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

- **always** have a grounded, conductive table mat in front of your test equipment.
- **always** wear a grounded wrist strap, connected to a grounded conductive table mat, having a 1 MΩ resistor in series with it, when handling components and assemblies or when making connections.
- **always** wear a heel strap 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 1-1 shows a typical ESD protection setup using a grounded mat and wrist strap. Refer to "Electrostatic Discharge Protection" on page 1-6 for part numbers.

Figure 1-1 ESD Protection Setup



esd_setup

ESD Equipment Required for the Installation

Description	Keysight Part Number
ESD grounding wrist strap	9300-1367
5-ft grounding cord for wrist strap	9300-0980
2 x 4 ft conductive table mat and 15-ft grounding wire	9300-0797
ESD heel strap (for use with conductive floors)	9300-1308

Regulatory Information

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

Instrument Markings

The table below lists the definitions of markings that may be on or with the product. Familiarize yourself with each marking and its meaning before operating the instrument.

NOTE **All instrument markings may not appear on your instrument.**

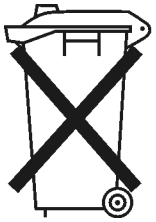
	This symbol marks the standby position of the power line switch.
	This symbol marks the ON position of the power line switch.
	This symbol marks the OFF position of the power line switch.
	This symbol indicates that the input power required is AC.
	This symbol indicates DC voltage
	This symbol indicates a three-phase alternating current.
	This symbol indicates Frame or chassis Terminal.
	The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction in the documentation.
	This symbol indicate the presence of a Laser device.
	This symbol indicates the surface can be hot.
	This symbol indicated the product is sensitive to electrostatic discharge.

	This symbol identifies the Protective Conductor terminal.
	This symbol indicates the equipment is protected throughout by double or reinforced insulation.
	The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all the relevant directives.
	The UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.
	The Keysight email address is required by EU directives applicable to our product.
	The CSA mark is a registered trademark of the CSA International.
	Two person lift required.
CA N ICE S/NMB-001(A)	Canada EMC label. Interference-Causing Equipment Standard for industrial, scientific and medical (ISM) equipment. Matériel industriel, scientifique et médical (ISM).
	CE/ICES/ISM label. (Old mark for reference only.) This is a space saver label that combines three markings - CE with CAN ICES and ISM (see above) and ISM (see below).
	This is a space saver label that combines three markings - CE with CAN ICES and ISM (see above) and ISM (see below).
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
CAN ICES/NMB-001(A) ISM GRP 1-A	This is a space saver label that combines two markings - CAN ICES and ISM.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
	South Korean Certification (KC) mark. It includes the marking's identifier code.

	The crossed-out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation. Please refer to www.keysight.com/go/takeback to understand your trade-in options with Keysight, in addition to product takeback instructions.
	China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.
IP x y	This mark indicates product has been designed to meet the requirements of “IP x y”, where “x” is the solid particle protection and “y” is the liquid ingress protection.

Lithium Battery Disposal

If the battery on your network analyzer’s CPU board needs to be disposed of, dispose of it in accordance with your country’s requirements. If required, you may return the battery to Keysight Technologies for disposal. Refer to “Contacting Keysight” on page 5-4 for assistance.



DO NOT THROW BATTERIES AWAY BUT COLLECT AS SMALL CHEMICAL WASTE.

EMC and Safety Information

EMC Information

Complies with European EMC Directive 2014/30/EU

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, Class A
- AS/NZS CISPR 11
- ICES/NMB-001

This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme a la norme NMB-001 du Canada.

South Korean Class A EMC declaration:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

– This EMC statement applies to the equipment only for use in business environment.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

Safety:

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

– IEC/EN 61010-1

– Canada: CSA C22.2 No. 61010-1

– USA: UL std no. 61010-1

Acoustic Statement: (European Machinery Directive)

Acoustic noise emission

LpA <70 dB

Operator position

Normal operation mode per ISO 7779

To find a current Declaration of Conformity for a specific Keysight product, go to:
http://www.keysight.com/go/conformity

N5292A Test Set Equipment Ratings

Table 1-1 N5292A Equipment Ratings

Nominal voltage and frequency or range	100/120V/220/240 Vac, 50/60 Hz
Power in watts, VA or current	210 W MAX

Environmental Requirements

CAUTION

Ventilation Requirements: 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 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, then forced convection must be used.

The environmental requirements shown below are characteristic for the system and are based on the limitations of the PNA network analyzer used.

Table 1-2 Millimeter-wave System Environmental Conditions (Operating)

Environment	Temperature
Operation	0 °C to 40 °C (41 °F to 104 °F)
Storage	–40 °C to +65 °C (–40 °F to 158 °F)
Measurement Calibration	20 °C to 26 °C (68 °F to 79 °F)
Performance Verification	Temperature must be within 1 °C (1.8 °F) of the temperature at which the measurement calibration was performed.
Relative Humidity	Type tested at 95%, +40 °C (non-condensing)
Pressure Altitude	Type tested 0 to 4600 meters (~15,000 feet)

Table 1-3 N5292/3/5A Environmental Conditions (Operating)

Environment	Temperature
for indoor use only (unless specified otherwise.)	0 °C to 40 °C
Altitude up to	4,600 meters
Temperature	0 to 40 °C
Relative humidity	Type tested, 0 to 95% relative humidity, non-condensing up to 40°C

System Heating and Cooling

Install air conditioning and heating, if necessary, to maintain the ambient temperature within the appropriate range (as given in the table above). Air conditioning capacity must be consistent with the BTU ratings given in Table 1-2 on page 1-13 and Table 1-3 on page 1-13.

Required Conditions for Accuracy Enhanced Measurement

Accuracy-enhanced (error-corrected) measurements require the ambient temperature of the millimeter-wave system to be maintained within ± 1 °C of the ambient temperature at calibration.

Site Preparation

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. An externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) should be used as the disconnecting device.The detachable power cord can also be used to disconnect 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.

Power Requirements

Before installing the system, be sure that the required ac power is available at all necessary locations.

- Three-wire power cables (which provide a safety ground) must be used with all instruments.
- Air-conditioning equipment (or other motor-operated equipment) should not be placed on the same ac line that powers the system.
- The table below lists the maximum VA ratings and BTU/hour ratings for all instruments in the system. This table can be used to determine both the electrical requirements and the air conditioning requirements of the system.

Table 1-4 Power Requirements of the System

Standard Equipment Instrument	Maximum VA Rating	Maximum BTU/hour
N522xB and N524xB	350	1195
N5292A millimeter head controller	210	717
OML/VDI millimeter head (x1, x2, x3, or x4)	(Maximum VA rating includes any millimeter heads powered from controller)	(Maximum BTU/hour rating includes any millimeter heads powered from controller)
Total	**560**	**1912**

NOTE

Values are verified with 120 Vac supplied to each instrument at 60 Hz.

The N5292A millimeter head controller supplies power to the test head modules.

2 System Description

NOTE The Low Frequency Extension (LFE) refers to the 900 Hz to 100 MHz frequency range sold as option 205, 220, 405, and 420 in the N522xB and option 205, 425, and 429 in the N524xB. All other configuration options are considered to be “non-LFE”. “Broadband” is defined as a system which can sweep from 900 Hz or 10 MHz to 110/120 GHz.

NOTE This document is applicable to non-LFE broadband millimeter-wave systems and non-LFE and LFE banded millimeter-wave systems. Where the text applies to both types of systems, “millimeter-wave system” is used. Where the content is specific to one or the other types of systems, “non-LFE broadband millimeter-wave system” or “banded millimeter-wave system” is used.

For N5290/91A LFE broadband millimeter-wave system information refer to https://www.keysight.com/us/en/assets/9018-04581/installation-guides/9018-04581.pdf.

Information in This Chapter

This chapter describes preparing to receiving your 2-port or 4-port self-configured banded or non-LFE broadband millimeter system and the system's installation procedure(s).

Chapter Two at-a-Glance

Section Title	Summary of Content
"Self-Configured Banded or Non-LFE Broadband Millimeter-Wave Network Analyzer System" on page 2-3	Overview of the banded or non-LFE broadband N52xxB millimeter-wave system.
"Network Analyzer Requirements" on page 2-8	Description of compatible PNA features.
"N5292A Test Set Description" on page 2-11	N5292A test set controller description of front and rear panel features.
"Interconnect Kits, Rackmount Kits, and Optional Parts" on page 2-14	Description of the interconnect heads, rackmount kits, and optional parts.
"Compatible Millimeter-wave Modules" on page 2-21	Keysight N5293A/95A millimeter head and OML/VDI millimeter head descriptions of their features.
"Basic System Measurement Configurations" on page 2-26	Millimeter-wave system basic measurement configurations.

Self-Configured Banded or Non-LFE Broadband Millimeter-Wave Network Analyzer System

CAUTION Non-LFE broadband millimeter-wave capability is only available with the N5293/5A millimeter-wave modules and operates from 10 MHz to 110/120 GHz. For banded systems, the frequency range will vary from 60 GHz to 1.5 THz depending on the OML/VDI millimeter-wave heads used in the system.

NOTE **IMPORTANT!** Only PNAs and PNA-X network analyzers with a frequency range equal to greater than 20 GHz are compatible with the N5292A test set controller.

NOTE **IMPORTANT!** For additional information on the OML/VDL heads, refer to "OML/VDI – Banded Configuration Calibration (Only)" on page 3-23.

Introduction

This section of this document describes system installation and operation for a banded or non-LFE broadband millimeter-wave system using an N5292A Millimeter Head Controller. Banded and non-LFE broadband millimeter-wave systems are made up of three types of major components: a PNA or PNA-X, a N5292A controller test set, and millimeter-wave heads. These components are generally purchased separately and assembled by the customer into a system at the customer's site. This section of the document focuses on receiving the controller with accessories and then on system installation and operation.

NOTE **IMPORTANT!** For banded systems that are using the OML modules that require DC bias, a separate N5260AK91 power supply and adapter is required. See also, Table 2-9 on page 2-19. And, for VDI modules that require DC bias, use the VDI-175 power supply.

Each OML/VDI module requires a N5290A304 cable adapter to connect to the N5292A test set. See also Table 2-9 on page 2-19.

For additional information on the OML/VDL heads, refer to "OML/VDI – Banded Configuration Calibration (Only)" on page 3-23.

Table 2-3 and Table 2-4 list compatible PNA and PNA-X models with required options. Figure 2-10 on page 22 and Figure 2-11 on page 23 list available millimeter-wave modules. Typical system configurations are pictured in Figure 2-1 on page 5, Figure 2-2 on page 5, Figure 2-3 on page 6, and Figure 2-4 on page 7.

The N5292A Millimeter Head Controller is also used as part of the banded and non-LFE broadband analyzer system. Refer to "N5292A Test Set Description" on page 2-11.

In this document the N5292A will be referred to as the test set.

- The self-configured Non-LFE broadband millimeter-wave system is a 2-port or 4-port vector network analyzer system 10 MHz to 110 GHz or 10 MHz to 120 GHz.
- The self-configured banded millimeter-wave system is a 2-port or 4-port vector network analyzer system. The bands are dependent on the type of OML/VDI heads (60 GHz to 1.5 THz).

The illustration below shows the N52xxB configured for broadband coaxial measurement with Keysight's N5293/5A millimeter-modules (refer to Figure 2-1 on page 5 and Figure 2-2 on page 5).

The illustrations below shows the third party OML/VDI modules (refer to Figure 2-3 on page 6 and Figure 2-4 on page 7).

Figure 2-1 N52xxB 2-Port Non-LFE Broadband Test System – Coaxial Measurement Configuration (using N5293/5A Millimeter Heads)

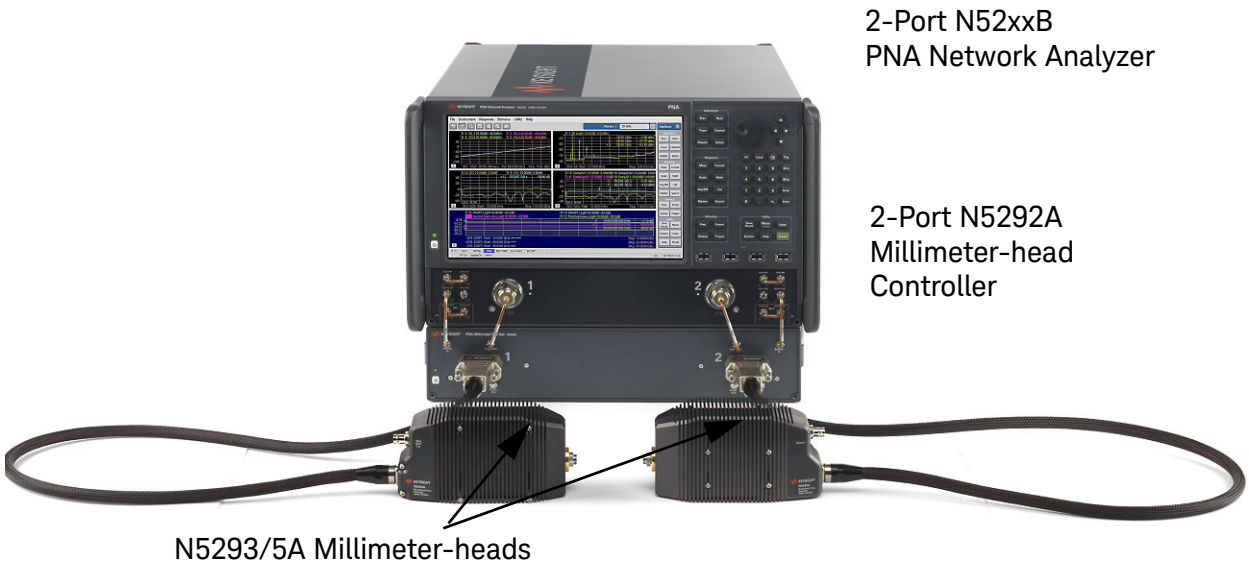


Figure 2-2 N52xxB 4-Port Non-LFE Broadband Test System – Coaxial Measurement Configuration (using N5293/5A Millimeter Heads)

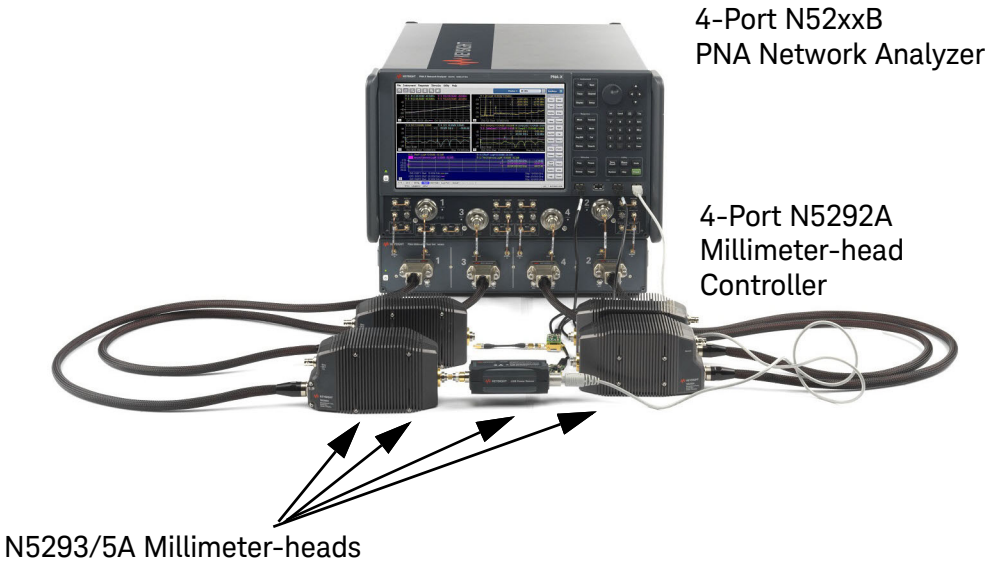
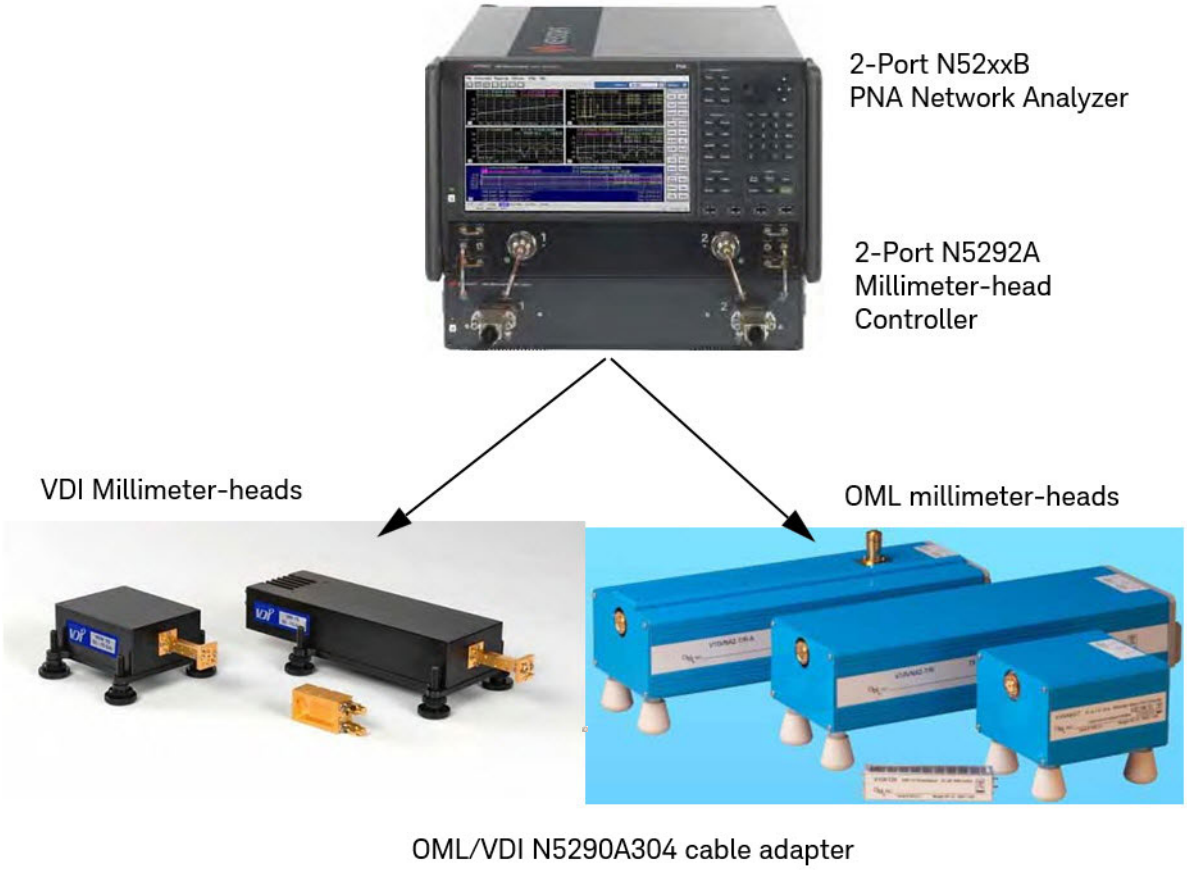


Figure 2-3 N52xxB 2-Port Banded Test System – Coaxial Measurement Configuration (using OML/VDI Millimeter Heads)



OML/VDI N5290A304 cable adapter

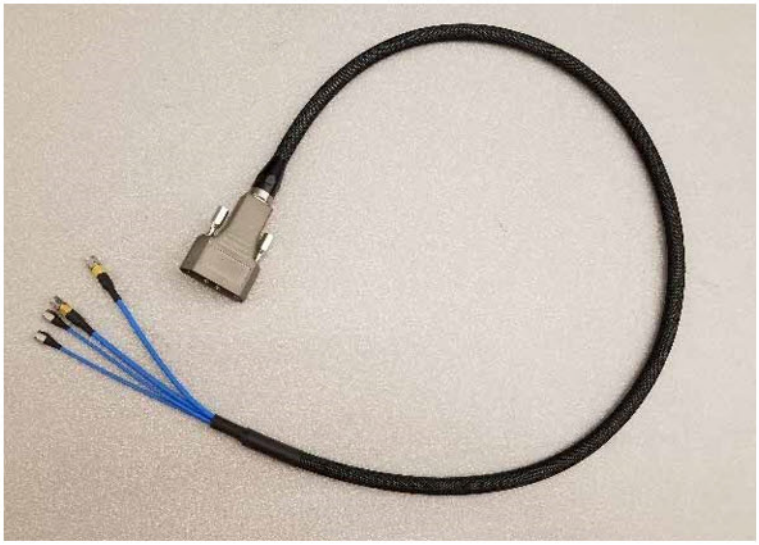
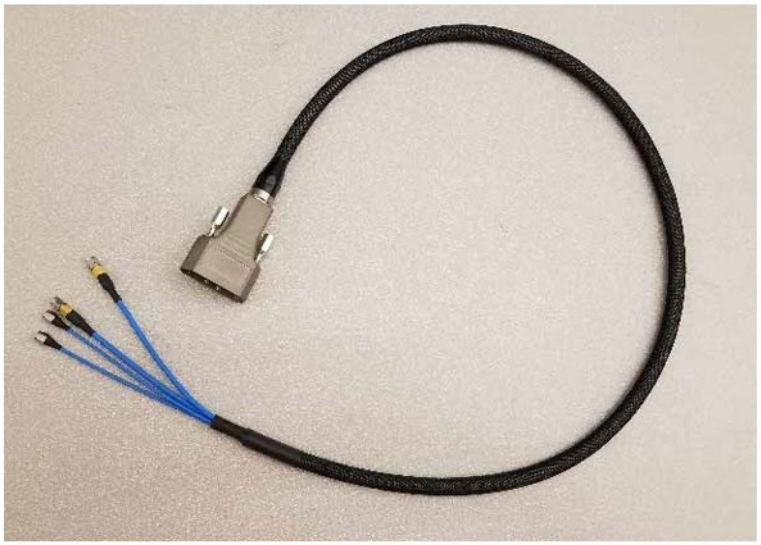


Figure 2-4 N52xxB 4-Port Banded Test System – Coaxial Measurement Configuration (using OML/VDI Millimeter Heads)

OML/VDI N5290A304 cable adapter



Network Analyzer Requirements

The required options for PNA models are indicated in the “PNA Option(s)” column of Table 2-3 on page 2-10. The required options for PNA-X models are indicated in the “PNA Option(s)” column of Table 2-4 on page 2-10.

The minimum firmware revision for PNA and PNA-X models is ≥A.12.80.

Space Requirements

Standard installation of the N52xxB with N5292A test set millimeter-wave system includes configuration and installation of the system on a customer provided lab bench or table top of adequate size and strength.

N52xxB with N5292A Test Set System Weight and Dimensions

Table 2-1 Stacked System Benchtop Dimensions[1]

Model	Weight[2]	Required Benchtop Dimensions for the System		
		Height[3]	Width	Depth
2-Port	48 kg to 64 kg	37.5 cm (8U)	48.3 cm	57.8 cm or 65 cm
4-Port	51 kg to 70 kg			

1. System benchtop dimensions are dependent on the number of ports, PNA model, and the style of the millimeter-head.
2. Minimum weights calculated with one VDI millimeter-head. Maximum weights calculated with four OML millimeter-heads.
3. All heights include the height of a single set of instrument feet (1.3 cm).

Component Weight and Dimensions

Table 2-1, “Stacked System Benchtop Dimensions,” shows the maximum weight and dimensions of the N52xxB with N5292A test set millimeter-wave system components. Refer also to Table 2-2 on page 2-9 for test head module dimensions.

Table 2-2 N52xxB Banded and Non-LFE Broadband Millimeter-wave System Components Weights and Dimensions

Model	Weight	Height[1]	Width	Depth
N5221B, N5222B, N5241B, N5242B, N5249B	36 kg to 37 kg, depending on hardware options	28.6 cm (6U)	48.3 cm	57.8 cm
N5224B, N5225B, N5244B, N5245B	36 kg to 45 kg, depending on hardware options			65 cm
N5227B, N5247B	41 kg to 49 kg, depending on hardware options			
N5292A	9 kg	10.2 cm (2U)	42.6 cm	60 cm
N5293/5A Millimeter-wave test head modules	1.6 kg	9 cm	7.3 cm	16.7 cm
OML Millimeter-wave test head modules	1.3 kg to 3 kg	6.9 cm (S & T/R) 6.9 cm (T)	10.9 cm (S & T/R) 10.9 cm (T)	33 cm (S & T/R) 11.9 cm (T)
VDI Millimeter-wave test head modules	1 kg (Rx) to 1.8 kg (TxRx & TxRef)	3.8 cm (Rx) 3.8 cm (TxRx & TxRef)	7.6 cm (Rx) 7.6 cm (TxRx & TxRef)	8.9 cm (Rx) 21.6 cm (TxRx & TxRef)

1. All heights include the height of a single set of instrument feet (1.3 cm).

System Configurations

Table 2-3 and Table 2-4 on page 2-10 document all supported module configurations for S-Parameter measurement capabilities for broadband and banded mm-wave systems using the N5292A Option 200 and N5292A Option 400 test set. See also, Table 2-10 on page 2-22 through Table 2-11 on page 2-23.

Table 2-3 PNA Based Configurations

PNA Model (s)	PNA Options[1]	Test Set	Cable Interface Kit
N5222B	201, 217, or 219	N5292A-200	N5292A-222
			N5292A-222
	401, 417, or 419	N5292A-200	N5292A-222
		N5292A-400	N5292A-442
N5224B/5B/7B	201, 217, or 219	N5292A-200	N5292A-224
	401, 417, or 419	N5292A-200	N5292A-224
		N5292A-400	N5292A-444

1. All PNA's require Option 020.

Table 2-4 PNA-X Based Configurations

PNA-X Model (s)	PNA Option(s)[1]	Test Set	Cable Interface Kit
N5242B	201, 217, 219, 222, or 224	N5292A-200	N5292A-222
	401, 417, 419, 422, or 423	N5292A-200	N5292A-222
		N5292A-400	N5292A-442
N5244/5B/47B	201, 217, 219, 222, or 224	N5292A-200	N5292A-224
	401, 417, 419, 422, or 423	N5292A-200	N5292A-224
		N5292A-400	N5292A-444

1. All PNA-X's require Option 020.

N5292A Test Set Description

The N5292A-200 and N5292A-400 millimeter head controllers provide the test interface between the millimeter-wave test head modules and the PNA/PNA-X (PNA) series network analyzers.

The millimeter-head controller, when used in conjunction with the millimeter-wave test head modules and the PNA, provides all of the feature and functions of a full S-Parameter test set.

The millimeter head controller supplies RF and LO signals to the millimeter-wave test head modules and returns the down converted reference and test IF signals to the PNA for processing and display. The N5292A-200 and N5292A-400 millimeter head controllers also supply the +12 volt bias to each millimeter-wave head module.

The front panels of the N5292A Option 200 and N5292A Option 400 millimeter head controllers are illustrated below.

See also “Compatible Millimeter-wave Modules” on page 2-21.

Front Panel Features

Figure 2-5 N5292A Option 200 (2-Port) Front Panel Features

Figure 2-6 N5292A Option 400 (4-Port) Front Panel Features

IF Ref Out

IF reference output connection provides direct access to the IF signal from the module and is accessed by changing a switch setting in the millimeter wave dialog. This enables you to connect and to measure higher frequency IF output signals.

IF Test Out

IF test output connection provides direct access to the IF signal from the module and is accessed by changing a switch setting in the millimeter wave dialog. This enables you to connect and to measure higher frequency IF output signals.

1 / 2/ 3/ 4 (Integrated Connector)

Provides an integrated interface for the RF, LO, and IF signals to and from the millimeter wave modules.

NOTE

Ports 3 and 4 features are not present on the N5292A with Option 200. Refer to Figure 2-5 on page 11.

Source In

Receives amplified RF signal to the millimeter-wave module's RF Input. Connects from the PNA's – SOURCE OUT to the corresponding N5292A Source In. This enables each port to have independent RF port power levels on all to 4-ports (if available).

Low Band

Only used in N5290A/1A broadband systems.

On/Standby Power Switch

LED is green when the power is on and amber when in standby mode.

Active LED

When the test set is connected and addressed by a analyzer, the LED is On (illuminated). The LED is Off (not illuminated) when the test set is in Standby, or not addressed by the analyzer.

Rear Panel Features

Figure 2-7 N5292A Option 200 (2-Port) and 400 (4-Port) – Rear Panel Features

IF OUTPUTS – SMA (female)

- D (from the test set to the analyzer's IF D Input)
- C (from the test set to the analyzer's IF C Input)
- R (from the test set to the analyzer's IF R Input)
- A (from the test set to the analyzer's IF A Input)
- B (from the test set to the analyzer's IF B Input)

LO IN

This input is from the LO drive of the analyzer. The signal is split and amplified and then output to the front panel of the N5292A Option 200/400.

Test Set I/O

The test set interface connector is used digitally control to the test set from the analyzer.

Line Module

This assembly houses the line cord connection. Line voltage selection is automatic and no setting is required.

Power Cords

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

Interconnect Kits, Rackmount Kits, and Optional Parts

Banded and Non-LFE Broadband N52xxB Millimeter System Interconnect Kits

CAUTION

IMPORTANT!

The N5292A-xx4 interconnect kits contain 2.4 mm to 3.5 mm cables. It is important to connect the 2.4 mm end to the PNA and to connect the 3.5 mm end to the N5292A test set controller. Improper connections will result in damage to your instruments (i.e., the 2.4 mm cable end is compatible with the 1.85 mm connector of the PNA).

It is important to use two wrenches when connecting the semi-rigid cables to the 1/2/3/4 front ports of the PNA to avoid stressing the connectors and causing damage to your PNA.

See also Table 2-7 on page 2-16.

Figure 2-8 PNA RF Port Connector to N5292A Test Set Lo Band Connector (2.4 mm)

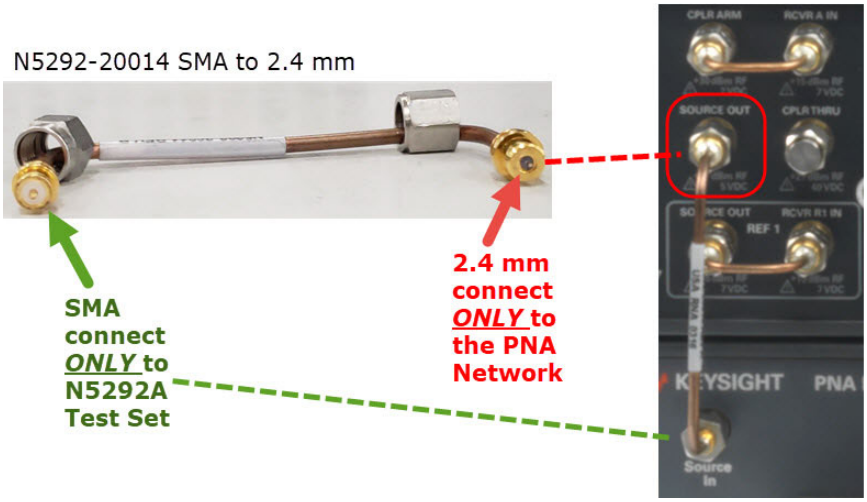


Table 2-5 N52xxB PNA Millimeter-Wave System Options and Interconnect Kit Part Numbers

N52xxB Banded or Non-LFE Broadband System – Models/ # of Ports/ Options/ Interconnect Kit Part Numbers		
Model / # of Ports	**N5292A Test Set Interconnect Kit Options**	**Interconnect Kit Part Numbers**
N5222B/42B 2-Port (26.5GHz)	N5292A-222 N5292A-422	N5292-60012 (3.5 mm)
	N5292A-242	N5292-60014 (3.5 mm)
N52xxB 2-Port (>26.5 GHz)	N5292A-224 N5292A-424	N5292-60013 (1.85 mm or 2.4 mm to 3.5 mm)
N52xxB 4-Port (26.5GHz)	N5292A-442	N5292-60016 (3.5 mm)
N52xxB 4-Port (>26.5 GHz)	N5292A-244	N5292-60015 (1.85 mm or 2.4 mm to 3.5 mm)
	N5292A-444	N5292-60017 (1.85 mm or 2.4 mm to 3.5 mm)

Interconnect Kit—Common Parts to All Kits

Table 2-6 Interconnect Kit Common Parts to All N5292-600xx Kits

Banded and Non-LFE Broadband Systems – Interconnect Kits			
Ref Desig.	**Description**	**Qty**	**Part Number**
--	Quick Start Poster (with links to Installation Guides & to the Critical Connector Care document)	1	N5292-90003
--	Machine screw, M4 x 25 mm, pan head (to attach locking feet)	4	0515-1619
--	Cable assy, coaxial 50 ohm SMA (m) to 50 ohm SMA (m) - 12 in long	5	8121-2970
--	External cable assy 25-way D-sub	1	N4011-21002
--	Cable assy-RF, SMA to SMA 16 in long – 26.5 GHz	1	N5240-60092
--	Lower lock foot, right	1	N5292-20012
--	Lower lock foot, left	1	N5292-20013

Interconnect Kits—Unique Parts

Table 2-7 Millimeter-wave System Contents - Interconnect Kits: N5292-60012, N5292-60013, N5292-60014, N5292-60015, N5292-60016, and N5292-60017 (2 of 2)

Banded and Non-LFE Broadband Systems – Interconnect Kits			
Ref Desig.	**Description**	**Qty**	**Part Number**
N5292-60012 – N5292A-222 (2-Port Test and 2-Port VNA with 3.5 mm Ports) and N5292A-422 (4-Port Test Set and 2-Port VNA with 3.5 mm Ports)			
--	Microwave Plug SMA Male Straight 50-Ohm, attached to network analyzer CPLR THRU	2	1250-4261
--	Upper lock foot, right, long	1	N5240-20093
--	Upper lock foot, left, long	1	N5240-20094
--	Cable assy-RF, RF Source to Test Set	2	N5292-20006
--	Cable assy-RF, 2-Port, LFE Source to Test Set (Not used)	2	N5292-20009
N5292-60013 – N5292A-224 (2-Port Test Set with 2-Port VNA with 2.4 mm Ports) and N5292A-424 (4 Port Test Set with 2-Port VNA with 2.4 mm Ports)			
--	Connector-RF Termination 2.4mm Plug Straight 50-Ohm 50GHz-MAX, attached to network analyzer CPLR THRU	2	0955-2394

Table 2-7 Millimeter-wave System Contents - Interconnect Kits: N5292-60012, N5292-60013, N5292-60014, N5292-60015, N5292-60016, and N5292-60017 (2 of 2)

Ref Desig.	Banded and Non-LFE Broadband Systems – Interconnect Kits Description	Qty	Part Number
--	Upper lock foot, right, short	1	N5240-20092
--	Upper lock foot, left, short	1	N5240-20095
--	Cable assy-RF, RF Source to Test Set, SMA 2.4 mm	2	N5292-20014
--	Cable assy-RF, 2-Port, LFE Source to Test Set, SMA 2.4 mm (Not used)	2	N5292-20017
N5292-60014 – N5292A-242 (2-Port Test Set and 4-Port VNA with 3.5 mm Ports)			
--	Microwave Plug SMA Male Straight 50-Ohm, attached to network analyzer CPLR THRU	4	1250-4261
--	Upper lock foot, right, long	1	N5240-20093
--	Upper lock foot, left, long	1	N5240-20094
--	Cable assy-RF, SMA to SMA 16 in long – 26.5 GHz	1	N5240-60092
--	Cable assy-RF, RF Source to Test Set	2	N5292-20006
--	Cable assy-RF, 4-port, LFE Source to Test Set – A (Not used)	2	N5292-20007
N5292-60015 – N5292A-244 (2-Port Test Set and 4-Port VNA with 2.4 mm Ports)			
--	Connector-RF Termination 2.4mm Plug Straight 50-Ohm 50GHz-MAX, attached to network analyzer CPLR THRU	4	0955-2394
--	Upper lock foot, right, short	1	N5240-20092
--	Upper lock foot, left, short	1	N5240-20095
--	Cable assy-RF, RF Source to Test Set, SMA 2.4 mm	2	N5292-20014
--	Cable assy-RF, 4-Port, LFE to Test Set – A, SMA 2.4 mm (Not used)	2	N5292-20015
N5292-60016 – N5292A-442 (4-Port Test Set and 4-Port VNA with 3.5 mm Ports)			
--	Microwave Plug SMA Male Straight 50-Ohm, attached to network analyzer CPLR THRU	4	1250-4261
--	Upper lock foot, right, long	1	N5240-20093
--	Upper lock foot, left, long	1	N5240-20094

Table 2-7 Millimeter-wave System Contents - Interconnect Kits: N5292-60012, N5292-60013, N5292-60014, N5292-60015, N5292-60016, and N5292-60017 (2 of 2)

Ref Desig.	Banded and Non-LFE Broadband Systems – Interconnect Kits Description	Qty	Part Number
--	Cable assy-RF, RF Source to Test Set	4	N5292-20006
--	Cable assy-RF, 4-port, LFE Source to Test Set – A (Not used)	2	N5292-20007
--	Cable assy-RF, 4-port, LFE Source to Test Set – B (Not used)	2	N5292-20008
N5292-60017 – N5292A-444 (4-Port Test Set and 4-Port VNA with 2.4 mm Ports)			
--	Connector-RF Termination 2.4mm Plug Straight 50-Ohm 50GHz-MAX, attached to network analyzer CPLR THRU	4	0955-2394
--	Upper lock foot, right, short	1	N5240-20092
--	Upper lock foot, left, short	1	N5240-20095
--	Cable assy-RF, RF Source to Test Set, SMA 2.4 mm	4	N5292-20014
--	Cable assy-RF, 4-Port, LFE to Test Set – A, SMA 2.4 mm (Not used)	2	N5292-20015
--	Cable assy-RF, 4-Port, LFE to Test Set – B, SMA 2.4 mm (Not used)	2	N5292-20016
Miscellaneous/Spare Parts			
--	Connector-RF Termination 2.4mm Plug Straight 50-Ohm 50GHz-MAX[1] (compatible with 1.85 mm connectors)	1	0955-2394
--	3.5 mm 50 ohm terminations[1]	1	1250-4087

1. IMPORTANT! Performace tests will fail, if 50 ohm terminations are not installed on the test ports.

See also Table 2-5 on page 2-15.

Millimeter System Rackmount Kits

Use the table below to order rackmount kits.

Table 2-8 Rackmount Hardware

√	Keysight Part Number	Description	Qty
	5063-1543	Rackmount Kits for installation without handles - PNA	1
	5063-1555	Rackmount Kits for installation with handles - PNA	1
	1CM110A	Rackmount Kits for installation without handles - N5292A	1
	1CP104A	Rackmount Kits for installation with handles - N5292A	1
	E3663A	Rails[1]	2

1. Depending on the type of instruments ordered for your system, you might receive an extra (duplicate) set of N5292A Test Controller mounting rails.

Millimeter System Optional Parts

NOTE For information on N5292A system rackmount kits, refer to "Rackmount Hardware" on page 2-19.

Use the table below to order optional accessories for your self-configured millimeter-wave system.

Table 2-9 Millimeter System Optional Parts

√	Keysight Part Number	Description	Qty
	N5260AK91	12V power supply and adapter–OML module	
	N5290A301	Frequency extender bias tee adapter kit (Only can be used with N5293A/95A millimeter modules (TxRx))	1
	N5290A302	Frequency extender desktop positioner. (LFE and Non-LFE Broadband Only)[1]	1
	N5290A304	OML/VDI cable adapter[2]	1

1. Refer to Figure 2-9 on page 2-20.
2. Refer to Figure 2-3 on page 2-6 and Figure 2-4 on page 2-7.

Figure 2-9 N5293/5AX03 Millimeter-wave module with N5290A302 Frequency Extender Desktop Positioner Kit

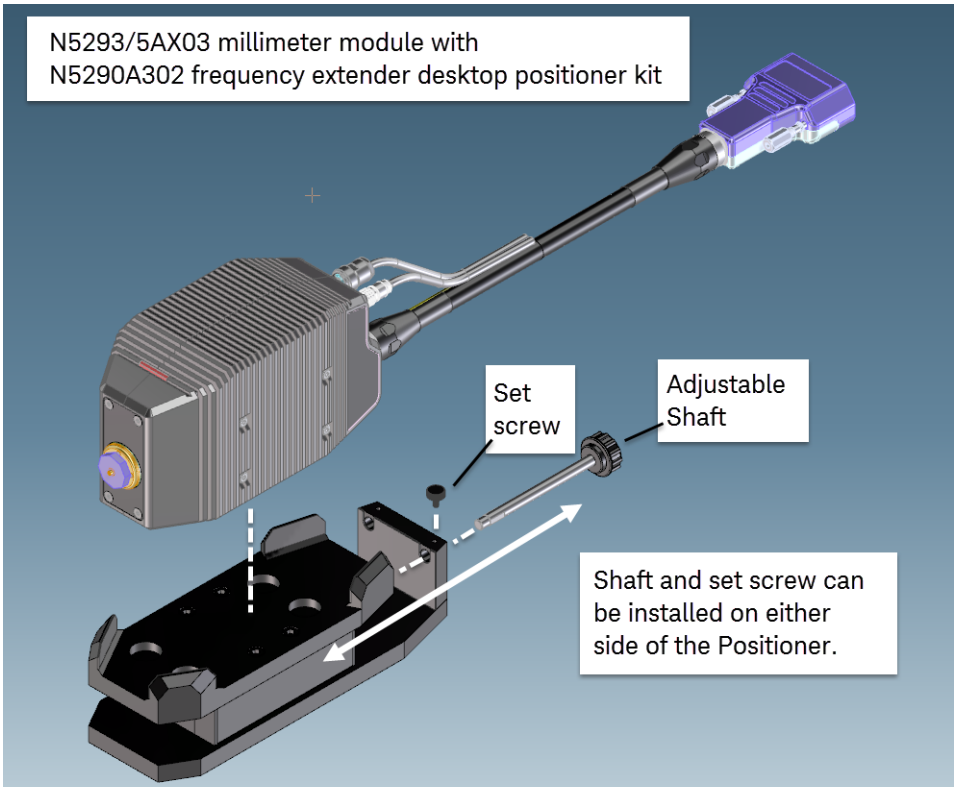
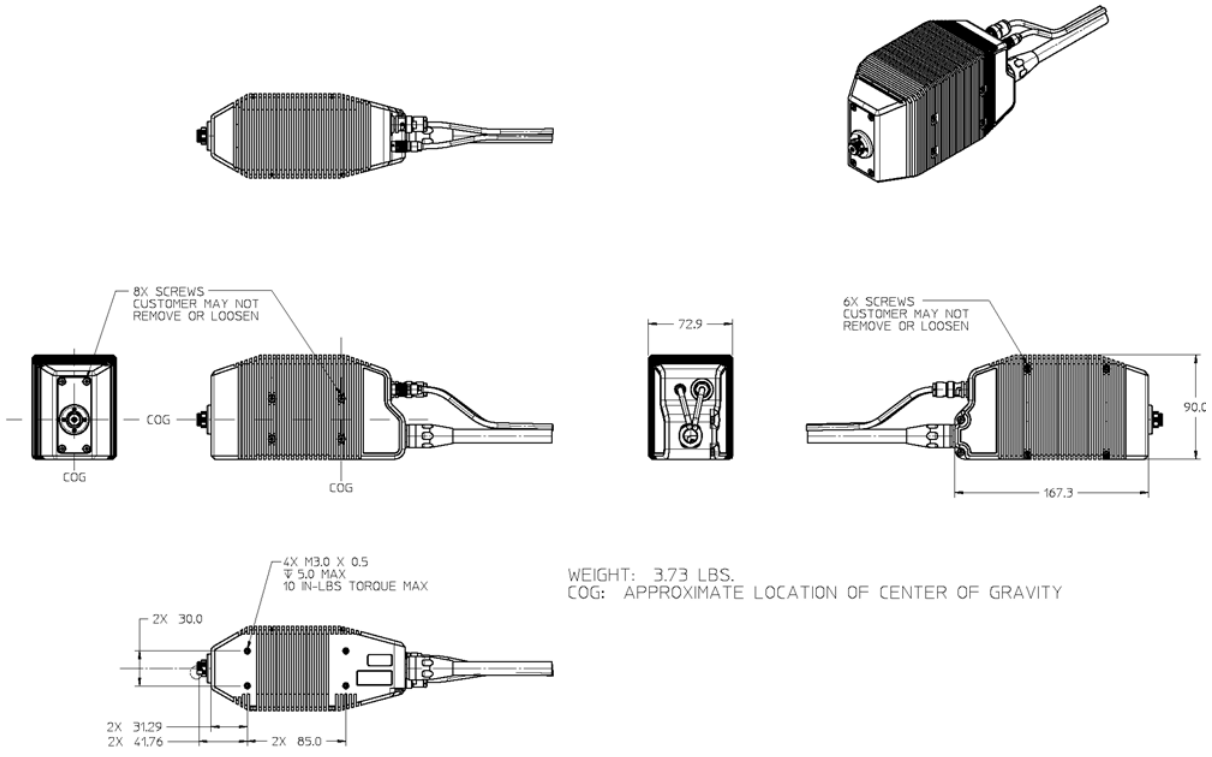


Figure 2-10 N5293/5AX03 Millimeter-wave module Mechanical Specifications



Compatible Millimeter-wave Modules

Non-LFE broadband systems use the N5293A and N5295A (TxRx) millimeter modules. For banded millimeter-wave system measurements, the Transmission (Tx) and Reflection (Rx) banded millimeter modules manufactured by Olsen Microwave Labs (OML) and Virginia Diodes Inc (VDI) can be used with the N52xxB banded mm-wave network analyzer systems. Both types of systems require the N5292A controller. Refer to Table 2-10 on page 2-22 and Table 2-11 on page 2-23.

Keysight's N5293A/5A, and OML's and VDI's Transmission/Reflection millimeter-wave modules contain an RF source multiplier, dual directional coupler, reference downconverter and a test downconverter. A single Transmission/Reflection module allows the measurement of reflection coefficient only (e.g., S11, S22, etcetera). Refer to Figure 2-11 on page 22.

OML/VDI's "Receive only" millimeter-wave modules contain a test downconverter to receive the test signal from a Transmission/Reflection millimeter-wave module. The use of a Receiver module, as the second module, allows the system capability to measure a single transmission coefficient only (e.g., S21, S12, etcetera). Refer to Figure 2-11 on page 22.

NOTE

"Receive only" millimeter-wave modules only apply to the OML/VDI modules.

The use of two Keysight N5293A/95A or OML/VDI Transmission/Reflection modules in the millimeter-wave VNA system allows for all four S-parameters to be measured. The test downconverters of Transmission/Reflection modules are the receivers for the signal from the modules sources. When the two modules waveguide are connected, S11 and S21 are measured in the forward direction, S22 and S12 are measured when the signal path is reversed. If a 4-Port system is configured with Transmission/Reflection modules, all 16 S-parameter measurements can be made on a 4-Port device. Refer to Figure 2-11 on page 22.

Figure 2-11 Module Configurations

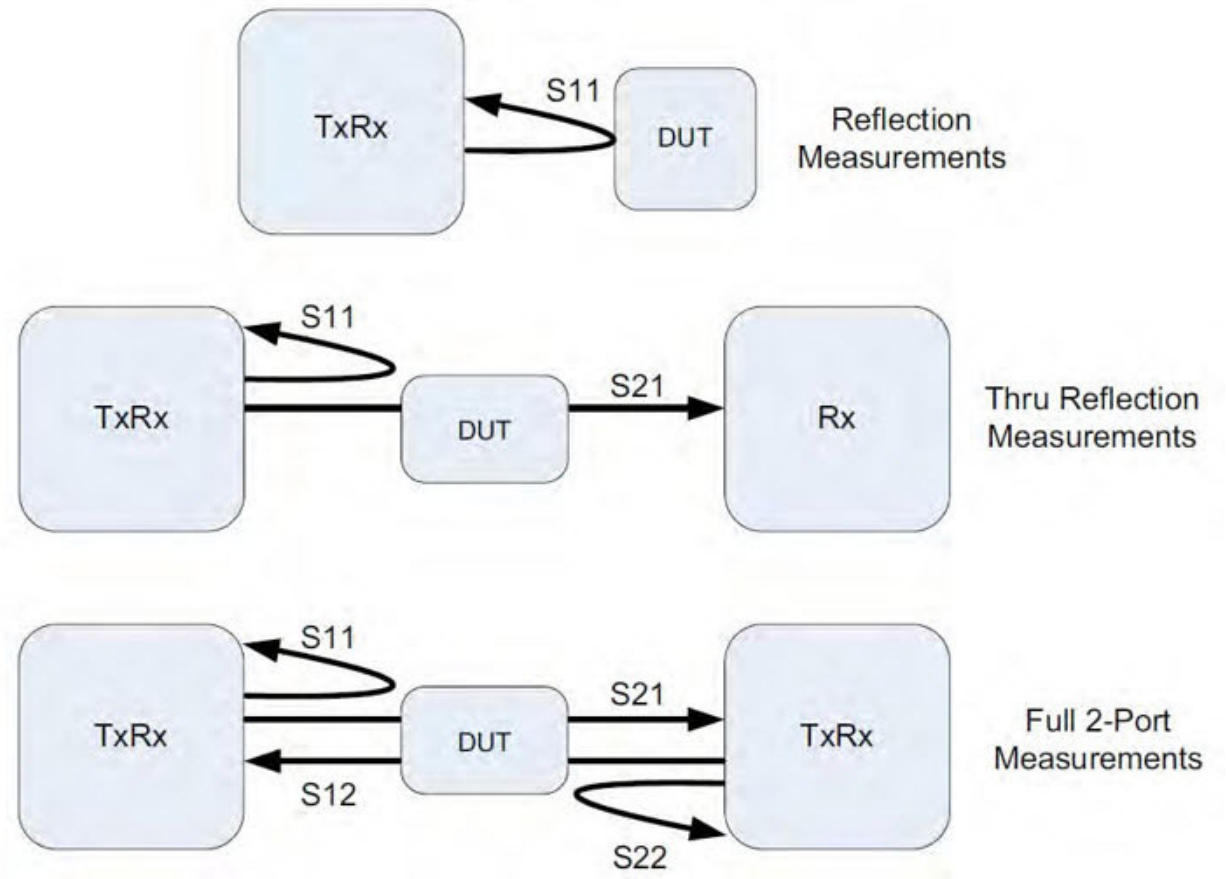


Table 2-10 Supported Broadband Module Assembly Model Numbers

Connector / Broadband Frequency Range	TxRx Module (Keysight)	Calibration Kit	Verification Kit	Bias Requirements
1.0 mm / 10 MHz to 110 GHz	N5293AX01 N5293AX02 N5293AX03 N5293AX51 N5293AX52 N5293AX53	85059B	85059V	Bias 50V 1A (BNC)
1.0 mm/ 10 MHz to 120 GHz	N5295AX01 N5295AX02 N5295AX03 N5295AX51 N5295AX52 N5295AX53	85059B	85059V	

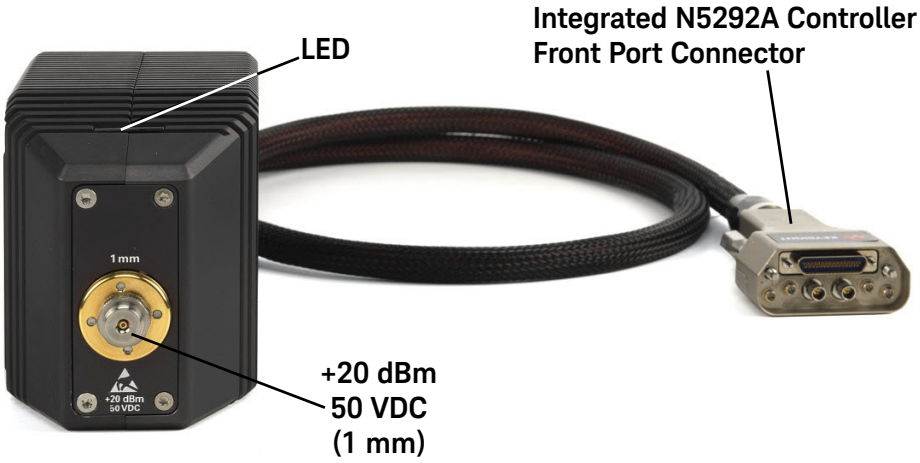
Table 2-11 Supported Banded Module Assembly Model Numbers[1]

Connector / Band	T/R Module (OML)	R-Only Module (OML)	Dual R Module (OML)	T/R Module (VDI)	R-Only Module (VDI)	Calibration Kit (OML)	Calibration Kit (OML)
WR15 (50-75 GHz)	N5256AW15 **N5256BW15**	N5257AR15 **N5257BR15**	N5258AD15 **N5258BR15**	N5262AW15 **N5262BW15**	N5262AR15 **N5262BR15**	-- --	N5262AC15
WR12 (60-90 GHz)	N5256AW12 **N5256BW12**	N5257AR12 **N5257BR12**	N5258AD12 **N5258BR12**	N5262AW12 **N5262BW12**	N5262AR12 **N5262BR12**	N5260AC12	N5262AC12
WR10 (75-110 GHz)	N5256AW10 --	N5257AR10 --	N5258AD10 --	N5262AW10 **N5262BW10**	N5262AR10 **N5262BR10**	-- --	N5262AC10
WR8.0 (90-140 GHz)	N5256AW08 --	N5257AR08 --	N5258AD08 --	N5262AW08 **N5262BW08**	N5262AR08 **N5262BR08**	N5260AC08	N5262AC08
WR06 (110-170 GHz)	N5256AW06 --	N5257AR06 --	N5258AD06 --	N5262AW06 **N5262BW06**	N5262AR06 **N5262BR06**	N5260AC06	N5262AC06
WR05 (140-220 GHz)	N5256AW05 --	N5257AR05 --	N5258AD05 --	N5262AW05 **N5262BW05**	N5262AR05 **N5262BR05**	N5260AC05	N5262AC05
WR04 (170-260 GHz)	-- --	-- --	-- --	N5262AW04 --	N5262AR04 --	-- --	-- --
WR03 (220-325 GHz)	N5256AW03 --	N5257AR03 --	N5258AD03 --	N5262AW03 **N5262BW03**	N5262AR03 **N5262BR03**	N5260AC03	N5262AC03
WR2.2 (325-500 GHz)	N5256AW02.2 --	N5257AR02.2 --	N5258AD02.2 --	N5262AW02 **N5262BW02**	N5262AW02 **N5262BR02**	N5260AC02	N5262AC02
WR1.5 (500-750 GHz)	-- --	-- --	-- --	N5256AW01 --	N5256AR01 --	-- --	N5260AC01
WR1.0 (750-1100 GHz)	-- --	-- --	-- --	N5262AW01 --	N5262AR01 --	-- --	N5262AC01
WR0.65 (1100-1500 GHz)	-- --	-- --	-- --	N5262AW065 --	-- --	-- --	-- --
Options for each column	STD: standard 001: 25 dB attenuator 002: 15 dB amplifier	STD: standard 001: 15 dB amplifier	STD: standard 001: 15 dB amplifier	700: standard 701: 25 dB attenuator	700: standard 701: 25 dB attenuator	-- --	-- --

1. All N52xxBxxx models are RoHS compliant and are shown in bolded text above.

Figure 2-12 Example of compatible Keysight N5293A/5A broadband millimeter-heads

N5293A/5A mm-W Head – Front



N5293A/5A mm-W Head – Rear

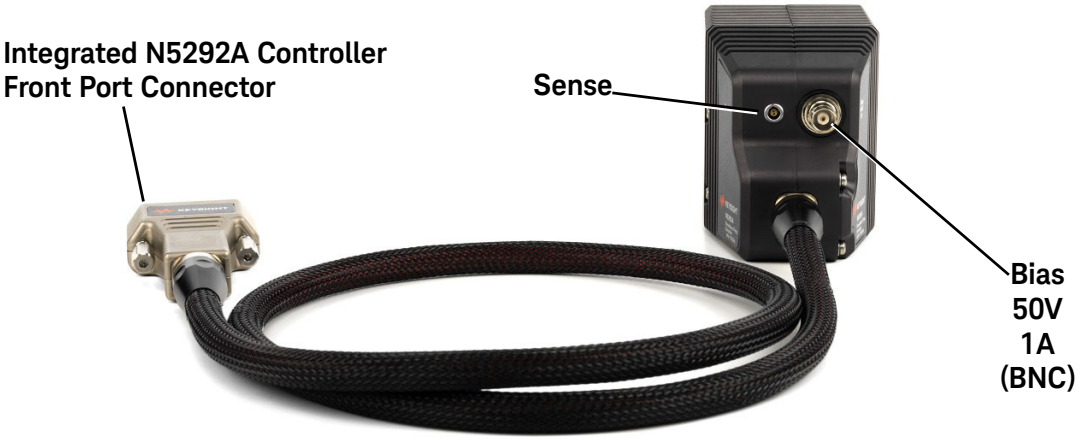


Figure 2-13 Example of compatible OML banded millimeter-heads

Figure 2-14 Example of compatible VDI banded millimeter-heads

Basic System Measurement Configurations

A banded millimeter-wave system can be used in either of two basic configurations, depending on how the test ports are connected to the device under test (DUT): coaxial measurement configuration or wafer probe measurement configuration. This document does not describe wafer configurations.

CAUTION

Millimeter Heads: Input power to the N5293A/95A or OML test ports must not exceed +20 dBm. Input power in excess of this level will damage expensive components. Observe proper precautions, especially when measuring amplifiers with gains of 20 dB or greater.

The maximum input power to the VDI test ports varies between +13 and +20 dBm. Please consult the VDI's VNAX specifications sheet for details on your VDI head. Input power in excess of this level will damage expensive components. Observe proper precautions, especially when measuring amplifiers with gains of 13 dB or greater.

Coaxial Measurement

In this configuration, the test head modules are placed on a work bench in front of the millimeter head controller.

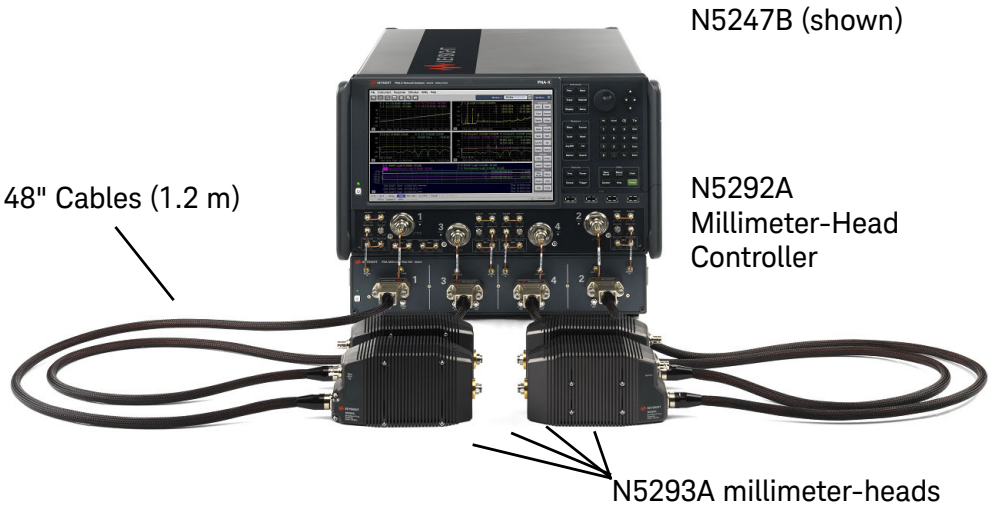
The DUT is normally connected to the test ports by way of a 1.0 mm coaxial cable (test port cable). Connect the DUT to Port 1 (left test head module) directly, and to Port 2 (right test head module) by way of a test cable. It is also possible to connect the DUT using a test port cable on each test port, although this configuration will result in greater signal loss.

CAUTION

Do not attempt to connect a test device directly between the two 1.0 mm test ports, without at least one test port cable. The test head modules will not move freely enough to allow such a connection to be made safely.

Figure 2-15 on page 27 shows how the instruments are configured on a work bench for the coaxial measurement configuration. The test head modules are placed on the bench top in front of the PNA and controller. See also, Figure 2-1 on page 5, Figure 2-2 on page 5, Figure 2-3 on page 6, and Figure 2-4 on page 7.

Figure 2-15 Non-LFE Broadband Millimeter-wave 4-Port Test System – Coaxial Measurement Configuration



3 System Installation

CAUTION

IMPORTANT!

The RF and LO test set controller power level is a nominal +10 dBm, and is configured to drive standard (+10 dBm input) VDI heads using 1.2m cables or low power (+2 dBm input) VDI heads using 5m cables. If low power VDI heads are connected to the test set controller using 1.2m cables, an 8 to 10 dB attenuator must be placed on each RF and LO cable connected to the modules.

For low power VDI modules that are directly connected to the Keysight PNA/PNA-X with a 1.2m cable set, the VNA port power driving the RF and LO must be set to the nominal +2 dBm.

For Option 003, OML modules that have the +15 dBm RF/LO amplifiers, please ensure that you use a 15 dB attenuator when connecting them directly to the test controller with a 1.2 m cable.

CAUTION

IMPORTANT!

A 85059B 1.0 mm Precision Calibration Kit and a 85059V 1.0 mm Precision Verification Kit are required to complete the installation of the N5290/1A Millimeter-wave Systems.

NOTE

This document is applicable to non-LFE broadband millimeter-wave systems and non-LFE and LFE banded millimeter-wave systems. Where the text applies to both types of systems, “millimeter-wave system” is used. Where the content is specific to one or the other types of systems, “non-LFE broadband millimeter-wave system” or “banded millimeter-wave system” is used.

For N5290/91A LFE broadband millimeter-wave system information refer to https://www.keysight.com/us/en/assets/9018-04581/installation-guides/9018-04581.pdf.

NOTE

IMPORTANT! For additional information on the OML/VDL heads, refer to “OML/VDI – Banded Configuration Calibration (Only)” on page 3-23.

Information in This Chapter

This chapter describes preparing to receiving your N5292A test set, N5293A/95A modules, and the millimeter-wave system's installation procedure(s).

Chapter Three at-a-Glance

Section Title	Summary of Content
"Getting Prepared" on page 3	Discusses how to download the service guide, tools required for installation, and the time required to install the system.
"Getting Assistance from Keysight" on page 4	How to contact Keysight for support with your system.
"Receiving the System" on page 5	What to do when you receive your system, verifying the parts received, and customer engineering support.
"PNA, Controller, and Test Head Module Interconnections" on page 7	A discussion and procedures for assembling your millimeter-wave system.
"Configuring the PNA Software for a Self Configured System" on page 19	Using your PNA/PNA-X's software to configure your system.
"N5293A/5A Test Head Modules Installation" on page 20	Adjust the N5293/5A millimeter wave broadband test heads.
"Millimeter Wave System Calibration" on page 21	
– "Running the Installation Calibration (Broadband Systems Only)" on page 21	Describes the broadband (only) millimeter-wave installation calibration.
– "OML/VDI – Banded Configuration Calibration (Only)" on page 23	Discusses how to calibrate a banded millimeter-wave system using 3rd party millimeter heads.
"Initializing the Banded Millimeter-wave System" on page 31	Discusses how to initialize the millimeter-wave system.
"Troubleshooting the Wideband Millimeter-Wave Calibration Using Adjustments" on page 32	How to troubleshoot on your millimeter-wave heads.

Getting Prepared

CAUTION

The banded and broadband N52xxB, N5292A test set, and modules contain extremely sensitive components that can be ruined if mishandled. Follow instructions carefully when making cable connections, especially wire harness connections.

The person performing the work accepts responsibility for the full cost of the repair or replacement of damaged components.

To successfully install this banded network analyzer system, you will need the following:

- Sufficient AC power – refer to "Site Preparation" on page 1-14
- Correct tools – refer to "Tools Required for the Installation" on page 3-3.
- Enough time - refer to "About Installing the System" on page 3-3.

Tools Required for the Installation

Description	Qty	Part Number
T-10 TORX driver (set to 9 in-lbs)	1	N/A
T-20 TORX driver (set to 21 in-lbs)	1	N/A
5/16-in torque wrench (set to 8 in-lbs)	1	N/A
5/16-in torque wrench (set to 10 in-lbs)	1	N/A
5/16-in torque wrench (set to 21 in-lbs)	1	N/A
14 mm open-end wrench (set to 4 in-lbs)	1	N/A
20 mm open-end wrench (set to 8 in-lbs)	1	N/A

CAUTION

Use a 5/16-in torque wrench set to 8 in-lbs on all semirigid front and rear panel cable connections.

About Installing the System

Products affected	N52xxB, N5292A, N5293A/95A (broadband), and OML/VDI (banded).
Installation to be performed by	Keysight customer engineer or personnel qualified by Keysight
Estimated installation time	4 hours
Estimated full instrument verification time	2.0 hours

Getting Assistance from Keysight

Installing this system requires special skills and experience. Keysight strongly recommends that the customer contact Keysight to arrange for on-site service. For a small fee, Keysight will provide a customer engineer to assist you with the system's installation. Refer to “Keysight Technologies Customer Engineering” on page 3-5.

Contacting Keysight

Refer to “Keysight Support, Services, and Assistance” on page 5-4.

Receiving the System

CAUTION

The N5292A millimeter head controller and the test head modules are sensitive to electrostatic discharge (ESD). Ground your work station before unpacking and installing the test head modules. See "Electrostatic Discharge Protection" on page 1-6.

Receiving the System

The N5292A and interconnect kit, N5293A/95A, or OML/VDI system components will arrive packaged separately. For a complete list of components shipped with your system, refer to Table 2-3 on page 2-10 through Table 2-9 on page 2-19.

When the entire shipment has arrived, contact Keysight Technologies to arrange for system installation. See "Keysight Support, Services, and Assistance" on page 5-4.

Keep the shipping containers until the system checklist has been completed, and the system has been checked for physical damage.

If the shipping container is damaged or the packaging material shows signs of stress, notify the carrier as well as Keysight Technologies. Keep the shipping materials for the carrier's inspection. Keysight Technologies will arrange for repair or replacement of damaged equipment without waiting for a claim settlement from the carrier. Refer to "Keysight Support, Services, and Assistance" on page 5-4.

Keysight Technologies Customer Engineering

A Keysight Technologies Customer Engineer will be assigned to help you install the system. During installation, the Customer Engineer will do the following:

- Unpack the system components.
- Complete the system parts inspection, see Table 2-5 on page 2-15 through Table 2-9 on page 2-19.
- Connect the PNA and the N5292A millimeter head test set. Install the N5293A/5A or OML/VDI millimeter-wave test head modules.
- Run the Operator's Check as described in Chapter 4, "Performance Verification."
- Run the System Verification as described in Chapter 4, "Performance Verification."
- Provide training for one user.

Review the Principles of Connector Care

Proper connector care and connection techniques are critical for accurate and repeatable measurements. Refer to Table 5-1 on page 5-3 for tips on connector care.

Prior to making connections to your analyzer, carefully review the information about inspecting, cleaning, and gaging connectors. Refer to the calibration kit documentation for detailed connector care information.

PNA, Controller, and Test Head Module Interconnections

CAUTION

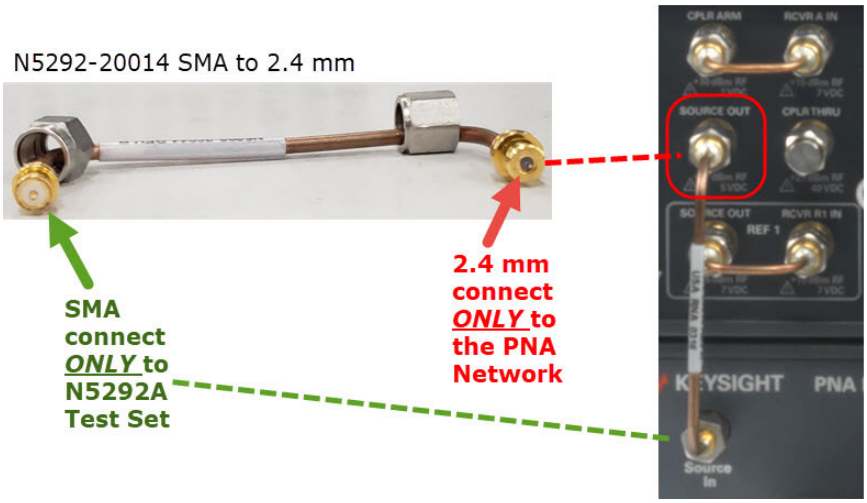
IMPORTANT!

The N5292A-xx4 interconnect kits contain 2.4 mm to 3.5 mm cables. It is important to connect the 2.4 mm end to the PNA and to connect the 3.5 mm end to the N5292A test set controller. Improper connections will result in damage to your instruments. Refer to Figure 3-1.

It is important to use two wrenches when connecting the semirigid cables to the 1/2/3/4 port 1.85 mm outputs front ports of the PNA to avoid stressing the connectors and causing damage to your PNA (i.e., the 2.4 mm cable end is compatible with the 1.85 mm connector of the PNA).

If not already done, open the interconnect kit and validate its contents against Table 2-7 on page 2-16.

Figure 3-1 PNA RF Port Connector to N5292A Test Set Lo Band Connector (2.4 mm)



System Setup

Mount the analyzer on top of the test set before connecting any cables to the PNA or to the test set. The cables can then be connected after the analyzer and test set are securely attached.

WARNING

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

Mounting a Network Analyzer on the Test Set

Refer to the following kits for your specific analyzer.In this procedure a N5242B 4-Port PNA-X is used with a N5292A. There are other kits available via the U3021M model. Refer to Table 2-5 on page 2-15 through Table 2-9 on page 2-19 and to ""Getting Assistance from Keysight" on page 3-4 for ordering information.

1. **On the PNA:** Remove the feet from the bottom of the analyzer.
2. Remove the 2 lower standoffs from the rear panel on the analyzer.
3. Remove the top two standoffs from the rear panel on the test set.

Figure 3-2 Rear Bottom Feet

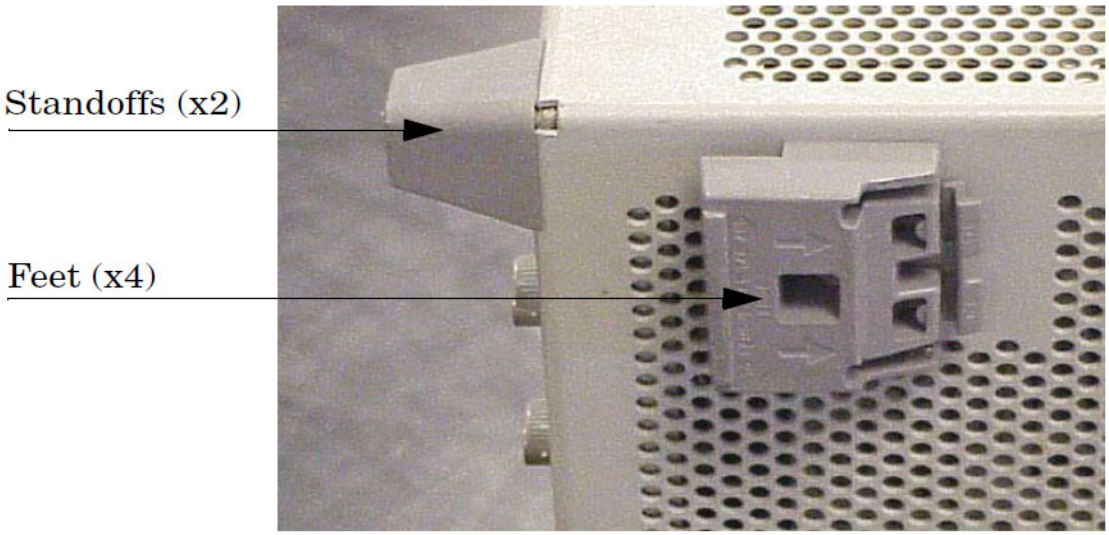
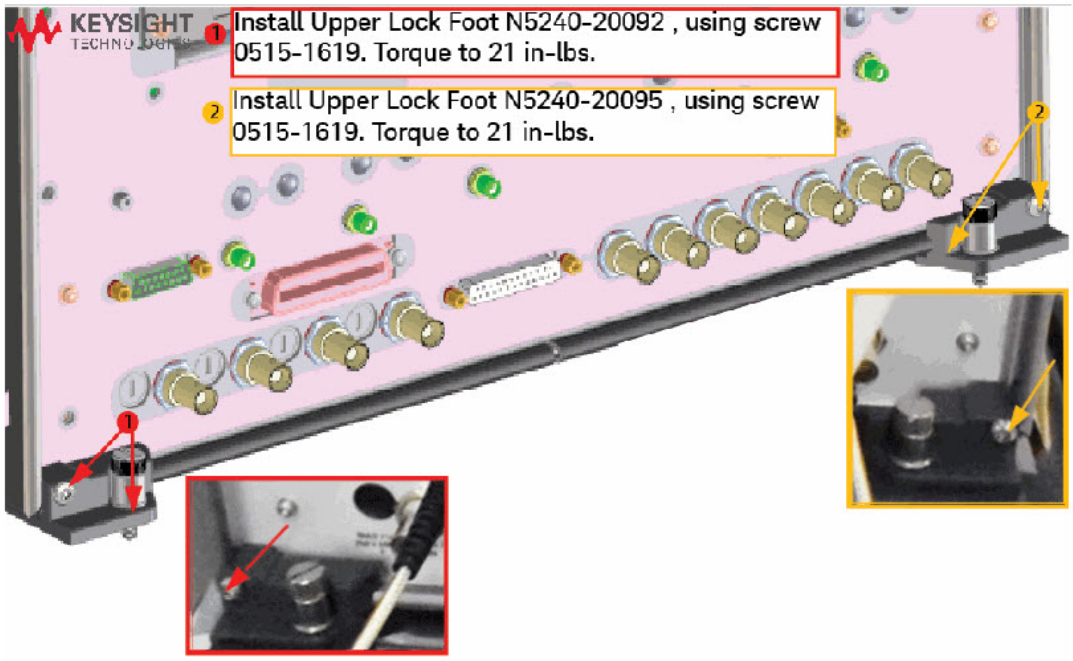
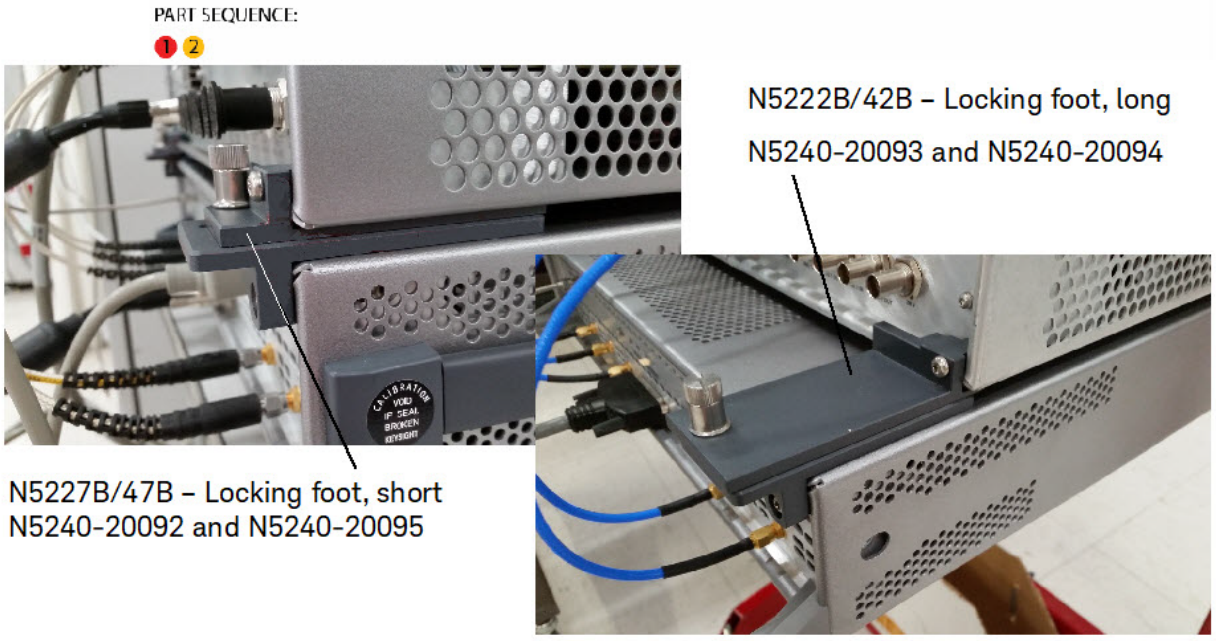


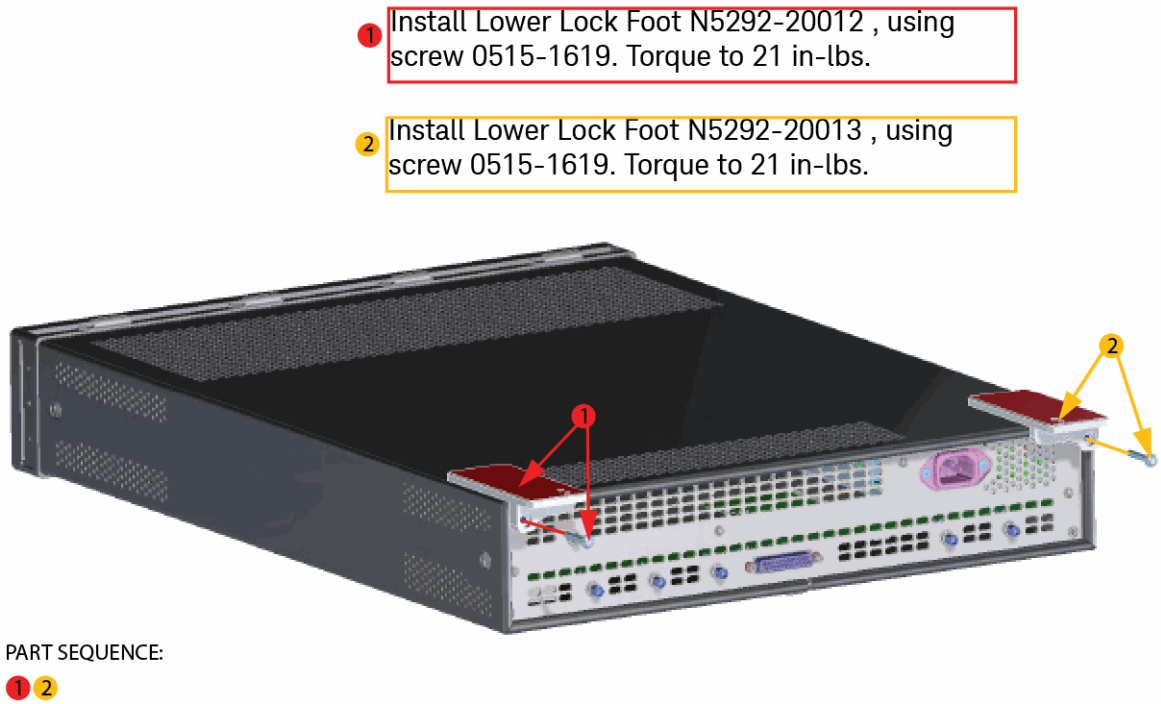
Figure 3-3 Install upper locking feet N5240-20092 and N5240-20095 (shorter feet used on N5227B/47B) or N5240-20093 and N5240-20094 (longer feet used on N5222B/42B) using 0515-1619 screws.) Do **NOT** torque these screws yet.





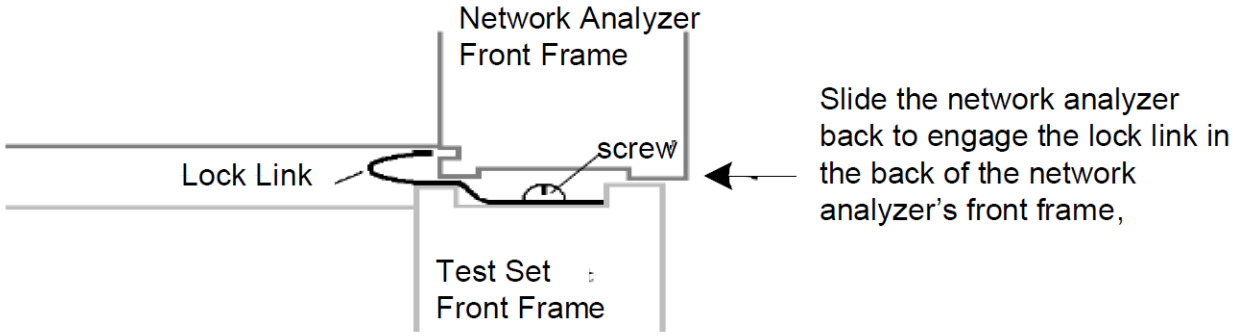
4. **On the N5292A**: Install lower lock feet N5292-20012 and N5292-20013, using screw 0515-1619. Do **NOT** torque these screws yet. Refer to Figure 3-4 on page 10.

Figure 3-4 Install lower lock feet N5292-20012 and N5292-20013 using screws 0515-1619. Do **NOT** torque these screws yet.



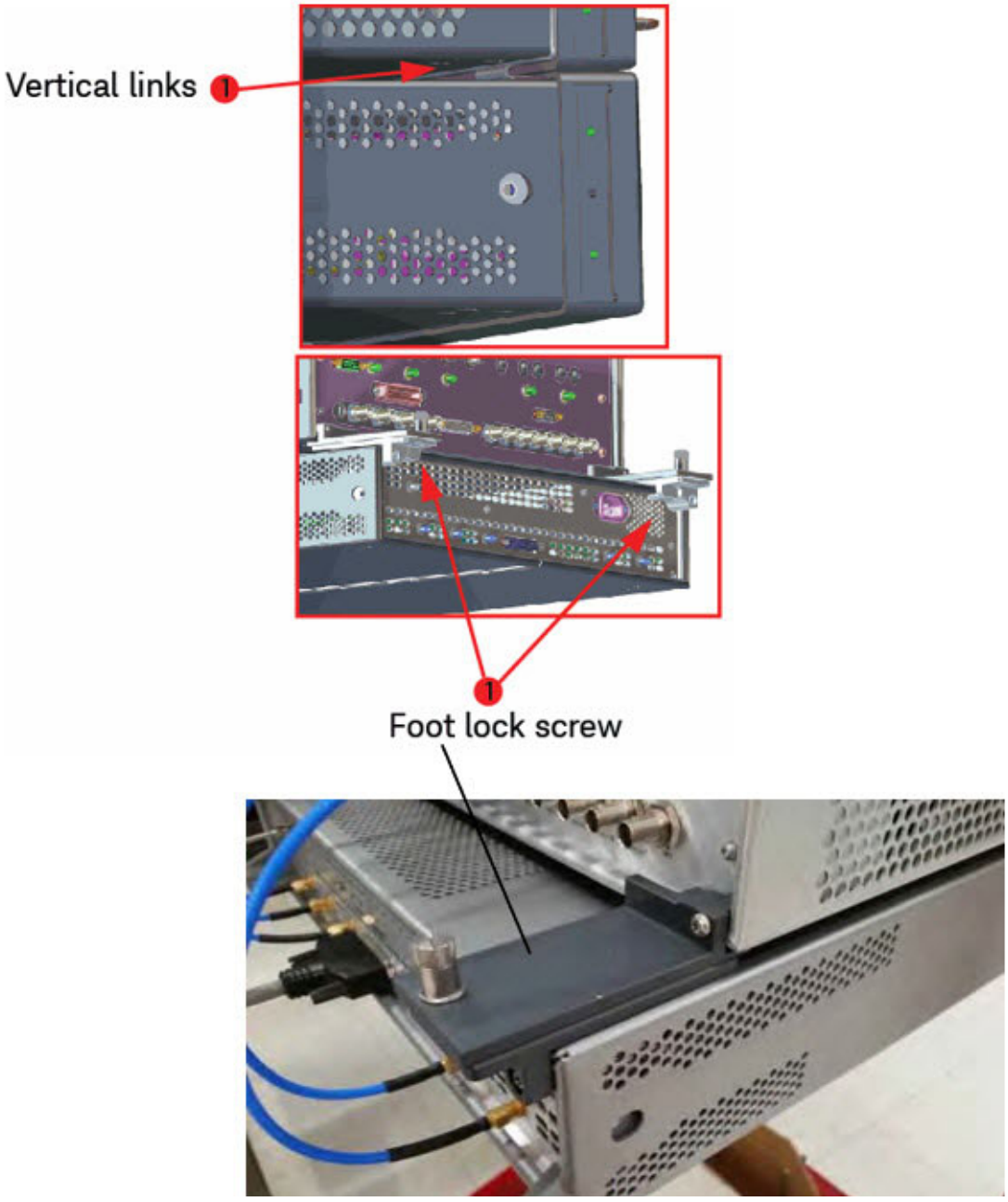
5. Mount the analyzer on top of the test set and ensure that the front frame of the analyzer is positioned slightly forward of the locks that are attached to the test set. Slide the analyzer back so the locks engage the front frame of the analyzer. Refer to Figure 3-5 and to Figure 3-6 on page 11.

Figure 3-5 Locking the Analyzer using the vertical links



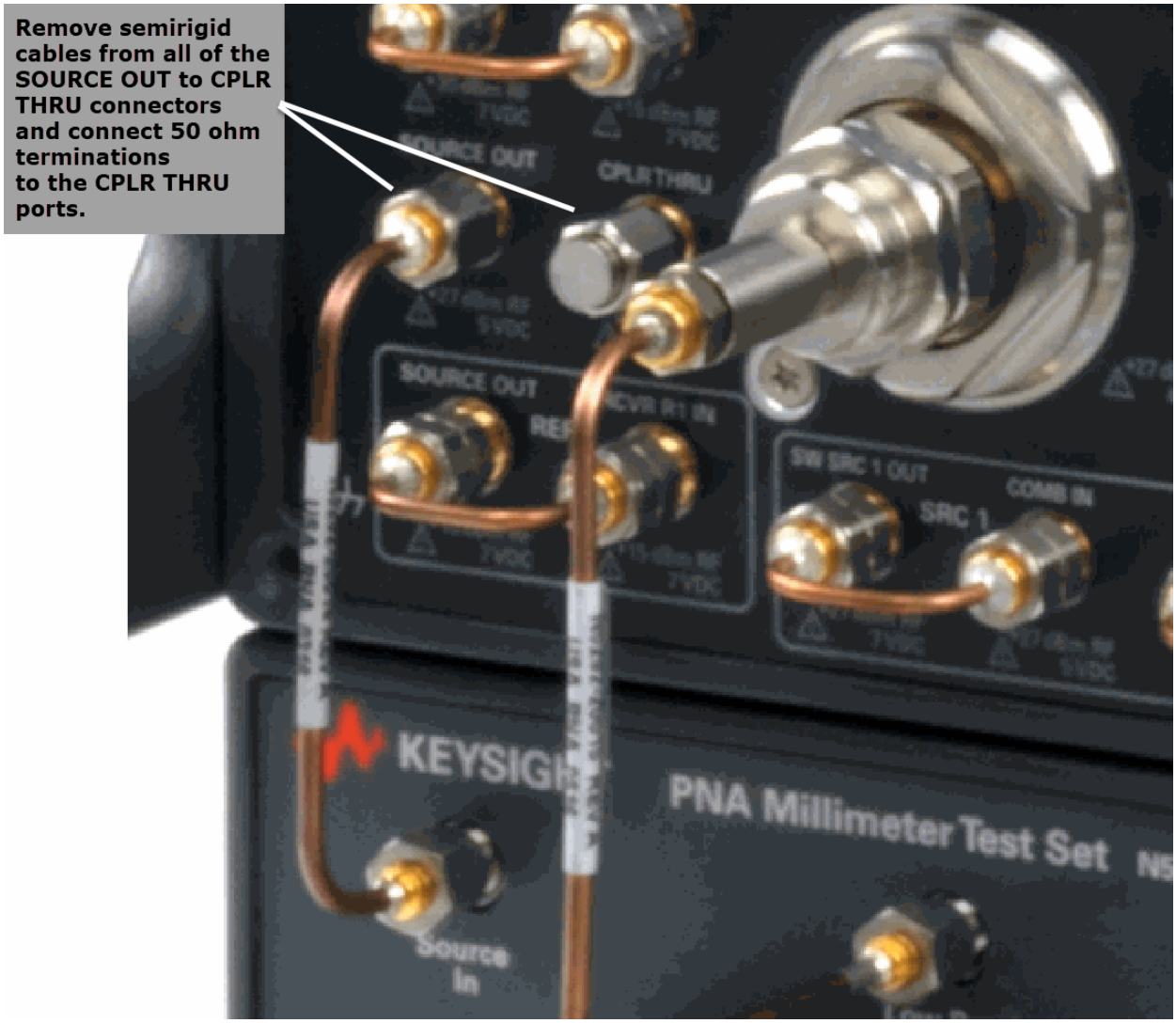
6. Secure the analyzer's lower locking feet (N5240-20092 and N5240-20095) to the test set's upper locking feet (N5292-20012 and N5292-20013) using the spring–loaded screws on the locking feet. Refer to Figure 3-6. If the locking feet are not aligned with the screw holes in the test set's upper locking feet, loosen the screws securing the feet to the instrument slightly to align and tighten. Do **NOT** torque these screws yet.

Figure 3-6 Install N5292A test set controller to the bottom of the PNA using vertical links and upper foot locks (N5292-20012 and N5292-20013). Long foot lock screws shown, but short lock screws are similar. Do **NOT** torque these screws yet.



7. Torque the 0515-1619 screws that were installed in step 4, Figure 3-3 on page 9, and Figure 3-4 on page 10. Use a T-21 to torque to 21 in-lbs. Optional: Rotate the PNA 180 degrees to install locking feet.
8. Optional: Install into rack.
9. Remove semirigid cables from SOURCE OUT to CPLR THRU. Refer to Figure 3-7.
10. Connect 50 ohm terminations to CPLR THRU ports. Refer to Figure 3-7.
    - Part number 1250-4261 for N5222B/42B (3.5mm).
    - Part number 0955-2394 for N5224B/25B/27B/44B/45B/47B (2.4mm).

Figure 3-7 Remove Semirigid Cables and Connect 50 termination (1250-4261 (3.5 mm) or 0955-2394 (2.4 mm)) to the CPLR THRU Ports



11. Install Interconnect Kit Semirigid Cables:

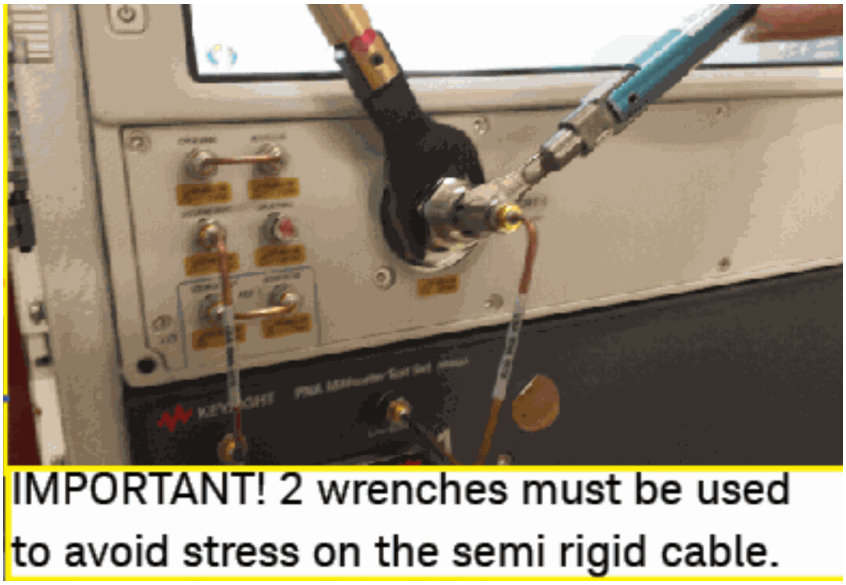
CAUTION

IMPORTANT!

The N52xxB interconnect kits contain 2.4 mm to 3.5 mm cables. It is important to connect the 2.4 mm end to the PNA and to connect the 3.5 mm end to the N5292A test set controller. Improper connections will result in damage to your instruments.

It is important to use two wrenches when connecting the semi-rigid cables to the 1/2/3/4 front ports of the PNA to avoid stressing the connectors and causing damage to your PNA.

Figure 3-8 To avoid damaging your RF ports 1/2/3/4, always use two wrenches



Rear Panel Cabling

Figure 3-9 on page 14 shows how to install the cables for 2-port and 4-port systems. Torque all RF connections to 8 in-lbs (0.90 N.m) to insure proper connection.

Figure 3-9 Millimeter-wave 2- and 4-Port Model Rear Panel Cabling. Connect the system cables to the rear panel (8120-2970 (x5), N5240-60092, and N4011-21002)

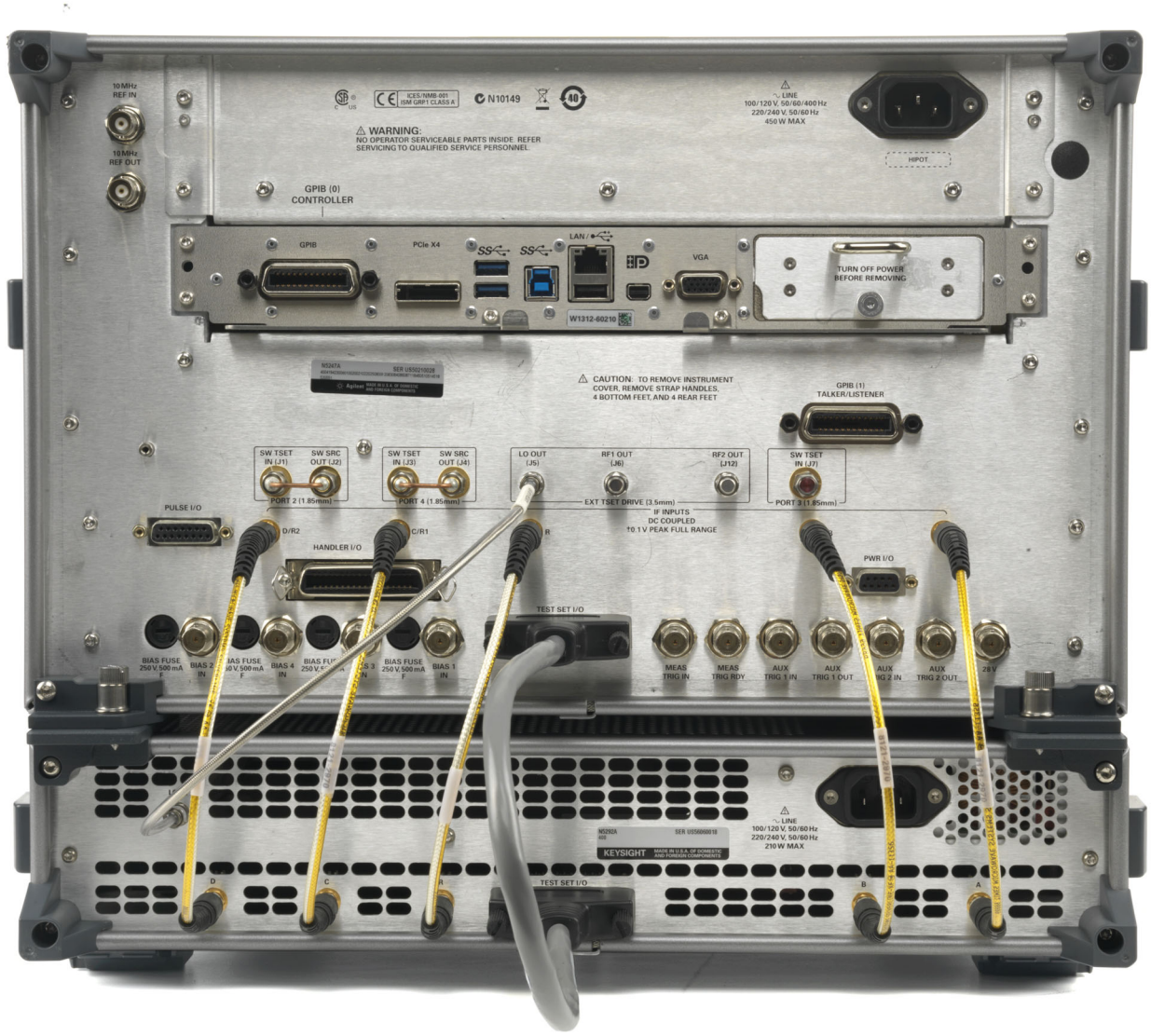


Table 3-10 N5290A 2- and 4-Port Rear Panel Cabling

From: PNA	LO OUT	D/R2	C/R1	R	TEST SET I/O	B	A
To: N5292A	LO IN	D	C	R	TEST SET I/O	B	A

Front Panel Cabling

The front-panel connections between the millimeter head controller and a test head module are shown in Figure 3-11 and for OML/VDI heads, refer to Figure Figure 3-12 on page 17, and Figure 3-13 on page 18. This cabling is similar for each test head module in the system. This cabling is duplicated for each test head module in the system.

Figure 3-11 Example of Cable Connections for N5293A/5A Four Test Heads Module

Millimeter-wave System Cable Connections

This section describes a typical 4-port cable connection process on the millimeter-wave system. 2-port cable connections are similar.

NOTE

Do not connect the LFE semi-rigid cables. Instead connect 50 ohm terminations (1250-4261). Refer to Figure 3-7 on page 12.

4-port connections are shown, but 2-port cable connections are similar, except where indicated.

This section assumes you have connected the rear panel connectors per "Rear Panel Cabling" on page 3-14.

1. Using the interconnect cables, connect all of the PNA's SOURCE OUT to the test set's Source In. Refer to Figure 3-7 on page 12.
2. Install connections for each head. Refer to next the section, "Test Head Connections" on page 3-16.

Test Head Connections

– **N5293A/5A Test Head Modules:**

1. Select a test head module to connect to the N5292A's integrated ports. The test head modules are independent and can connect to any port on the N5292A.
2. Connect to the N5292A using the integrated connector.
3. Continue with your system configuration by referring to "Configuring the PNA Software for a Self Configured System" on page 3-19.

– **N5290A304 (for OML/VDI) Heads:**

Select a test head module to connect to the N5292A's integrated ports. The test head modules are independent and can connect to any port on the N5292A. Connect one end of the N5290A504 cable to the OML/VDI head.

Refer to "OML/VDI Millimeter-wave Module Cable Connections" on page 3-16.

OML/VDI Millimeter-wave Module Cable Connections

Before connecting the millimeter-wave modules, verify that the test set and the power supplies (if used) are powered down. See also, Figure 3-12 on page 17 and Figure 3-13 on page 18.

There are four RF cables for each T/R module. Cables provided with the VDI modules are pre-labeled. The cables for use with the OML modules come in two types, two lighter and two heavier. Use the lighter cables for the IF signals and the heavier cables for the RF and LO signals.

Connecting the OML/VDI mm-heads to the N5292A test set requires a N5290A304 cable adapter. One cable adapter is required for each OML/VDI mm-wave head.

CAUTION

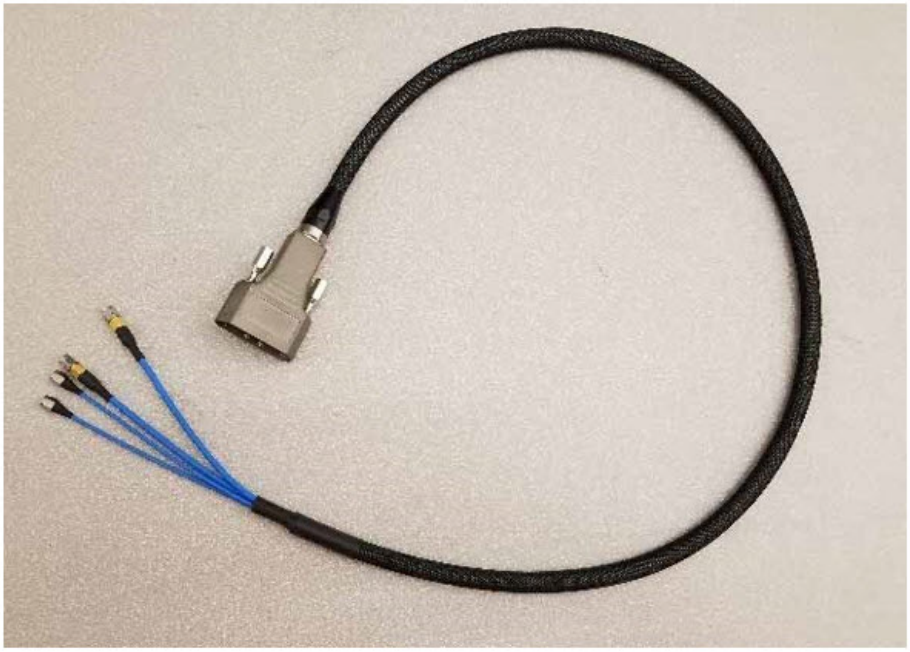
The N5290A304 cable is 1.2 m long. If longer cables are required, an N5260AKCBL cable kit and four 3.5mm f-f adapters can be added as a cable extension for the N5290A304. When using OML/VDI heads with an N5260AKCBL cable kit and four 3.5mm f-f adapters as the cable extension of the N5290A304, it is important that the minimum power level required is met for each head. Refer to the OML/VDI specifications on:

– **https://www.omlinc.com/**

and

– **https://www.vadiodes.com/.**

Figure 3-12 OML/VDI Cable Adapter N5290A304



The following detailed instructions are for connecting an OML T/R module. Modify the instructions appropriately for other types of modules.

1. Connect the separate cables end of the N5290A304 cable to the OML/VDI heads as indicated on the cable wire labels.
2. Place a Millimeter-wave module and place it on the work surface in front of the test set. Position each test head in the approximate location where it will be used for measurement operations.
3. Connect the N5290A304 cable to the front panel of the test set using the integrated connector.
4. Repeat steps 1 through step 3 for each module in the system.

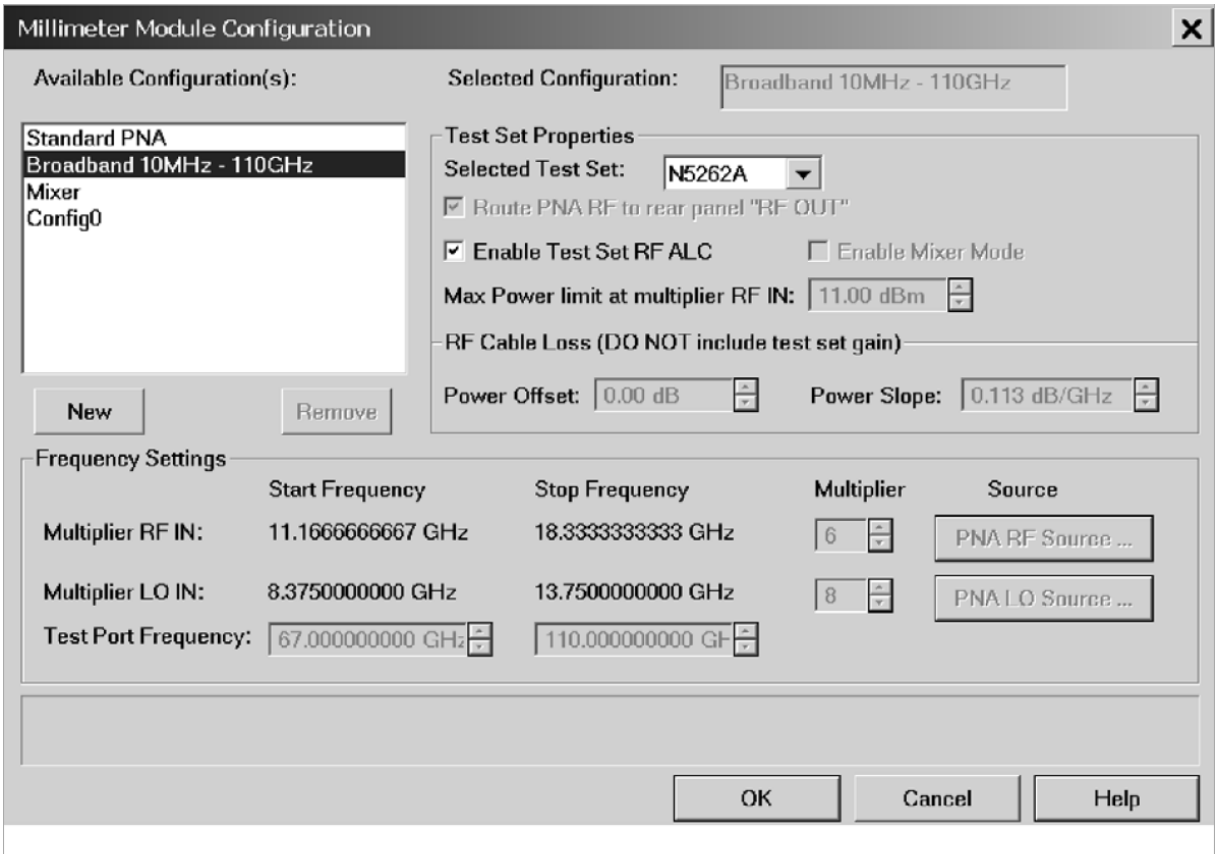
Figure 3-13 Banded Test Head Module Connections - OML Example

Configuring the PNA Software for a Self Configured System

Configuring Non-LFE Broadband and LFE and Non-LFE Banded Systems

1. On the PNA, select: **Setup > External Hardware > Millimeter Config**. The dialog box shown in the following figure will be displayed.

Figure 3-14 Millimeter Module Configuration Dialog Box



2. On the dialog box, under Available Configuration(s), select New.
3. Enter a name for your system (e.g., Non-LFE Broadband System 10 MHz to 110 GHz).
4. Select the appropriate test set (e.g., N5292A).
5. Select the check-box Enable Test Set RF ALC.
6. Click OK. This activates the millimeter-wave mode for the PNA.
   - Broadband systems: Continue with "N5293A/5A Test Head Modules Installation" on page 3-20.

– Banded systems: Continue with “Millimeter Wave System Calibration” on page 3-21.

CAUTION Before turning on this instrument, verify that the AC supply voltage is in the specified range.

N5293A/5A Test Head Modules Installation

After you have installed your N5293A/5A test head modules they need to be adjusted:

1. Press **Utility** > **System** > **Service** > **Adjustments** and run each adjustment sequentially.
2. Continue with the calibration of your broadband system, by referring to: “Millimeter Wave System Calibration” on page 3-21.

Millimeter Wave System Calibration

This section contains the following sections:

Running the Installation Calibration (Broadband Systems Only)

NOTE

This installation calibration should be ran when you first install your broadband system and whenever you make any changes to your system's configuration. See also "Troubleshooting the OML/VDI Millimeter Modules" on page 3-31 and "Troubleshooting the Wideband Millimeter-Wave Calibration Using Adjustments" on page 3-32.

1. On the PNA, verify your Millimeter-wave system is in the correct configuration: Press **Setup** > **External Hardware** > **Millimeter Config**.
2. The Millimeter Configuration window that opens should have the name of **your broadband system** highlighted.

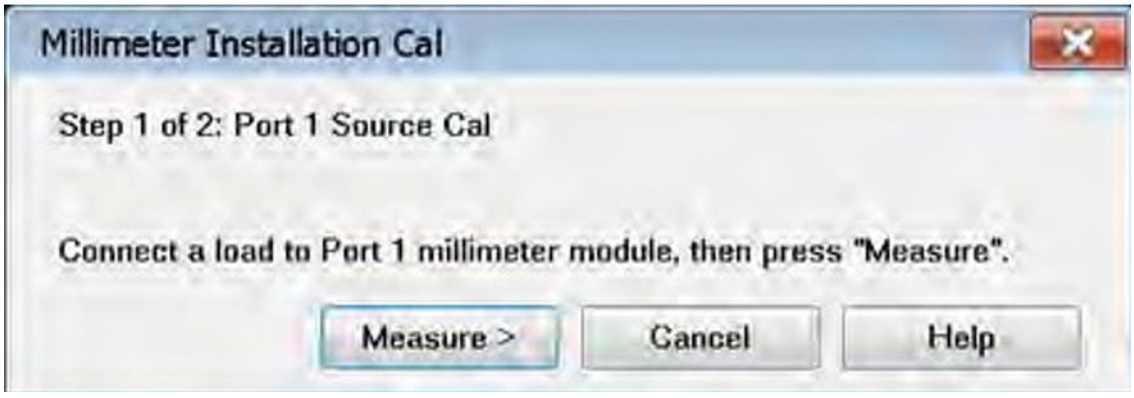
   Else, press your broadband system.
3. Press **Installation Cal**. In the dialog box opens, connect a load and press **Measure**. Refer to Figure 3-15 on page 21.

CAUTION

For best performance a 125 GHz broadband load is required.

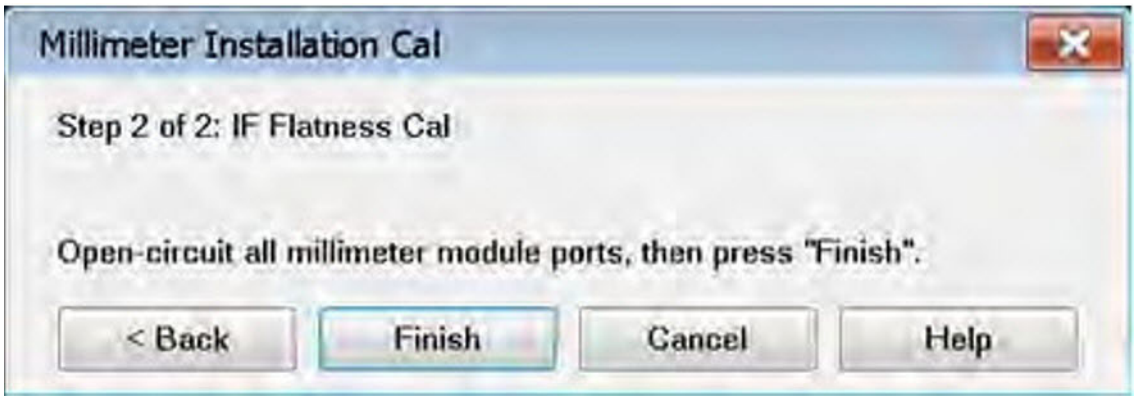
– The U8489A Power sensor can be used to terminate the ports.
– Alternatively, you can connect a through connection between the frequency extenders.

Figure 3-15 Millimeter Installation Cal - Dialog Box



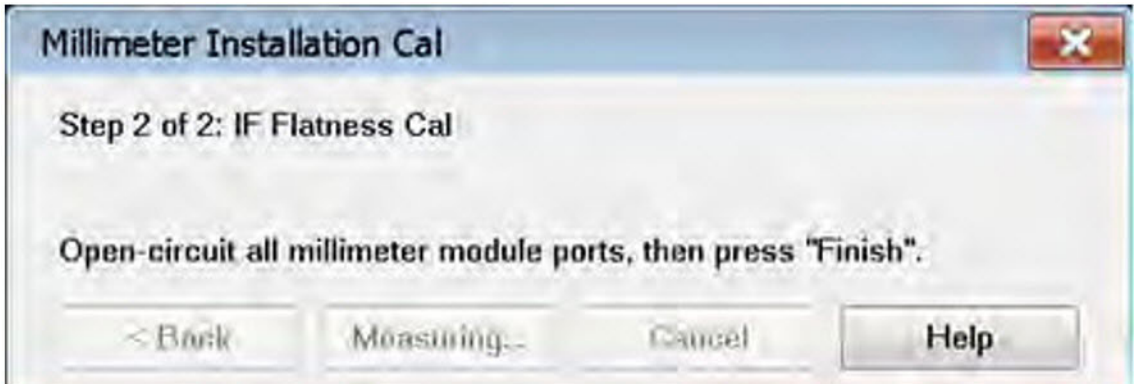
4. When finished, the following dialog box is displayed. Remove the load and press Finish. Refer to Figure 3-16 on page 22.

Figure 3-16 Millimeter Installation Cal - Dialog Box Load Calibration “Finish”



5. The following dialog box is displayed until the calibration is finished (i.e., It is not necessary to connect a calibration kit open for this step). Refer to Figure 3-17 on page 22.

Figure 3-17 Millimeter Installation Cal - Dialog Box Open-circuit Calibration Ongoing / “Finish”



6. If prompted, repeat steps 3 through 5 for all of the other ports requiring calibration.

OML/VDI – Banded Configuration Calibration (Only)

Overview:

The following detailed instructions are for the installation and calibration when using banded third party frequency extenders with a PNA/PNA-X that is connected via a N5292A test controller.

This is to ensure that when the N5290/91A broadband is used with the N5290A304 1.8m cable adapter the system is optimized for the best power levels being applied to the RF and LO of the external modules. In addition, it will ensure that we have a calibrated IF channel for accurate raw receiver measurements that require this level of accuracy, like the Spectrum Analysis application.

NOTE

This calibration and installation process is optimized for use with supported VDI and OML frequency extenders. While other Frequency extenders maybe used, they should at minimum comply to the requirements as follows:

- Nominal RF saturated power requirement of 10 dBm +/- 4 dBm. (9.2GHz-21.3GHz)
- Nominal LO saturated power requirement of 10 dBm +/- 3 dBm. (9.2GHz-21.3GHz)
- The IF level should be optimized for an operation of 7.606 MHz and not exceed -20 dBm

System Hardware

- N5247B
- N5292A Test Set Controller
- WR-10 3rd party frequency extenders

Required Calibration Hardware

The process would require a at least a 26.5 GHz power sensor and adapter to complete.

Overall Process

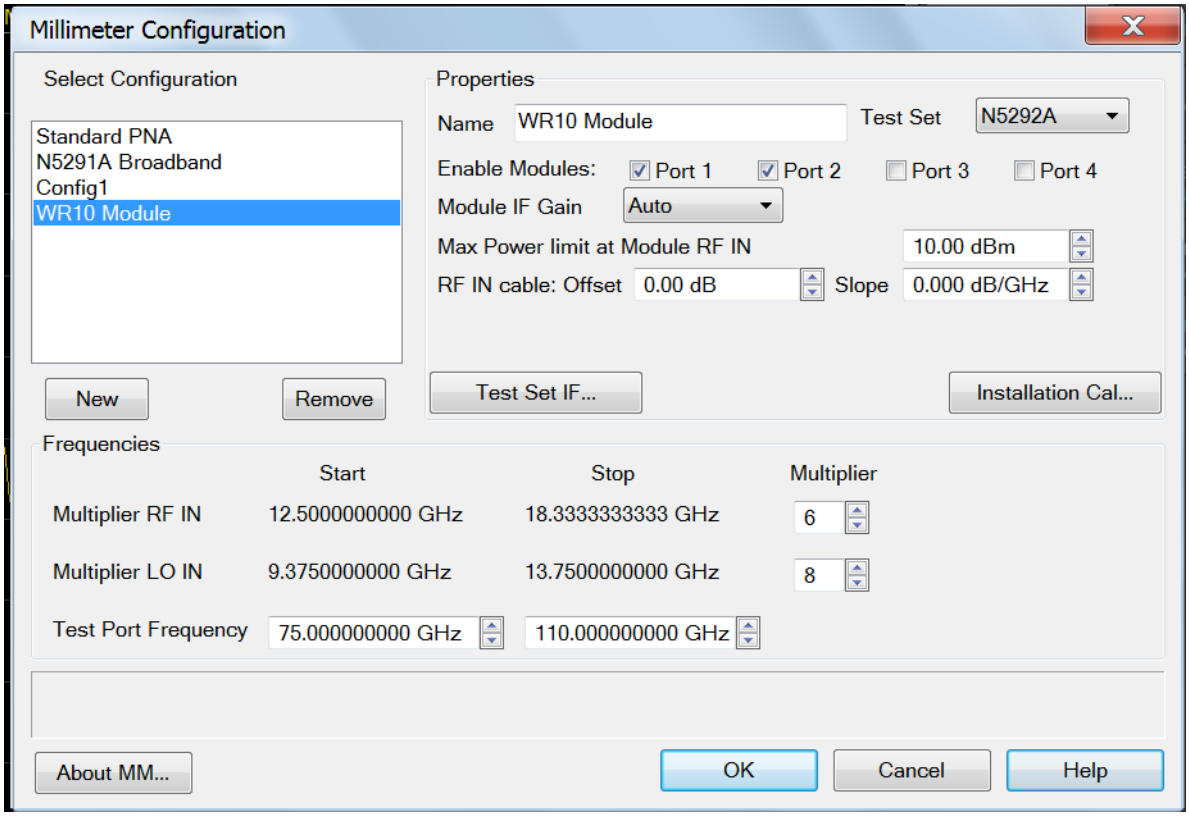
1. Connect the PNA-X, controller and attach the N5290A304 cable adapters
2. Do not connect the frequency extenders to the N5290304A cable adapters
3. Connect the power sensor to the PNA-X
4. Configure the power sensor for measurements
5. Use the millimeter Wave Configuration Dialog to configure the modules.
6. Select the installation menu to start the calibration of the system

7. Complete the calibration steps, for optimal performance all steps should be completed.

Detailed Procedure

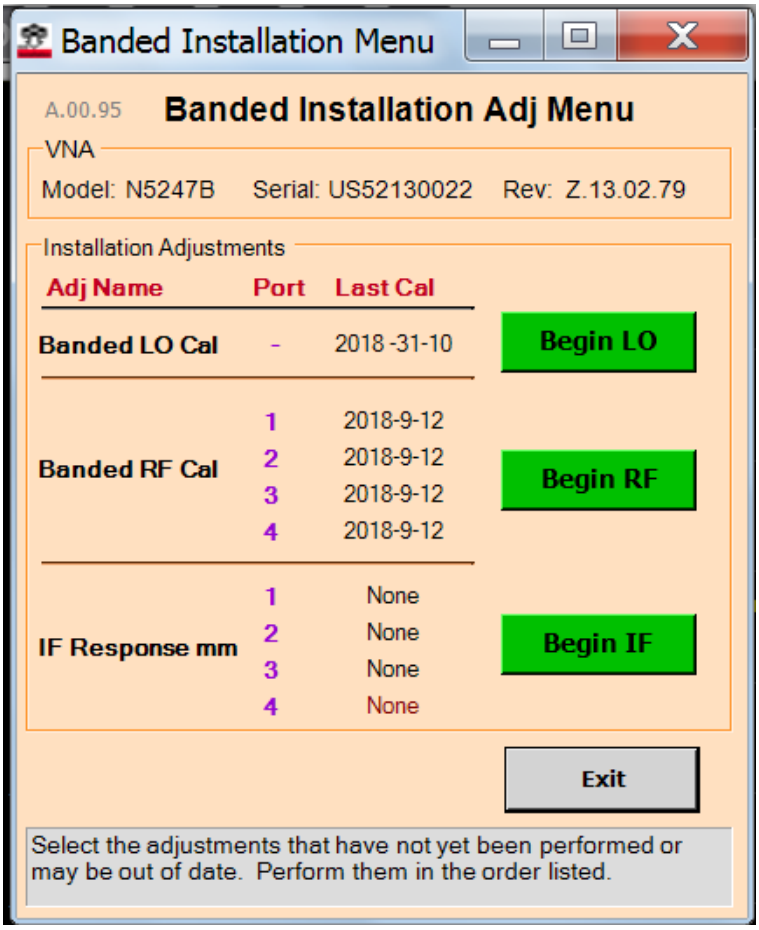
The following set of descriptions are intended to walk through the individual steps needed to complete the calibration of the banded setup:

Figure 3-18 Millimeter Configuration Dialog Box



1. Assign a name to the configuration in this example we use “WR10 Module”.
2. Assign the ports on the N5292A to which the Frequency extenders will be connected.
3. Set the RF and LO Multipliers, 6 and 8 in this example.
4. Assign Test Set to be a N5292A and the ports for the modules to be connected.
5. Click the “Installation Cal” button. The following dialog will appear.

Figure 3-19 Banded Installation Menu Dialog Box



Running the Calibrations (LO, RF, and IF)

These 3 Cals should be run in the order shown:

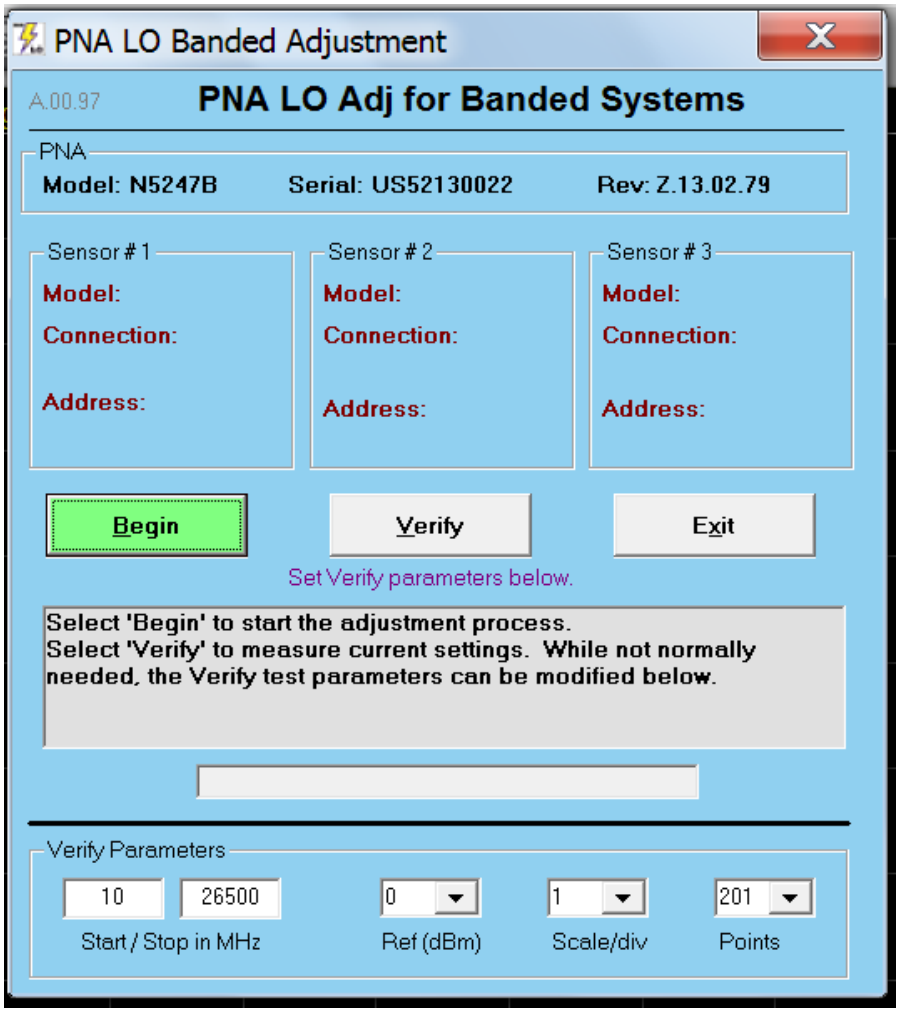
1. “LO Calibration” on page 3-25
2. “RF Calibration” on page 3-28
3. “IF Calibration” on page 3-30

LO Calibration

1. Before starting the LO calibration disconnect the (Test Set to PNA) rear panel LO cable from the PNA. The Banded LO Cal requires a 3.5 mm Power Sensor to be connected to the PNA rear panel LO connector.
2. In the Banded Installation CAL window, click “Begin LO”.

   The PNA LO Banded Adjustment window opens. See Figure 3-20 on page 26.

Figure 3-20 PNA LO Banded Adjustment



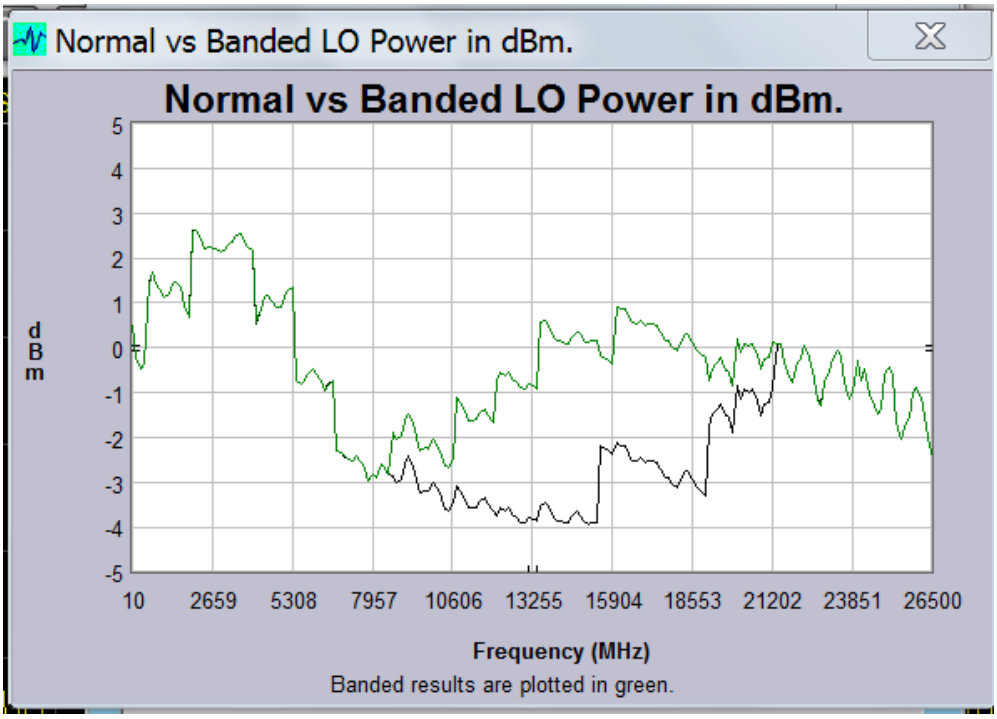
3. Use the system default settings to complete the LO calibration.
4. Zero and Calibrate the Power Sensor.
5. Connect the Power Sensor to the PNA Rear Panel LO as shown in Figure 3-21 on page 27.

Figure 3-21 Connect Power Sensor to PNA Rear Panel LO

6. Click “Begin” to run the LO Calibration. It will complete in less than a minute.
7. When the LO Calibration is done, disconnect the power sensor from the PNA rear panel and reconnect the test set LO cable. Refer to Figure 3-22 on page 28.
   - The first (bottom) trace shows LO Power without the Cal applied. Refer to Figure 3-22 on page 28.
   - The second (top) trace shows LO power after the Cal is applied.

NOTE Overlap is normal for frequencies less than 8 GHz and greater than 22 GHz.

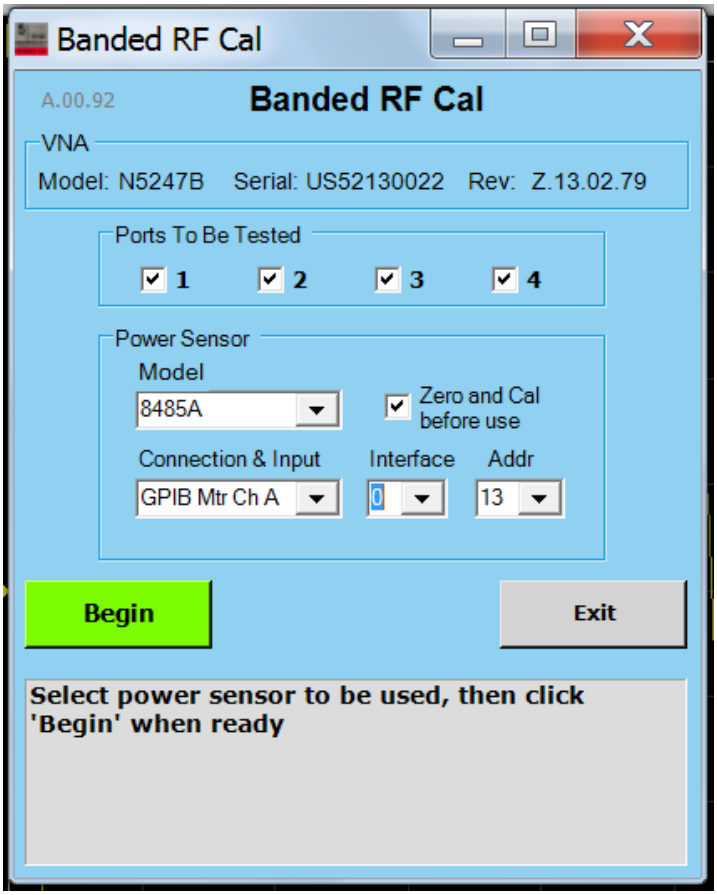
Figure 3-22 Normal vs. Banded LO Banded Power in dBm



RF Calibration

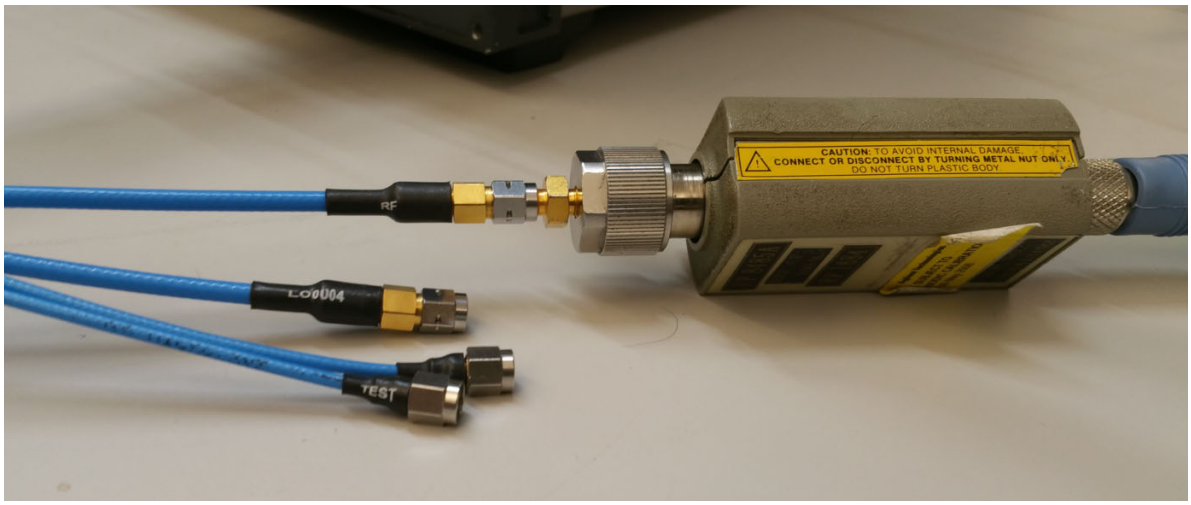
1. In the Banded Installation CAL window, click “Begin RF”. The Banded RF Cal dialog box opens. Refer to Figure 3-23 on page 29.

Figure 3-23 Banded RF Cal Dialog Box



2. Select the correct Power meter model and complete the calibration by connecting the power sensor to the end of the N5290A304 adapter cable RF cable as shown in Figure 3-24 on page 29.

Figure 3-24 Connect the Power Meter to N5290A304 Adapter Cable



3. Click “Exit” when done with the RF Cal.

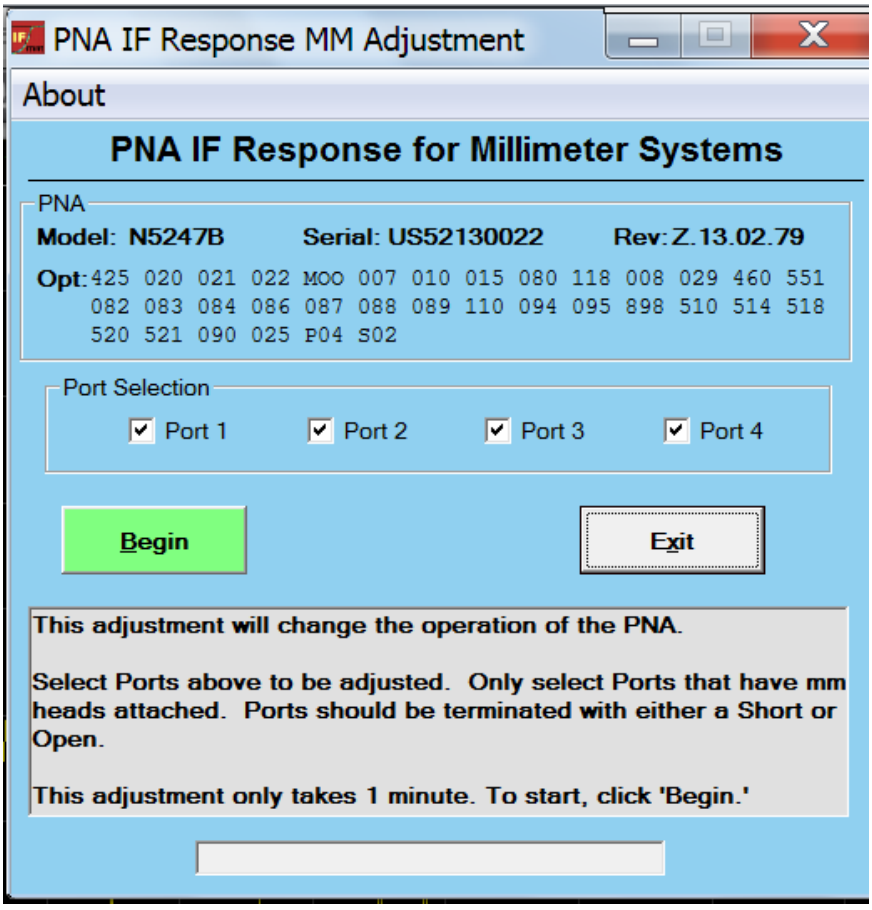
IF Calibration

NOTE You may leave all ports on the modules open however flush shorts are recommended for optimal results.

1. In the Banded Installation CAL window, click “Begin IF”.
2. The “PNA IF Response MMAdjustment” dialog box opens. Follow the prompts to perform the calibration.

   Once complete with the system will be optimized for the best settings to be used by the banded system configured.

Figure 3-25 PNA IF Response MM Adjustment Dialog Box



Initializing the Banded Millimeter-wave System

After the PNA has been received from the factory, you need to change your PNA over to “Millimeter Config”:

1. Ensure that PNA and N5292A test set are powered on.
2. On the PNA: press **Setup** > **External Hardware** > **Millimeter Config**
3. The PNA application will close and reopen.
4. Verify the PNA is sweeping across the band that was specified in “OML/VDI – Banded Configuration Calibration (Only)” on page 3-23.

For N5293A/5A, the banded millimeter-wave system should now initialize and recognize the test set modules. The port 1 module LED should be blue (addressed by the PNA and active) and the other test port(s) should be green (no bias and on standby). See also, “Troubleshooting the Wideband Millimeter-Wave Calibration Using Adjustments” on page 3-32.

Troubleshooting the OML/VDI Millimeter Modules

When contact Keysight support, if it is determined that the OML/VDI modules require repair, you will need to contact:

– https://www.omlinc.com/

and

– https://www.vadiodes.com/.

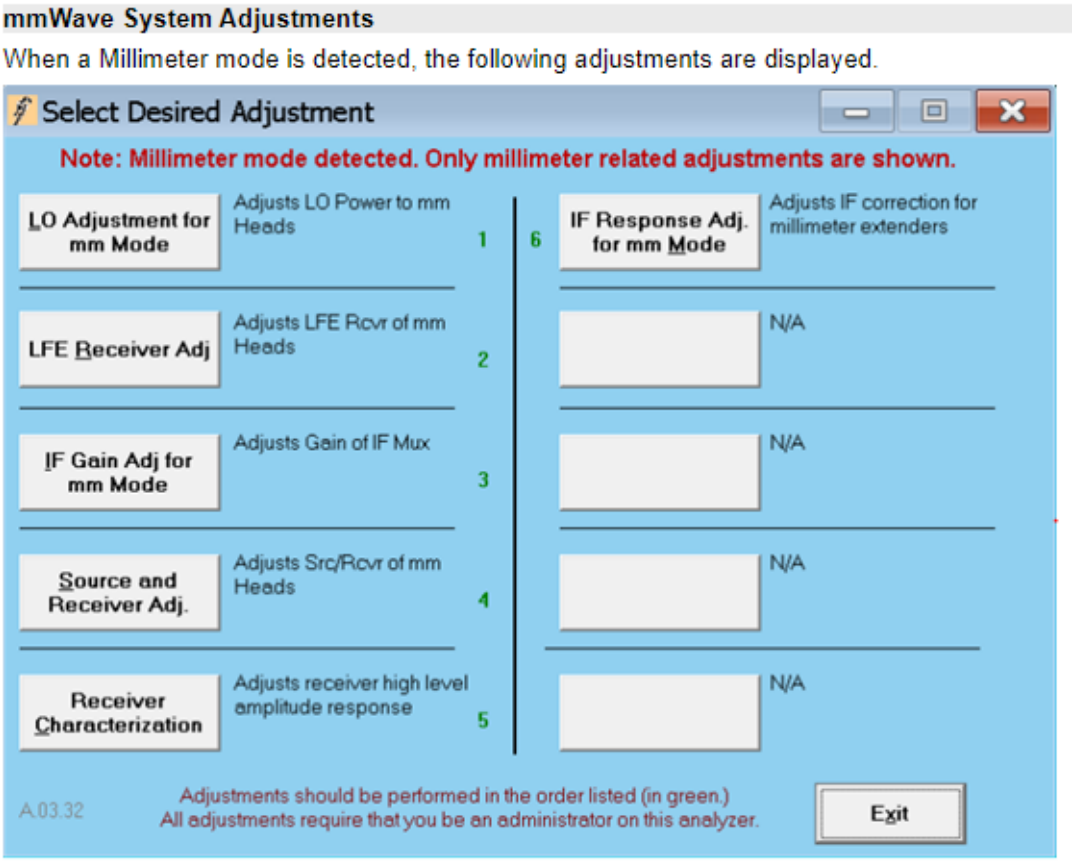
Troubleshooting the Wideband Millimeter-Wave Calibration Using Adjustments

If there are issues with your system's trace response and you suspect the millimeter-wave system wideband calibration is suspect, perform the mmWave System Adjustments. Refer to Figure 3-25.

Press **Utility > System > Service > Adjustments** and then run the adjustments in the following order:

1. LFE Receiver Adj
2. IF Gain Adj for mm Mode
3. Source and receiver Adj
4. IF Response Adj for mm Mode
5. Perform installation calibration
6. Receiver Characterization

Figure 3-26 Millimeter Wave Adjustments Screen



4 Performance Verification

NOTE

This document is applicable to non-LFE broadband millimeter-wave systems and non-LFE and LFE banded millimeter-wave systems. Where the text applies to both types of systems, “millimeter-wave system” is used. Where the content is specific to one or the other types of systems, “non-LFE broadband millimeter-wave system” or “banded millimeter-wave system” is used.

For N5290/91A LFE broadband millimeter-wave system information refer to https://www.keysight.com/us/en/assets/9018-04581/installation-guides/9018-04581.pdf

NOTE

IMPORTANT! For additional information on the OML/VDL heads, refer to “OML/VDI – Banded Configuration Calibration (Only)” on page 3-23.

Information in This Chapter

This chapter contains procedures to help you check, verify, and adjust your Network Analyzer Banded Millimeter Waveguide System.

- The checks verify the operation of the instruments in your system.
- The verification compares the operation of your analyzer to a gold standard.
- The adjustments allow you to tune your system for maximum response.

Chapter Four at-a-Glance

Section Title	Summary of Content
"Preliminary Checks" on page 4-3	Overview
"System Verification" on page 4-4	Describes the System Verification for validating your millimeter-wave systems. Includes descriptions of printed and graphical system verification output displays. Also, what to do if System Verification Fails. – When to verify. – What materials are needed to verify. – What are verification results files. – How to interpret and improve the system verification results. – Saving verification results.
"If the System Verification Fails" on page 4-12	Description of what to do if the System Verification Check fails.

Preliminary Checks

Preliminary checks include the following:

– “Performing System Verification” on page 4-7

System Verification

System verification is used to verify system-level, error-corrected uncertainty limits for network analyzer system measurements. The verification procedure is automated and is contained in the firmware of the analyzer.

The device data provided with the verification kit has a traceable path to a national standard. The difference between the supplied traceable data and the measured data must fall within the total uncertainty limits at all frequencies for the system verification to pass.

The total measurement uncertainty limits for the system verification are the sum of the factory measurement uncertainties for the verification devices and the uncertainties associated with the system being verified. You can determine your system measurement uncertainty limits by referring to the analyzer embedded on-line help.

NOTE **Passing this system verification does not guarantee that the analyzer meets all of its performance specifications. However, it does show that the network analyzer being verified measures the same devices with the same results as a factory system which has had all of its specifications verified and its total measurement uncertainty minimized.**

What the System Verification Verifies

The system verification procedure verifies proper operation of the:

- network analyzer
- test set controller
- millimeter head modules
- calibration kit
- test port cables

together as a “system”. It DOES NOT verify that any of these components pass their specifications independently. The user is responsible for independently calibrating and verifying the proper operation of the calibration kit and test port cables prior to performing the system verification.

NOTE **Additional equipment or accessories used with the above system are not verified by system verification.**

Measurement Uncertainty

Measurement uncertainty is defined as the sum of:

- the residual systematic (repeatable) errors, and
- the random (non-repeatable) errors

in the measurement system after calibration.

The systematic errors are:

- directivity,
- source match,
- load match,
- reflection and transmission frequency tracking, and
- isolation (crosstalk).

The random errors include:

- noise,
- drift,
- connector repeatability, and
- test cable stability.

A complete description of system errors and how they affect measurements is provided in the analyzer's on-line embedded help.

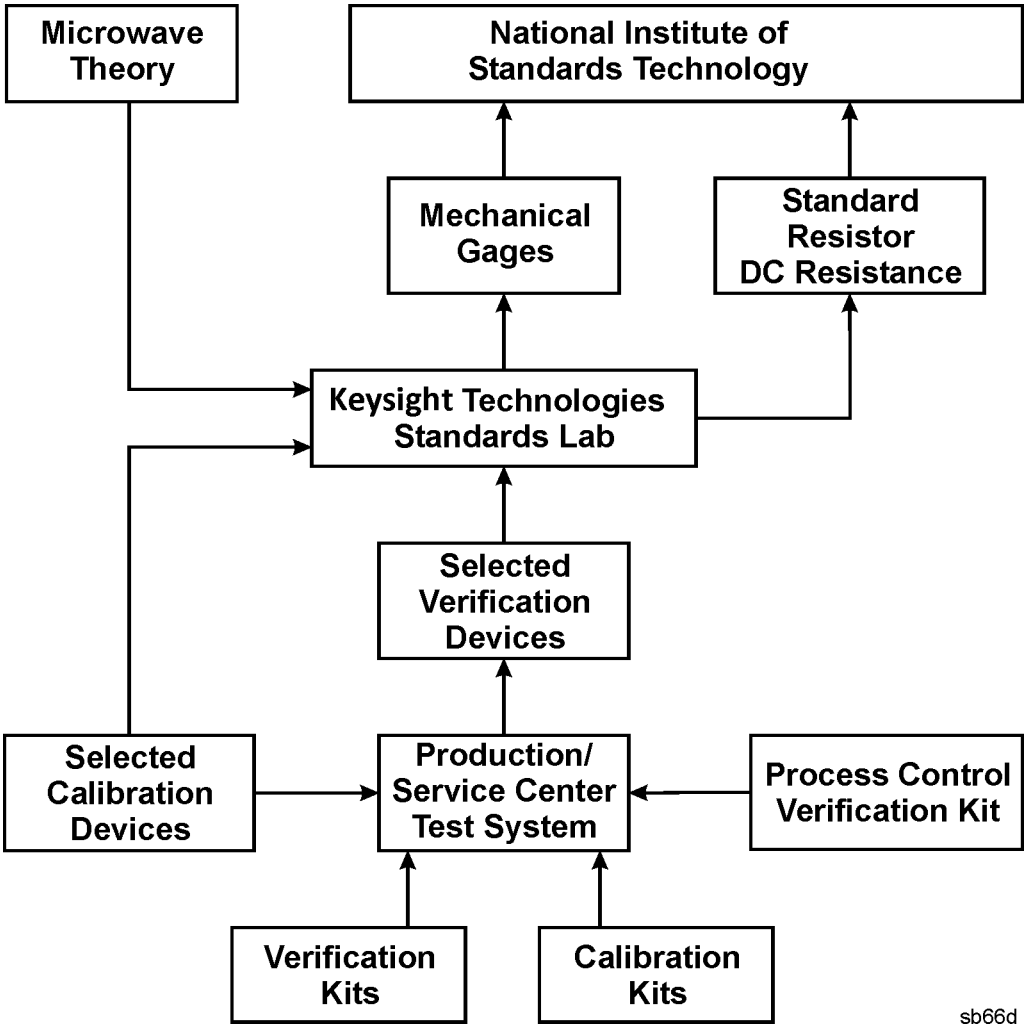
Any measurement result is the vector sum of the actual test device response plus all error terms. The precise effect of each error term depends on its magnitude and phase relationship to the actual test device response. When the phase of an error response is not known, phase is assumed to be worst-case (–180° to +180°). Random errors such as noise and connector repeatability are generally combined in a root-sum-of-the-squares (RSS) manner.

Measurement Traceability

To establish a measurement traceability path to a national standard for a network analyzer system, the overall system performance is verified through the measurement of devices that have a traceable path. This is accomplished by measuring the devices in a Keysight verification kit.

The measurement of the devices in the verification kit has a traceable path because the factory system that measured the devices is calibrated and verified by measuring standards that have a traceable path to the National Institute of Standards and Technology (NIST) (see Figure 4-1). This chain of measurements defines how the verification process brings traceability to the network analyzer system.

Figure 4-1 Traceability Path for Calibration and Verification Standard



Performing System Verification

The following verification procedure is automated by the analyzer firmware. The process for the verification is:

- connect cables to the analyzer test ports
- perform a calibration or recall a recent calibration
- run the system verification program for the verification devices

Each time through the verification process, you are prompted to make necessary connections and perform or recall a calibration as part of performing the verification. If you select to perform a calibration, you are guided through the calibration procedure. This part of the process can be eliminated if you choose to load an existing recent calibration that was created by the verification process. If necessary, refer to the analyzer's on-line embedded help for information on storing and recalling calibrations.

For each verification device, the analyzer reads a file from the verification media and sequentially measures the magnitude and phase for all four S-parameters.

CAUTION

IMPORTANT!

If a 2.4 mm or 3.5 mm 50 ohm termination is not connected to the test ports during the performance tests the tests will fail. Refer to "Miscellaneous/Spare Parts" in Table 2-7 on page 2-16.

NOTE

For system verification to perform correctly, it is NECESSARY that the verification devices be measured with their female connectors connected to port 1 or 3 and their male connectors connected to port 2 or 4.

NOTE

Although the performance for all S-parameters are measured, the S_{11} and S_{22} phase uncertainties for the attenuators and airlines are less important for verifying system performance. Therefore, the limit lines will not appear on the printout.

Equipment Used in the System Verification Procedure

Equipment Type	1.0 mm
Calibration kit	85059B
Verification kit	85059V
Cables	Included in the 85059B Kit
Adapters	None required

Cable Substitution

The test port cables specified for the network analyzer system have been characterized for connector repeatability, magnitude and phase stability with flexing, return loss, insertion loss, and aging rate. Since test port cable performance is a significant contributor to the system performance, cables of lower performance will increase the uncertainty of your measurement. It is highly recommended that the test port cables be regularly tested.

If the system verification is performed with a non-Keysight cable, ensure that the cable meets or exceeds the specifications for the test cable specified in the previous table, "Equipment Used in the System Verification Procedure." Refer to the cable's user's guide for specifications.

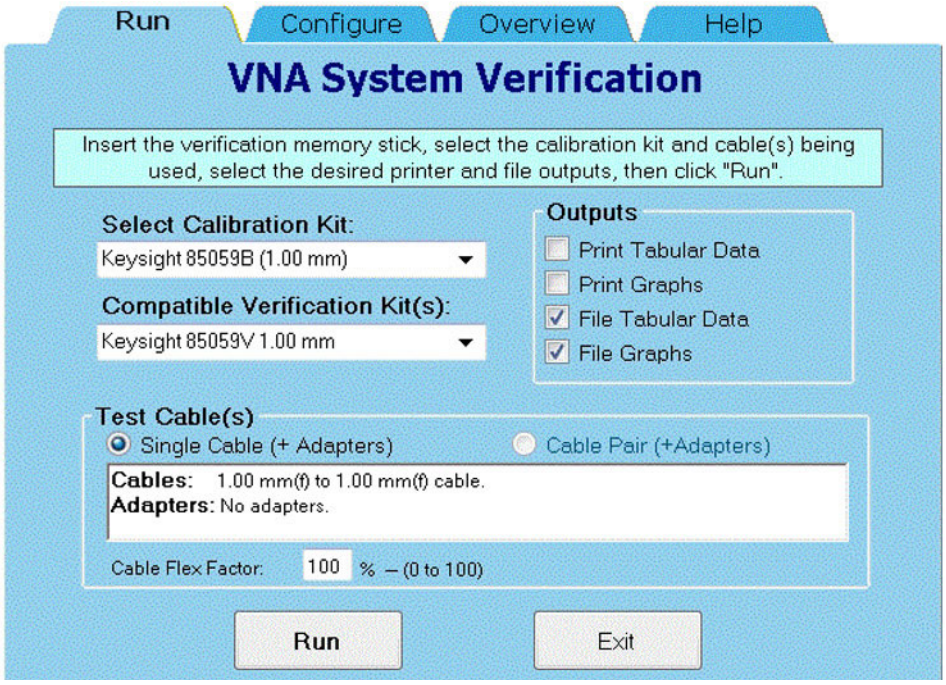
Kit Substitution

Non-Keysight calibration kits and verification kits are not recommended nor supported.

System Verification Procedure

1. If you desire printed test outputs, connect a printer to the analyzer. For the printer, ensure that the correct driver is loaded and the printer is defined as the default printer. Refer to the embedded help in the analyzer for printer setup. Let the analyzer warm up for at least 90 minutes.
2. Insert the verification kit memory stick into the analyzer USB port.
3. Press **UTILITY** > **System** > **Service** > **System Verification**. The VNA System Verification dialog box is displayed; refer to Figure 4-2.

Figure 4-2 System Verification Dialog Box



4. In the Calibration Kit box, select the calibration kit or electronic calibration module (ECal) that is being used by clicking on it. The corresponding verification kit to use is selected for you and displayed in the Verification Kit box. Refer to Figure 4-2.
5. Under Outputs, select the desired output(s). Refer to Figure 4-2 on page 4-9.
   - Print Tabular Data: Prints the verification data in tabular form which includes measured data and uncertainty limits.
   - Print Graphs: Prints the verification data in graphical form. The graphical form includes the measured data trace, factory supplied data trace, and uncertainty limits. For an example, refer to Figure 4-3 on page 4-11.
   - File Tabular Data: Writes the tabular data to a text file in the Windows 7 directory `D:\SysVer`.
   - File Graphs: Saves a screen image in PNG format in the Windows 7 directory `D:\SysVer`.

NOTE For printed output, it is assumed that the printer has been tested and the Windows driver is installed for the printer that is being used. The system verification test prints to the printer that has been designated as the default printer. (On the Windows Desktop display, click on My Computer, Control Panel, and then Printers to verify the printer setup.)

To modify the number of ports to be verified or to change the number of devices to measure, click on the Configure tab and make the desired selections.

6. Click **Run**.
7. Follow the instructions on the analyzer for performing a full calibration or recalling an existing recent calibration.

NOTE When performing a full calibration, it recommended that the calibration be saved when prompted. If the verification needs to be repeated, this calibration can be recalled, saving time.

8. Follow the instructions on the analyzer for performing the system verification; inserting the verification devices as prompted.

If the System Fails the Verification Test

NOTE Inspect all connections. Do not remove the cable from the analyzer test port. This will invalidate the calibration that you performed earlier.

1. Disconnect and clean the device that failed the verification test.
2. Reconnect the device making sure that all connections are torqued to the proper specifications.
3. Measure the device again.
4. If the analyzer still fails the test, contact Keysight. Refer to “Contacting Keysight” on page 5-4.
5. Refer to “If the System Verification Fails” on page 4-12 for additional troubleshooting steps.

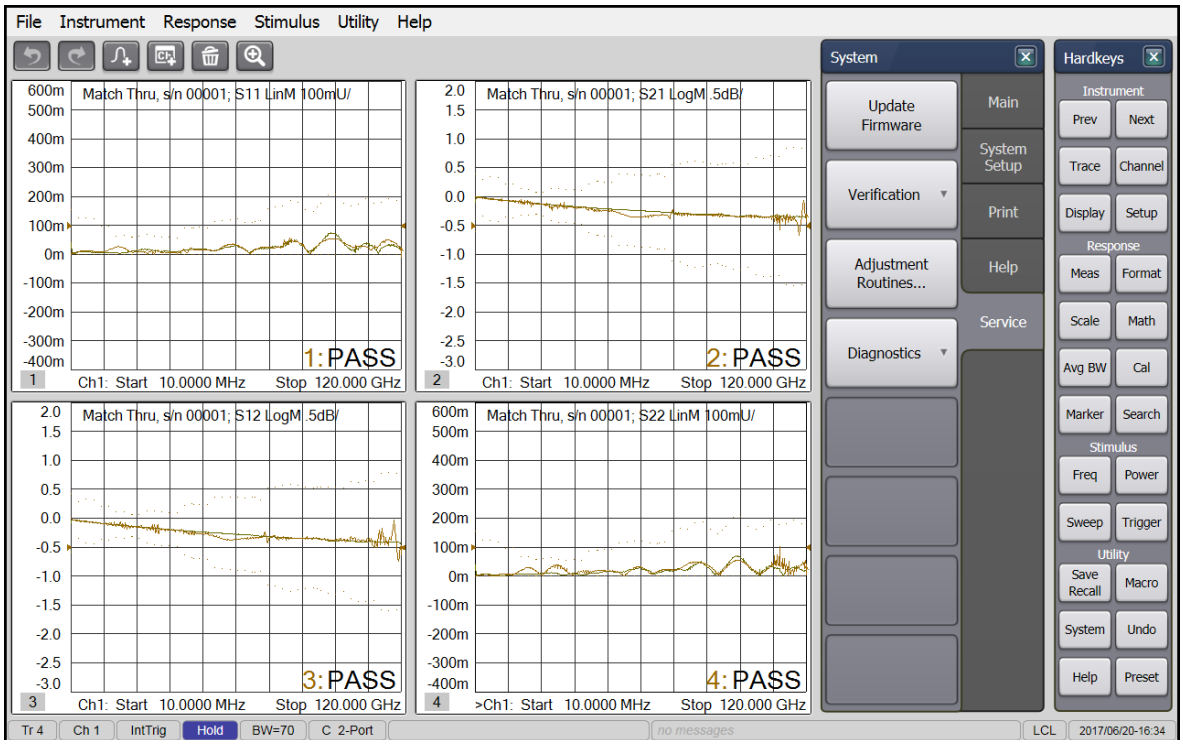
Interpreting the Verification Results

At the top of the printed output is the name of the device, the serial number of the device, and the date tested.

Figure 4-3 shows an example of typical verification results with Print Graphs selected in the Printer Output area of the System Verification dialog box. The printed graphical results show the following:

- the name of the device measured
- the serial number of the device
- the parameters measured
- Results of the measurements.
- Data measured at the factory from the verification kit.
- Upper and lower limit points as defined by the total system uncertainty system.

Figure 4-3 Example of Printed Graphical Verification Results (4-port is Shown)



If the System Verification Fails

NOTE

If the System Verification fails, refer to “Contacting Keysight” on page 5-4.

5 Maintenance and Support

NOTE

This document is applicable to non-LFE broadband millimeter-wave systems and non-LFE and LFE banded millimeter-wave systems. Where the text applies to both types of systems, “millimeter-wave system” is used. Where the content is specific to one or the other types of systems, “non-LFE broadband millimeter-wave system” or “banded millimeter-wave system” is used.

For N5290/91A LFE broadband millimeter-wave system information refer to

https://www.keysight.com/us/en/assets/9018-04581/installation-guides/9018-04581.pdf.

Information in This Chapter

Chapter Five at-a-Glance

Section Title	Summary of Content
“Maintenance” on page 5-2	How to take care of your system electrically and your system’s connector care.
“Keysight Support, Services, and Assistance” on page 5-4	Discusses your system’s warranty, how to contact Keysight and ship an item to Keysight for repair.

Maintenance

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

Physical Maintenance

Clean the cabinet, including the front panel, using a dry or slightly damp cloth only.

Electrical Maintenance

Refer to "Keysight Support, Services, and Assistance" on page 5-4.

Caring for Waveguide (WG) Interfaces

A clean surface at millimeter-wave frequencies is much more important than at lower frequencies because any debris on the waveguide surface can potentially distort the measurement results.

Caring for WG interfaces is not difficult. Dirt and dust can be removed using the following:

- Isopropyl alcohol 99.5%[1]
- Lint-free cloth
- Pressurized air (for dust removal)

To remove dirt on the waveguide surface, simply put a few drops of isopropyl alcohol on a lint-free cloth and gently wipe the surface.

To remove dust, simply spray the pressurized air on the waveguide surface.

Principles of Connector Care

Proper connector care and connection techniques are critical for accurate and repeatable measurements. Refer to Table 5-1 on page 5-3 for tips on connector care.

Prior to making connections to your analyzer, carefully review the information about inspecting, cleaning, and gaging connectors. Refer to the calibration kit documentation for detailed connector care information.

1. Use isopropyl alcohol only in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate, prior to assembling waveguide interfaces.

For course numbers about additional connector care instruction, contact Keysight Technologies. Refer to “Contacting Keysight” on page 5-4.

Table 5-1 Connector Care Quick Reference Guide

Handling and Storage			
Do	– Keep connectors clean – Extend sleeve or connector nut – Use plastic end-caps during storage	Do Not	– Touch mating-plane surfaces – Set connectors contact-end down – Store connectors or adapters loose
Visual Inspection			
Do	– Inspect all connectors carefully – Look for metal particles, scratches, and dents	Do Not	– Use a damaged connector - ever
Connector Cleaning			
Do	– Try compressed air first – Use isopropyl alcohol[a] – Clean connector threads	Do Not	– Use any abrasives – Get liquid into plastic support beads
Gaging Connectors			
Do	– Clean and zero the gage before use – Use the correct gage type – Use correct end of calibration block – Gage all connectors before first use	Do Not	– Use an out-of-specification connector
Making Connections			
Do	– Align connectors carefully – Make preliminary connection contact lightly – Turn only the connector nut – Use a torque wrench for final connection	Do Not	– Apply bending force to connection – Over tighten preliminary connection – Twist or screw any connection – Tighten past torque wrench “break” point

a. Cleaning connectors with alcohol shall only be done with the instrument’s power cord removed, and in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

Keysight Support, Services, and Assistance

Information on the following topics is included in this section.

- "Service and Support Options"
- "Contacting Keysight"
- "Shipping an Item to Keysight for Service or Repair"

Service and Support Options

The N5292A test set controller and interconnect cables have a one-year warranty which covers troubleshooting the system to an individual instrument, device, or cable. The service warranty includes repair or replacement of defective components. Most repairs require that the defective component be returned to Keysight.

NOTE Extended warranties are available in many geographical areas. Contact Keysight for additional information on available service agreements for this product. Refer to "Contacting Keysight".

Contacting Keysight

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

If you do not have access to the Internet, please contact your Keysight 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 whether your product is still within its warranty period.

Shipping an Item to Keysight for Service or Repair

NOTE

Keysight Technologies reserves the right to reformat or replace the internal SSD in the network analyzer, contained in this system, 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 an item from your system to Keysight Technologies for service or repair:

- Contact Keysight to open a service order. Refer to "Contacting Keysight".
- 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 item using the original or comparable anti-static packaging materials.

Downloading the Online System Service Guide

NOTE

There are two different service guides that support a millimeter wave system:

- **PNA service guide and**
- **N5292A service guide**

To view the online Service Guide for your PNA or the N5292A test set controller, use the following steps:

1. Go to www.keysight.com.
2. In the Search box, enter the model number of the analyzer (Ex: N5292A) and click **Search**.
3. Click **Technical Support** > **Manuals**.
4. Click **Service Manual**.
5. Click the service guide title to download the PDF file.
6. When the PDF of the Service Guide is displayed, scroll through the Contents section bookmarks to locate the information needed.

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www.keysight.com