Keysight
N5231A (300 kHz – 13.5 GHz)
N5232A (300 kHz – 20 GHz)
2-Port and 4-Port PNA-L
Microwave Network Analyzers
and
N5239A (300 kHz – 8.5 GHz)
2-Port PNA-L
RF Network Analyzer

KEYSIGHT TECHNOLOGIES

Service Guide

NOTICE: This document contains references to Agilent Technologies. Agilent's former Test and Measurement business has become Keysight Technologies. For more information, go to **www.keysight.com.**

KEYSIGHT TECHNOLOGIES

Notices

Manual Part Number

N5232-90001

Edition

December 1, 2014

Published in USA

Keysight Technologies
1400 Fountaingrove Parkway
Santa Rosa, CA 95403 USA

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Safety Notices

CAUTION

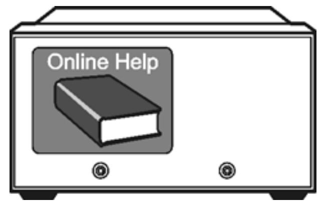
A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully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

Documentation Map

The online Help files are embedded in the analyzer, offering quick reference to programming and user documentation. From the Help drop-down menu, you can access the Help system in five different languages. Also, you can view the Analyzer Product Overview multimedia presentation and access the analyzer's Web page.



The *Installation and Quick Start Guide* helps you to quickly familiarize yourself with the analyzer. Procedures are provided for installing, configuring, and verifying the operation of the analyzer.

Printing Copies of Documentation from the Web

To print copies of documentation from the Web, download the PDF file from the Keysight web site:

- Go to http://www.keysight.com.
- Enter the product model number (Ex: N5227A) in the Search box.
- Click the Search icon (magnifying glass).
- Click the **Manuals** hyperlink.
- Click the hyperlink title for the document you want to print - this downloads the PDF
- Print the document after the PDF has fully downloaded.

Contents

1 Safety and Regulatory Information

Information in This Chapter

This chapter provides safety information that will help protect you and your network analyzer. It also contains information that is required by various government regulatory agencies.

Chapter One at-a-Glance

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.**

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 **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.**

CAUTION This instrument has autoranging line voltage input. Be sure the supply voltage is within the specified range.

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.**

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

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.

CAUTION	The measuring terminals on this instrument are designed to be used with external signals described in Measurement Category I, but NOT with external signals described in Categories II, III, and IV. The input of this instrument cannot be connected to the mains.

Servicing

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

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

WARNING	**Procedures described in this document may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.**

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.

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

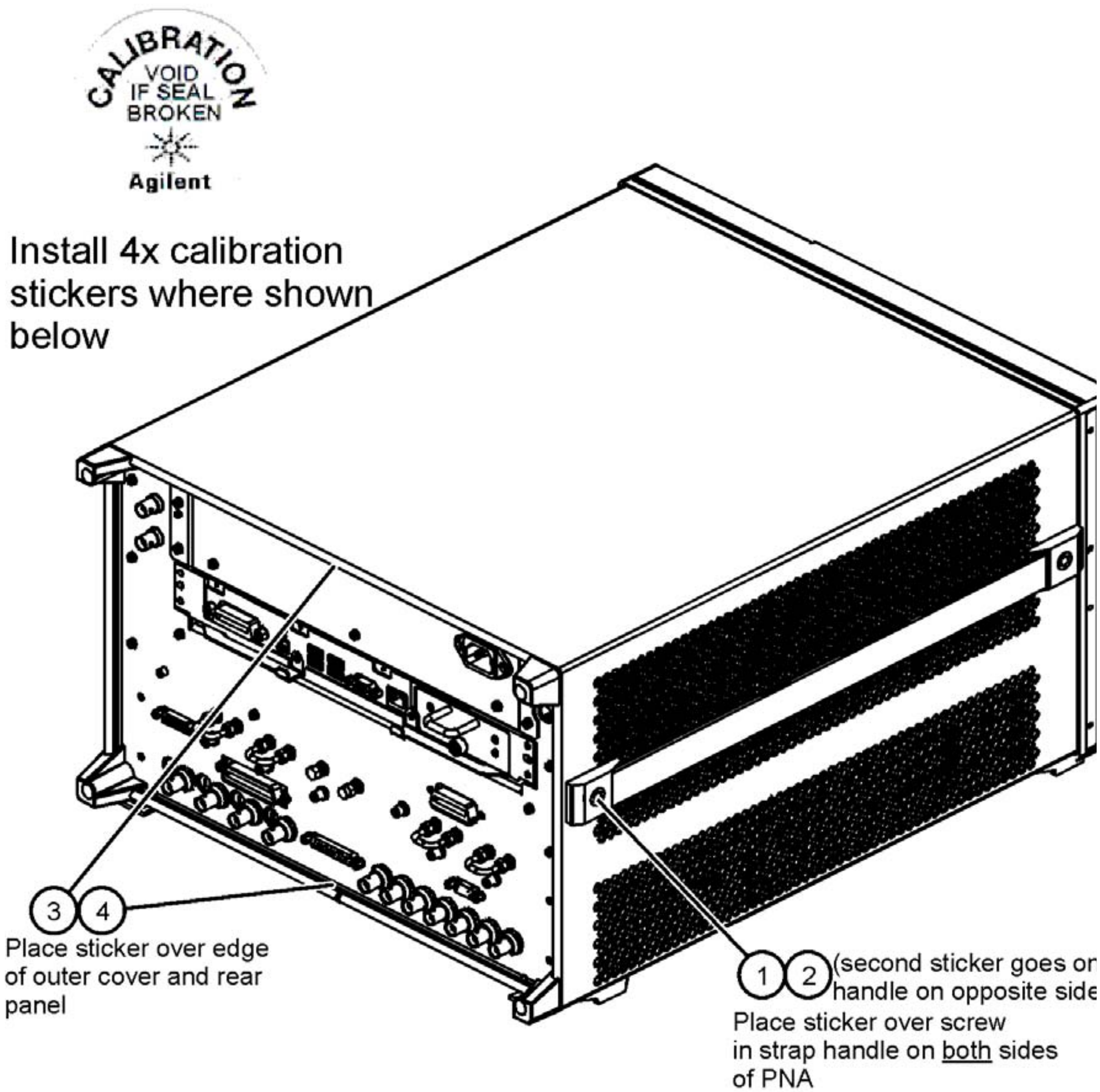
WARNING	**The opening of covers or removal of parts may expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

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

NOTE There are no replaceable fuses in the mains input or within the power supply assembly.

IMPORTANT Keysight personnel: after calibration is completed, attach four “calibration void if seal broken” stickers to the PNA as shown in Figure 1-1.

Figure 1-1 Location of Calibration Stickers on PNA



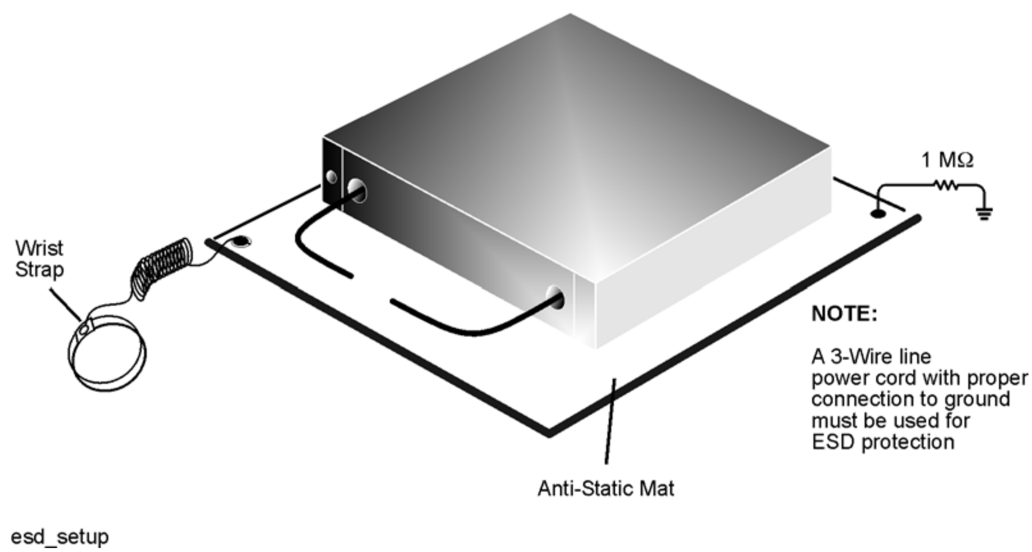
Electrostatic Discharge Protection

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

- *always* have a grounded, conductive table mat 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 1-2 shows a typical ESD protection setup using a grounded mat and wrist strap. Refer to **"Miscellaneous Part Numbers" on page 6-52** for part numbers.

Figure 1-2 ESD Protection Setup



Regulatory Information

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

Instrument Markings

NOTE	Some instrument markings may not appear on your analyzer.

	The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.
~	The AC symbol indicates the required nature of the line module input power.
	This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).
|	This symbol indicates that the power line switch is ON.
	This symbol indicates that the power line switch is in the STANDBY position.
O	This symbol indicates that the power line switch is in the OFF position.
	This symbol is used to identify a terminal which is internally connected to the product frame or chassis.
CE	The CE mark is a registered trademark of the European Community. (If accompanied by a year, it is when the design was proven.)
C US ®	The CSA mark is a registered trademark of the CSA International.
ISM1-A	This mark designates the product is an Industrial Scientific and Medical Group 1 Class A product (reference CISPR 11, Clause 5).
ICES/NMB-001	This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001).
	Direct Current.
IP 2 0	The instrument has been designed to meet the requirements of IP 2 0 for egress and operational environment.
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
40	Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.

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

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

2 General Product Information

Information in This Chapter

Chapter Two at-a-Glance

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 "Review the Principles of Connector Care" on page 3-5.

Analyzer Options, Accessories, and Upgrades Available

To see a list of the options, accessories, and upgrades available for the network analyzers, refer to the *Keysight PNA Family Microwave Network Analyzers Configuration Guide*, available online at http://literature.cdn.keysight.com/litweb/pdf/5990-7745EN.pdf.

Required Service Test Equipment

Equipment[a]	Critical Specifications	Recommended Model or Part Number	Alternate Model or Part Number	Use[b]
Test Instruments and Software				
Compression test set	None specified	U3070AK01	None	P
Dynamic accuracy test set	None specified	U3020AD01	None	P
Test software[c]	N/A	N7840A	None	P
Frequency counter	Freq: 10 MHz to 20 GHz Accuracy : ±0.5 ppm	53151A Opt 001	None	P, A,T
Signal generator	CW Freq: 1.185 GHz	N5181A,	E8257D, Option 520	P, A, T
Power meter	Accuracy: ±0.0068 dB	N1913A/14A	E4418A/B, E4419A/B[d]	P, A,T
Power sensor	Freq: 10 MHz to 4.2 GHz Range: –30 to +20 dBm	N8482A	8482A	P, A,T
Power sensor	Freq: 50 MHz to 40 or 50 GHz Range: –30 to +20 dBm	N8485A	8485A or U8485A	P, A,T
Spectrum analyzer	Min Freq: 1 MHz Max Freq: > 4 GHz Resolution BW: 300 Hz	E444xA PSA series, N90xxA signal analyzer family	856xE	A,T
Digital voltmeter	Resolution: 10 mV	Any	Any	T
Printer	N/A	Any printer with Microsoft Windows XP or Windows 7 driver		--
Mouse	N/A	Any	Any	--
Keyboard	N/A	Any	Any	--

a. Unless specified otherwise, equipment listed is required for all analyzer models.
b. P = Performance tests, A = Adjustments, T = Troubleshooting, V = System verification
c. The recommended model or part number for all equipment listed with a "P" in the Use column is required for proper operation of this test software.
d. If an accurate measurement of the dynamic accuracy specification is not required, the E4418A or E4419A can be used.

Required Service Test Equipment (Cont'd)

Equipment[a]	Critical Specifications	Recommended Model or Part Number	Alternate Model or Part Number	Use[b]
Calibration and Verification Kits				
3.5 mm calibration kit	Freq: 10 MHz to 26.5 GHz	85052B	85052D	P,T,V
3.5 mm verification kit	Freq: 10 MHz to 26.5 GHz	85053B	None	V
Cables				
BNC cable (2 required)	50Ω, length ≥ 60 cm	8120-1839	None	A
3.5 mm RF cable (Qty 2)	50Ω, length ≥ 60 cm	85131C	85131E	P,A,V
GPIB cable	N/A	10833A/B/C/D	None	P,A
Adapters				
3.5 mm (f) to 3.5 mm (f)	Return Loss: ≥ 32 dB	83059B	85052-60012[c]	P,A,T
3.5 mm (f) to type-N (m)	Return Loss: ≥ 28 dB	1250-1743	None	P,A,T
Attenuators				
3.5 mm (m,f), 10-dB fixed attenuator	Accuracy: ± 0.5 dB Freq: 10 MHz to 26.5 GHz	8493C Option 010	None	P
3.5 mm (m,f), 20-dB fixed attenuator	Accuracy: ± 0.5 dB Freq: 10 MHz to 26.5 GHz	8493C Option 020	None	P

a. Unless specified otherwise, equipment listed is required for all analyzer models.
b. P = Performance tests, A = Adjustments, T = Troubleshooting, R = Repair, V = System verification
c. Included in the 85052B/D calibration kits.

Required Service Test Equipment (Cont'd)

Equipment[a]	Critical Specifications	Recommended Model or Part Number	Alternate Model Number	Use[b]
Tools				
T-8 TORX driver	0.6 N-m (5 in-lb) setting	N/A	N/A	R
T-10 TORX driver	0.5, 0.8, and 1.0 N-m (4, 7, and 9 in-lb) settings	N/A	N/A	T, R
T-15 TORX driver	1.5 N-m (14 in-lb) setting	N/A	N/A	T, R
T-20 TORX driver	2.4 N-m (21 in-lb) setting	N/A	N/A	T, R
1/4 inch and 5/16 inch open-end wrench	Thin profile	8710-0510	N/A	A, R
5/16 inch, open-end torque wrench (metric equivalent is 8 mm)	1.1 and 2.4 N-m (10 and 21 in-lb) settings (for semi-rigid cables)	N/A	N/A	T, R
1 inch, open-end torque wrench (metric equivalent is 26 mm)	8.1 N-m (72 in-lb) setting (for Port 1 and Port 2 connector nuts)	N/A	N/A	R
9-mm, socket or open-end wrench	2.38 N-m (21 in-lb) setting (for all front panel and most rear panel connector hex nuts)	N/A	N/A	R
20 mm, open-end torque wrench	0.9 N-m (8 in-lb) setting (for measurement port connections)	8710-1764	N/A	P, A, T
Static Safety Parts				
Adjustable antistatic wrist strap	N/A	9300-1367	None	P, A, T
Antistatic wrist strap grounding cord (5 foot)	N/A	9300-0980	None	P, A, T
Static control table mat and earth ground wire	N/A	9300-0797	None	P, A, T
Miscellaneous				
USB flash ROM drive	N/A	Any	None	P, A, R

a. Unless specified otherwise, equipment listed is required for all analyzer models.
b. P = Performance tests, A = Adjustments, T = Troubleshooting, R = Repair, V = System verification

Keysight Support, Services, and Assistance

Information on the following topics is included in this section.

- "Service and Support Options"
- "Contacting Keysight"
- "Shipping Your Analyzer to Keysight for Service or Repair"

Service and Support Options

The analyzer's standard warranty is a *three-year return to Keysight Technologies* service warranty.

NOTE There are many other repair and calibration options available from the Keysight Technologies support organization. These options cover a range of service agreements with varying response times. Contact Keysight for additional information on available service agreements for this product. Refer to "Contacting Keysight" on page 2-7.

Contacting Keysight

Assistance with test and measurements needs and information on 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 Your Analyzer to Keysight for Service or Repair

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

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

- Include a complete description of the service requested or of the failure and a description of any failed test and any error message.
- Remove and retain the front handles and all rack mount hardware. The analyzer should be sent to Keysight in the same configuration as it was originally shipped.
- Ship the analyzer using the original or comparable antistatic packaging materials.
- Contact Keysight for instructions on where to ship your analyzer. Refer to "Contacting Keysight" on page 2-7.

3 Tests and Adjustments

Information in This Chapter

This chapter contains procedures to help you check, verify, and adjust your PNA.

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

Conventions Used for Hardkeys, Softkeys, and Menu Items

The following conventions are used in this document:

Hardkey	This represents a “hardkey”, a key that is physically located on the instrument.
Softkey	This represents a “softkey”, a key whose label is determined by the instrument firmware.
Menu Item	This represents an item in a drop-down or pop-up menu.

Chapter Three at-a-Glance

Section Title	Summary of Content	Start Page
Preliminary Checks	Performing the operator's check. Checking your test cables. *Perform these checks before performing system verification.*	page 3-11
System Verification	What the system verification does. How to perform the verification test. How to interpret the results.	page 3-20
Performance Tests[a]	A brief summary of each performance test: • Source Power Accuracy Test • Source Maximum Power Output Test • Source Power Linearity Test • Frequency Accuracy Test • Trace Noise Test • Receiver Compression Test • Noise Floor Test • Calibration Coefficients Test • Dynamic Accuracy Test	page 3-29
Adjustments[b]	Setups and procedures for adjusting your analyzer: • 10 MHz Frequency Reference Adjustment • IF Gain Adjustment • Synthesizer Bandwidth Adjustment • Source Adjustment • Receiver Adjustment • EE Default Adjustment	page 3-40

a. These performance tests are included in the analyzer's firmware for Options 897 and 898.
b. These adjustments are included in the analyzer's firmware on all models and options.

Before You Begin

Before checking, verifying, or adjusting the analyzer, refer to the following paragraphs to:

- make sure the operating environment is within its requirements
- make sure that proper electrostatic discharge (ESD) protection is provided
- make sure the analyzer has warmed up properly to achieve system stability
- review the principles of connector care

IMPORTANT Keysight personnel: see Figure 1-1 on page 1-5 to review where the calibration stickers should be placed on the PNA.

Verify the Operating Environment

Due to their operating specifications, the verification and calibration kit devices determine your operating environment conditions. Open the calibration and verification kits and place all the devices on top of the foam inserts so they will reach room temperature. As the device dimensions change with temperature, their electrical characteristics change as well.

It is necessary to keep the environmental levels within the following limits:

- Temperature: +23 °C ± 3 °C (Error-corrected temperature range)

  Once the measurement calibration has been done, the ambient temperature must be maintained to within ± 1 °C of the calibration temperature.
- Humidity: 0% to 95% at 40 °C maximum, non-condensing
- Altitude: 0 to 4,600 meters (≈15,000 feet.)

Protect Against Electrostatic Discharge (ESD)

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

CAUTION To reduce the chance of electrostatic discharge, follow all of the recommendations outlined in "Electrostatic Discharge Protection" on page 1-6, for all of the procedures in this chapter.

Allow the Analyzer to Warm Up

NOTE To achieve the maximum system stability, allow the analyzer to warm up for at least 90 minutes.

Review the Principles of Connector Care

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

For course numbers about additional connector care instruction, contact Keysight Technologies. Refer to "Contacting Keysight" on page 2-7.

Table 3-1 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.

About System Verification and Performance Tests

The performance of the network analyzer is specified in two ways: system specifications, and instrument specifications. It is the end user's responsibility to determine which set of specifications is applicable to their use of the PNA.

A network analyzer measurement "system" includes the analyzer, calibration kit, test cables, and any necessary adapters. **The system verification software in the PNA is used to verify the system's conformance to the "system" specifications.** A "pass" result demonstrates that the analyzer, test cables, and adapters, perform correctly as a system. It DOES NOT demonstrate that any one component performs according to its individual specifications. A change to any part of this measurement system requires a re-verification of the system.

Instrument specifications specify the network analyzer's uncorrected measurement port characteristics and its output and input behavior. **The PNA performance tests are used to verify the analyzer's conformance to "instrument" specifications.**

System Specifications

System specifications specify warranted performance of the measurement system when making error-corrected measurements using the same calibration kit and test cables used during the system verification routine. System specifications are applicable only when the measurement system is used to make error-corrected measurements.

The analyzer's system specifications are described in the *"N523xA Data Sheet and Technical Specifications,"* available online at http://literature.cdn.keysight.com/litweb/pdf/N5235-90004.pdf.

System specifications are expressed in two ways:

- residual errors of the measurement system shown as tabular specification values
- graphs of measurement uncertainty versus reflection and transmission coefficients

System specifications are verified in one of the following ways:

- Complete the system verification procedure using a certified verification kit and certified calibration kit that will be used for future measurements, or
- Complete all of the performance tests using a certified calibration kit that will be used for future measurements. This alternative verifies both the system specifications and the instrument specifications for the analyzer.

Instrument Specifications

The analyzer's instrument specifications are described in the *"N523xA Data Sheet and Technical Specifications,"* available online at http://literature.cdn.keysight.com/litweb/pdf/N5235-90004.pdf.

These specifications apply when the analyzer is used to make either raw or error-corrected measurements.

System Verification Procedure

The system verification procedure tests the network analyzer measurement "system", as defined previously, against the system specifications. If confirmation is successful, the measurement system is capable of making measurements to the accuracy specified by the graphs of measurement uncertainty.

The procedure consists of calibrating the analyzer with a calibration kit, measuring a set of characterized devices, and comparing the resultant measured data to the data and uncertainty limits supplied with the verification kit. The device data provided with the verification kit has a traceable path to NIST. The total measurement uncertainty limits for the performance verification are the sum of the factory measurement uncertainties and the uncertainties associated with measuring the same devices on the system being verified. The difference between the factory-measured data and the verification-measured data must fall within the total uncertainty limits at all frequencies for the total system uncertainty test to pass.

NOTE Calibration kits are different from verification kits. Calibration kits are used to determine the systematic errors of a network analyzer measurement system. Verification kits are used to confirm system specifications and are not used to generate error correction.

Performance Tests

Performance tests are used to confirm analyzer performance against the “instrument” specifications. If confirmation is successful, the analyzer meets the instrument specifications.

Performance tests are contained in the analyzer’s firmware with Options 897 or 898 and are described at “Performance Tests” on page 3-29.

An illustrated outline of the performance verification procedure:

- for ANSI/NCSL Z540.3-2006 and ISO/IEC 17025 verification, is shown in Figure 3-1 on page 3-9.
- for non-standards verification, is shown in Figure 3-2 on page 3-10.

Certificate of Calibration

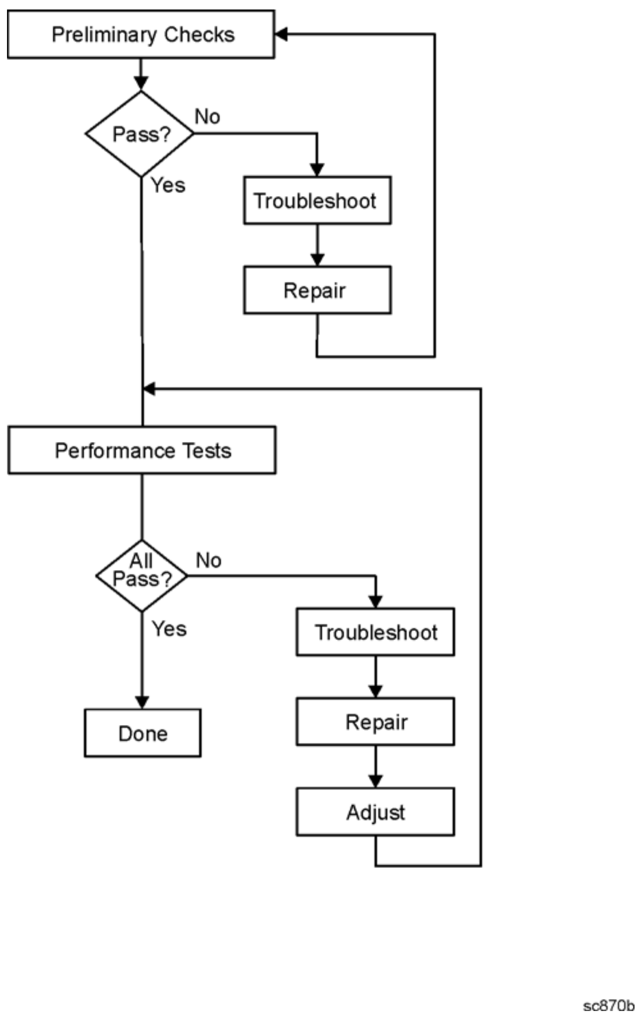
Keysight Technologies will issue a certificate of calibration upon successful completion of system verification or completion of the performance tests. The certificate of calibration will apply to the "system" (analyzer, calibration kit, test cables, and any necessary adapters) if the system verification procedure is used to confirm the system specifications. If the performance tests are used to confirm instrument specifications, the certificate of calibration will apply to the PNA as an independent instrument. The equipment and measurement standards used for the tests must be certified and must be traceable to recognized standards.

NOTE If you have a measurement application that does not use all of the measurement capabilities of the analyzer, you may ask your local Keysight Technologies service office to verify only a subset of the specifications. However, this "limited calibration" creates the possibility of making inaccurate measurements if you then use the analyzer in an application requiring additional capabilities.

ANSI/NCSL Z540.3–2006 and ISO/IEC 17025 Verification

To meet the criteria for ANSI/NCSL Z540.3-2006 and ISO/IEC 17025 verification, perform the preliminary checks and all performance tests *without stopping to repair or adjust*[1]. Refer to Figure 3-1 for test flow. Print data at the completion of all the tests, even if you are aware that the analyzer did not pass. If there is a failure, complete the verification before you troubleshoot, repair, and adjust. After the failure has been corrected, repeat the entire set of performance tests and generate a new set of data.

Figure 3-1 ANSI/NCSL Z540.3–2006 and ISO/IEC 17025 Verification Flowchart

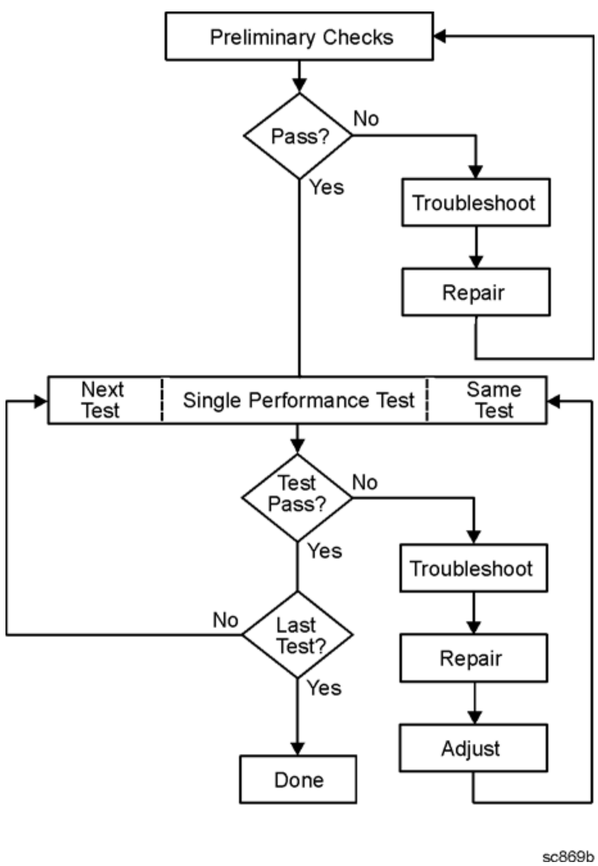


1. Stop only in case of a catastrophic failure or cable connector damage

Non-Standards Compliant Verification

To meet the criteria for non-standards compliant verification, perform the preliminary checks and the performance tests while *stopping to troubleshoot.* Refer to Figure 3-2 for test flow. Troubleshoot and repair the first problem encountered without continuing to other tests. After you troubleshoot, repair, and adjust, repeat the *last failed* portion and generate a new set of data.

Figure 3-2 Non–Standards Compliant Verification Flowchart



Preliminary Checks

Preliminary checks include the following:

- "The Operator's Check" on page 3-11

  The operator's check tests the network analyzer's basic functionality of the source, switch, and receivers.

- "The Test Port Cable Checks" on page 3-13

  The test port cable checks are not required, but are recommended to verify the performance of the test port cables before performing the verification test.

The Operator's Check

NOTE To achieve the maximum system stability, allow the analyzer to warm up for at least 90 minutes before performing the Operator's Check.

The operator's check is a software driven test that checks the basic operation of the assemblies in all of the measurement port signal paths. By performing the operator's check, the following are determined:

- attenuation ranges of all installed attenuators
- calibration of the receivers
- frequency response of the receivers
- phase lock and leveling
- noise floor and trace noise

Accessories Used in the Operator's Check

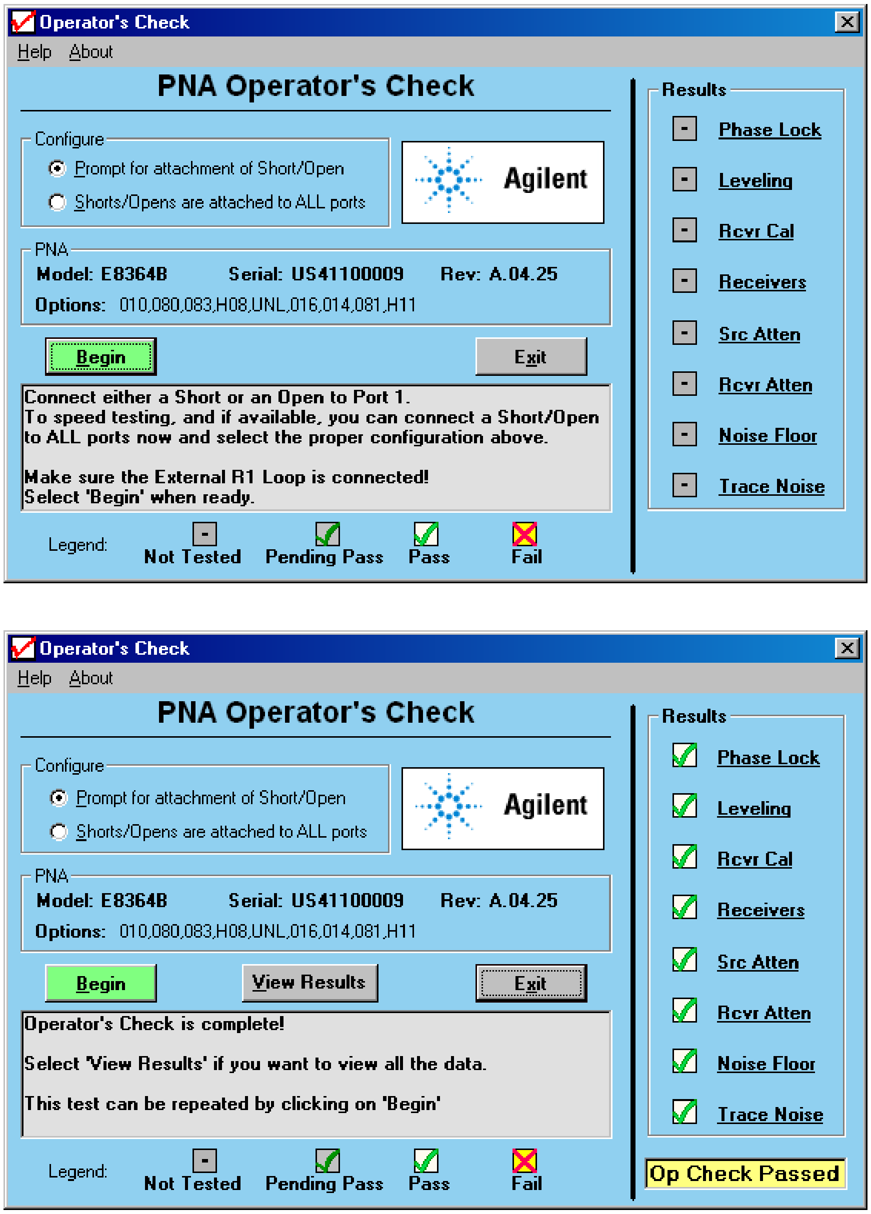
Equipment Type	Part Number
Female short, 3.5 mm	(any short from the 85052B calibration kit)
Female open, 3.5 mm	(any open from the 85052B calibration kit)

Performing the Operator's Check

1. Press UTILITY System , then Service , then Operator's Check .
2. In the **PNA Operator's Check** dialog box (refer to Figure 3-3), under **Configure**, select either **Prompt for attachment of Short/Open**, to pause at each step in the process to allow moving the short/open to the appropriate port, or **Shorts/Opens are attached to ALL ports**, to run through the test without stopping. Shorts and opens can be mixed on the test ports.
3. Click **Begin**.
4. If shorts and opens are not connected to all ports, you will be prompted to connect them as they are needed.
5. The result of the operator's check will be shown as a PASS or FAIL next to each test (refer to Figure 3-3).

The PNA Operator’s Check dialog box will look different for different PNA model numbers and installed options. Some of the tests are performed only if the appropriate options are installed in the PNA.

Figure 3-3 Operator’s Check Dialog Box



If the Operator’s Check Fails

1. Clean the test ports, shorts, and adapters. Torque to specification. Repeat the check.
2. If the check still fails, suspect a faulty component. Refer to “Measurement System Troubleshooting” on page 4-24 to begin troubleshooting to determine the faulty component.

The Test Port Cable Checks

A faulty test port cable can cause a failure in the verification test. The following checks are not required, but are recommended to verify the performance of the test port cable.

- "Cable Return Loss Check" on page 3-14
- "Cable Insertion Loss Check" on page 3-15
- "Cable Magnitude and Phase Stability Check" on page 3-16
- "Cable Connector Repeatability Check" on page 3-18

Accessories Used in the Test Port Cable Checks

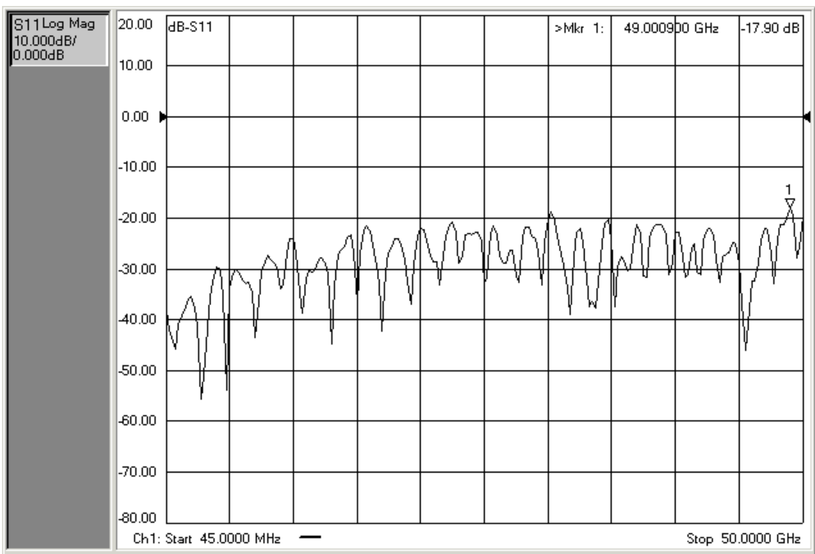
Equipment Type	Model or Part Number	Alternate Model or Part Number
Calibration kit, 3.5 mm	85052B	85052D
Test cable, 3.5 mm (f) to 3.5 mm (f)	85131C	85131E

Cable Return Loss Check

1. Press UTILITY Preset.
2. Perform a one-port calibration on Port 1, **1-Port Reflection**. Refer to the embedded help in the analyzer if necessary.
3. Connect the test port cable to Port 1. Connect a broadband load to the other end of the cable. Tighten to the specified torque for the connector type.

   The analyzer now displays the return loss of the cable.
4. Press MARKER/ANALYSIS Search, then Search. In the **Marker Search** dialog box, in the **Search Type** box, make sure **Maximum** is selected. Click **Execute**, and then click **OK**.
5. The marker annotation on the screen indicates the worst case return loss. Refer to the cable manual to see if it meets the return loss specification. For an example of a typical return loss measurement, see Figure 3-4.

Figure 3-4 Typical Cable Return Loss Response



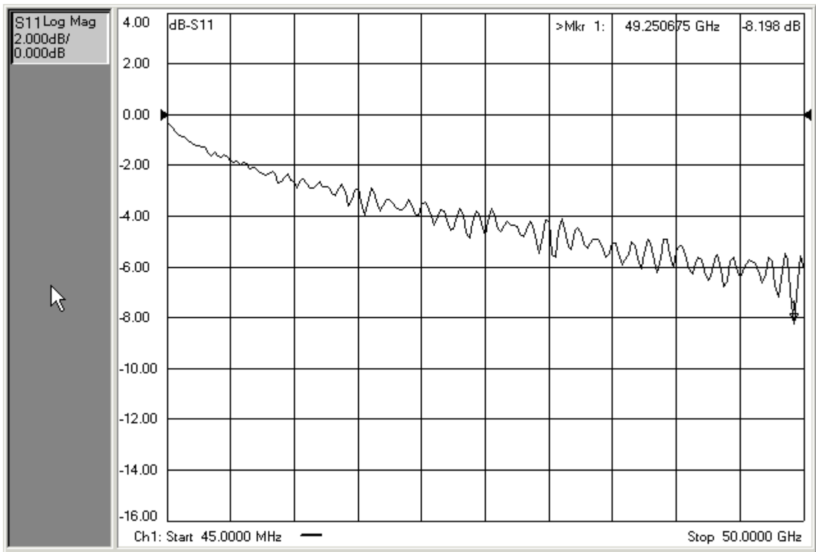
If the Cable Return Loss Check Fails

1. Clean the cable and devices and torque to specification. Repeat the check.
2. If the check still fails, the cable should be repaired or replaced.

Cable Insertion Loss Check

1. With the test port cable still connected to Port 1, connect a short to the other end of the cable.
2. Press MARKER/ANALYSIS Search , then Search . In the **Marker Search** dialog box, in the **Search Type** box, select **Minimum**.Click **Execute**, and then click **OK**.
3. The displayed response is twice the actual loss. To get the actual worst case insertion loss, divide the value at the marker annotation by two. Refer to the cable manual to see if it meets the insertion loss specification. For an example of a typical insertion loss measurement, see Figure 3-5.

Figure 3-5 Typical Cable Insertion Loss Response



If the Cable Insertion Loss Check Fails

1. Clean the cable and devices and torque to specification. Repeat the check.
2. If the check still fails, the cable should be repaired or replaced.

Cable Magnitude and Phase Stability Check

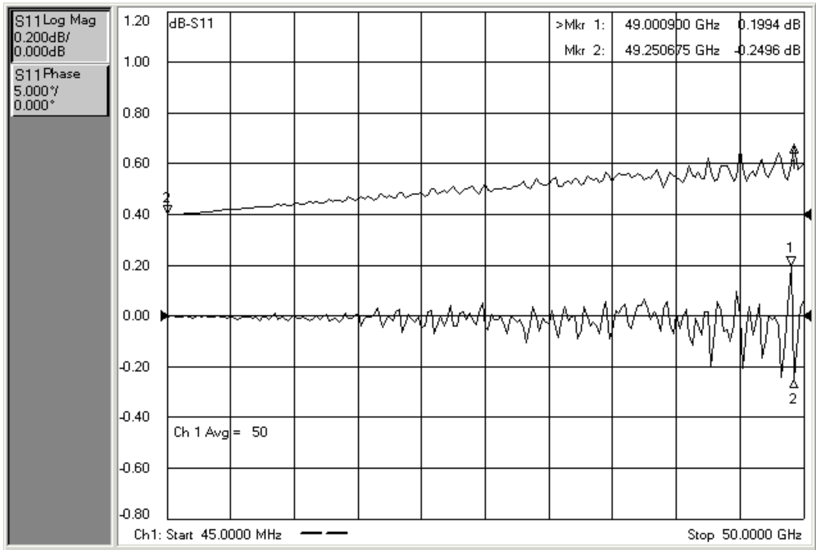
1. With the test port cable still connected to Port 1, connect a short to the other end of the cable.
2. Press UTILITY Preset .
3. Press TRACE/CHANNEL Traces , then New Trace... . In the **New Trace** dialog box, click the **S11** box, and then click **OK**.
4. Press RESPONSE Format , then Phase , then ENTRY Enter .
5. Press RESPONSE Avg . Verify that Average ON/off is **ON**. If not, press the Average on/OFF softkey to toggle it **ON**.

   The **Averaging Factor** box will appear directly above the display. In the **Averaging Factor** box, type **50** or click the arrows to select **50**, and then press ENTRY Enter .
6. To provide a good reference, hold the test cable in a straight line perpendicular to the front panel of the network analyzer.
7. Press RESPONSE Avg , then Averaging Restart .
8. Wait for the analyzer to average the measurement 50 times (approximately two seconds).
9. To normalize the data trace: press MARKER/ANALYSIS Memory , then Data Trace , then Data Math , then Data/Memory , then ENTRY Enter .
10. Slowly make a 180 degree bend in the middle of the cable and hold it in that position.
11. For each trace: press RESPONSE Scale , then Scale .

    The **Scale Per Division** box will appear directly above the display. Set the **Scale Per Division** for optimum viewing as shown in Figure 3-6.
12. Place a marker on the largest deflection that goes above the reference line and is within the cable's specified frequency range. For a typical response of cable magnitude and phase stability, see Figure 3-6.
13. Place a marker on the largest deflection that goes below the reference line and is within the cable's specified frequency range.

    In this S_{11} measurement, the displayed trace results from energy being propagated down the cable and reflected back from the short. Therefore, the measured deflection value must be divided in half to reach the correct value.

Figure 3-6 Typical Cable Magnitude and Phase Stability Response



If the Cable Magnitude and Phase Stability Check Fails

1. Clean the cable and devices and torque to specification. Repeat the check.
2. If the check still fails, the cable should be repaired or replaced.

Cable Connector Repeatability Check

NOTE The connector repeatability measurement should be done at the test port as well as at the end of the test port cable.

1. With the test port cable still connected to Port 1, connect a broadband load to the other end of the cable.
2. Press UTILITY Preset .
3. Press RESPONSE Avg . Verify that Average ON/off is **ON**. If not, press the Average on/OFF softkey to toggle it **ON**.

   The **Averaging Factor** box will appear directly above the display. In the **Averaging Factor** box, type **100** or click the arrows to select **100**, and then press ENTRY Enter .
4. Wait for the analyzer to average the measurement 100 times (approximately five seconds).
5. To normalize the data trace: press MARKER/ANALYSIS Memory , then Data Trace , then Data Math , then Data/Memory , then ENTRY Enter .
6. To adjust the display scale:
   a. Press RESPONSE Scale , then Scale .

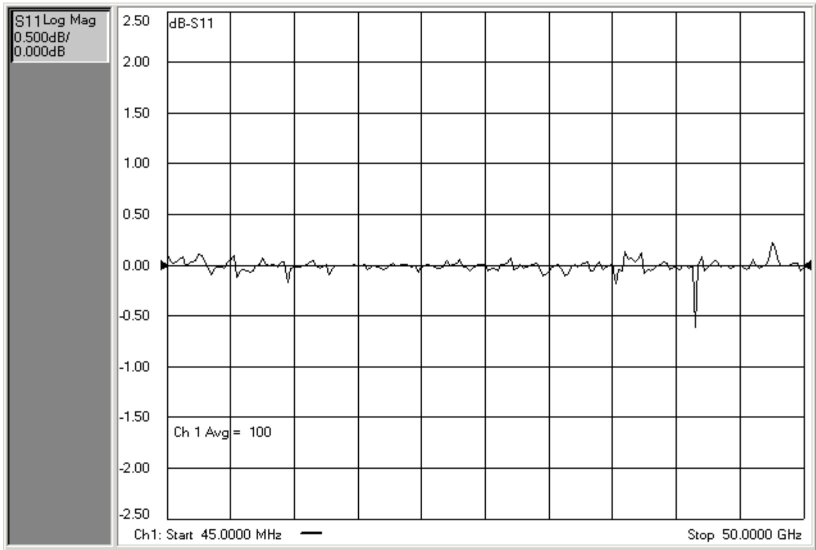
      The **Scale Per Division** box will appear directly above the display. Set the **Scale Per Division** for **0.5 dB**. Press ENTRY Enter .

   b. Press Reference Level .

      The **Reference Level** box will appear directly above the display. Set the **Reference Level** for **0 dB**. Press ENTRY Enter .
7. Disconnect and then reconnect the cable to the test port. Tighten the connection to the specified torque for the connector type.
8. Press RESPONSE Avg , then Averaging Restart .
9. Look at the trace for spikes or modes.
10. To re-normalize the data trace of the reconnected cable: press MARKER/ANALYSIS Memory , then Data->Memory , then ENTRY Enter .
11. Repeat steps 7 through 9 at least three times to look for modes. Modes appear when a harmonic of the source fundamental frequency is able to propagate through the cable or connector. It is helpful to print a plot of the trace each time to compare several connections. If any mode appears each time the cable is connected and reconnected, measurement integrity will be affected.

    For a typical response of cable connector repeatability, see Figure 3-7.
12. For the Port 2, 3, and 4 Check, connect the cable (with the load attached) to the respective port and repeat steps 2 through 11.

Figure 3-7 Typical Cable Connector Repeatability Response



If the Cable Connector Repeatability Check Fails

1. Clean the cable and devices, and torque to specification. Repeat the check.
2. If the check still fails, the cable should be repaired or replaced.

System Verification

System verification is used to verify system-level, error-corrected uncertainty limits for network analyzer 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.

IMPORTANT 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
- 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.

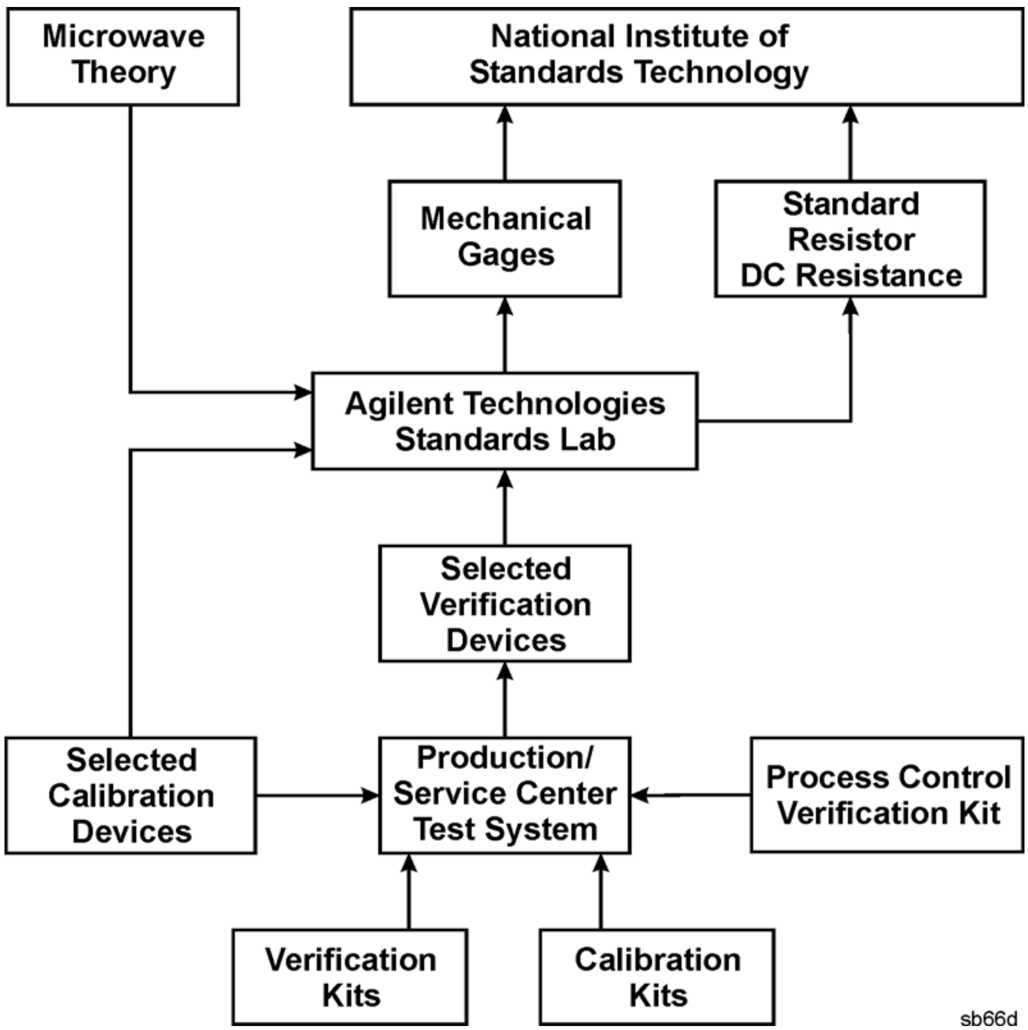
Any measurement result is the vector sum of the actual test device response plus all error terms. The precise effect of each error term depends on its magnitude and phase relationship to the actual test device response. When the phase of an error response is not known, phase is assumed to be worst-case (–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 3-8). This chain of measurements defines how the verification process brings traceability to the network analyzer system.

Figure 3-8 NIST 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. 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 disk and sequentially measures the magnitude and phase for all four S-parameters.

IMPORTANT For system verification to perform correctly, it is NECESSARY that the verification devices be measured with their female connectors connected to the analyzer's test ports.

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	3.5 mm	Type-N
Calibration kit	85052B, C, D N4691A E-cal	85054B/D N4690A E-cal
Verification kit	85053B	85055A
Cables	Single cable: 85131C/E Cable pair: 85131D/F	Single cable: 85132C/E (3.5 mm NMD to 7 mm) Cable pair: 85132D/F (3.5 mm NMD to 7 mm)
Adapters	None required.	With single cable: an 85130C adapter and a 7mm to Type-N adapter from the 85054B calibration kit. With cable pair: Two 7mm to Type-N adapters from the 85054B calibration kit.

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. Refer to the plots in the cable tests (earlier in this chapter) that show the performance of good cables. 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.

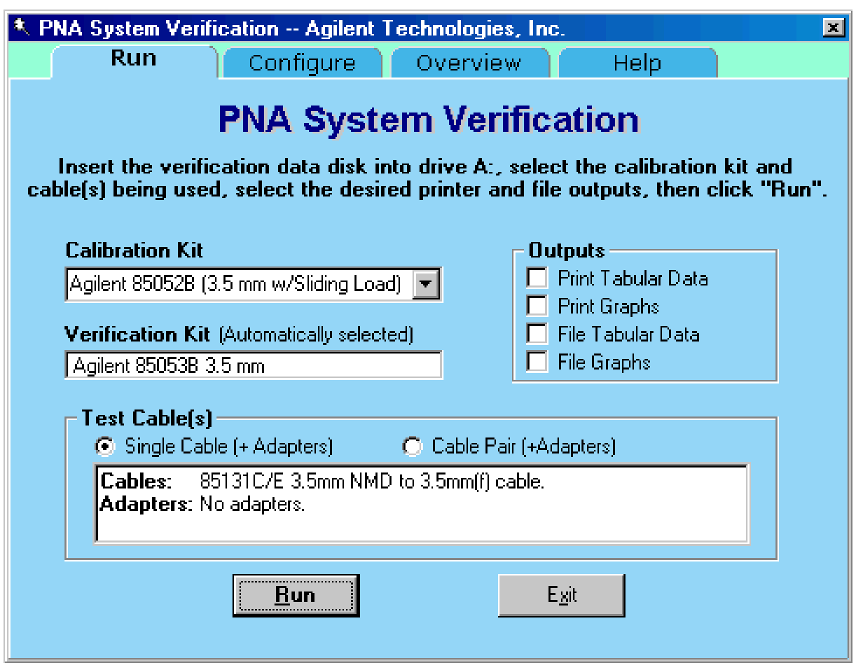
Kit Substitution

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 disk into the analyzer disk drive.
3. Press UTILITY System, then Service, then System Verification. The **System Verification** dialog box is displayed; refer to Figure 3-9.

Figure 3-9 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 3-9.

5. Under **Printer Output,** click one of the following options. Refer to Figure 3-9.
   - **Print Tabular Data**: Prints the verification data in tabular form which includes measured data and uncertainty limits. For an example, refer to Figure 3-11 on page 3-27.
   - **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 3-12 on page 3-28.
   - **File Tabular Data**: Writes the tabular data to a text file in the Windows XP directory C:\Program Files\Keysight\Network Analyzer\Documents\ or in the Windows 7 directory C:\Users\Public\Public Documents\Network Analyzer\SysVer\.
   - **File Graphs**: Saves a screen image in PNG format in the Windows XP directory C:\Program Files\Keysight\Network Analyzer\Documents\ or in the Windows 7 directory C:\Users\Public\Public Documents\Network Analyzer\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.

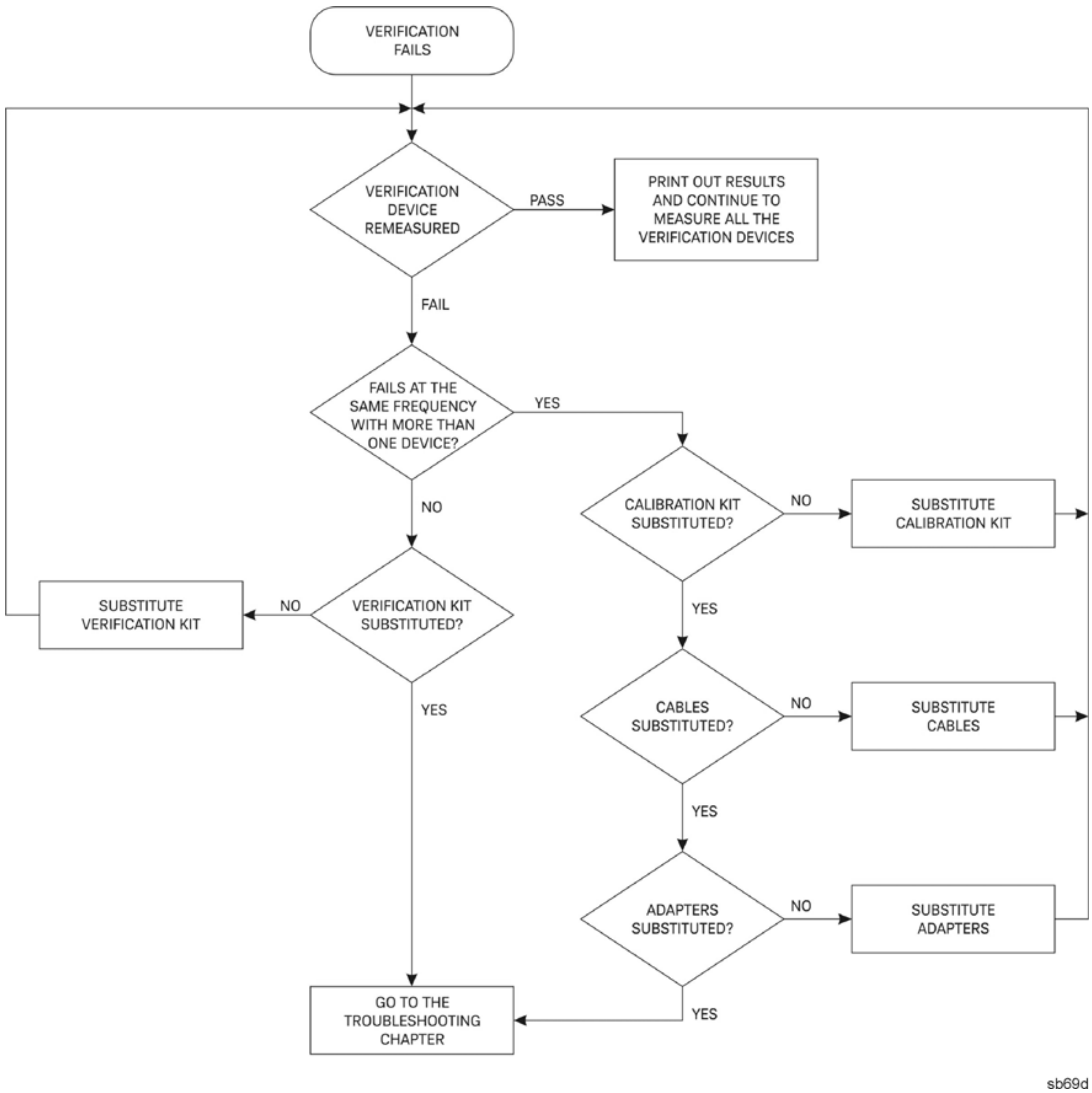
6. Click **Run**.
7. Follow the instructions on the analyzer for performing a full calibration or recalling an existing recent calibration.
8. Follow the instructions on the analyzer for performing the system verification; inserting the verification devices as prompted.

If the System Fails the Verification Test

IMPORTANT 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, check the measurement calibration by viewing the error terms as described in "Accessing Error Terms" on page 8-8.
5. Refer to Figure 3-10 for additional troubleshooting steps.

Figure 3-10 System Verification Failure Flowchart



Interpreting the Verification Results

Figure 3-11 shows an example of typical verification results with **Print Tabular Data** selected in the **Printer Output** area of the **System Verification** dialog box.

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

Each S-parameter measurement result is printed with frequency tested, lower and upper limit lines, the measured data, and the result of the test.

Figure 3-11 Example of Printed Tabular Verification Results

PNA System Verification

Model: N5230A 225   Ser. Num.: US43390055   Test Time: 12/8/2004 2:08:35 PM

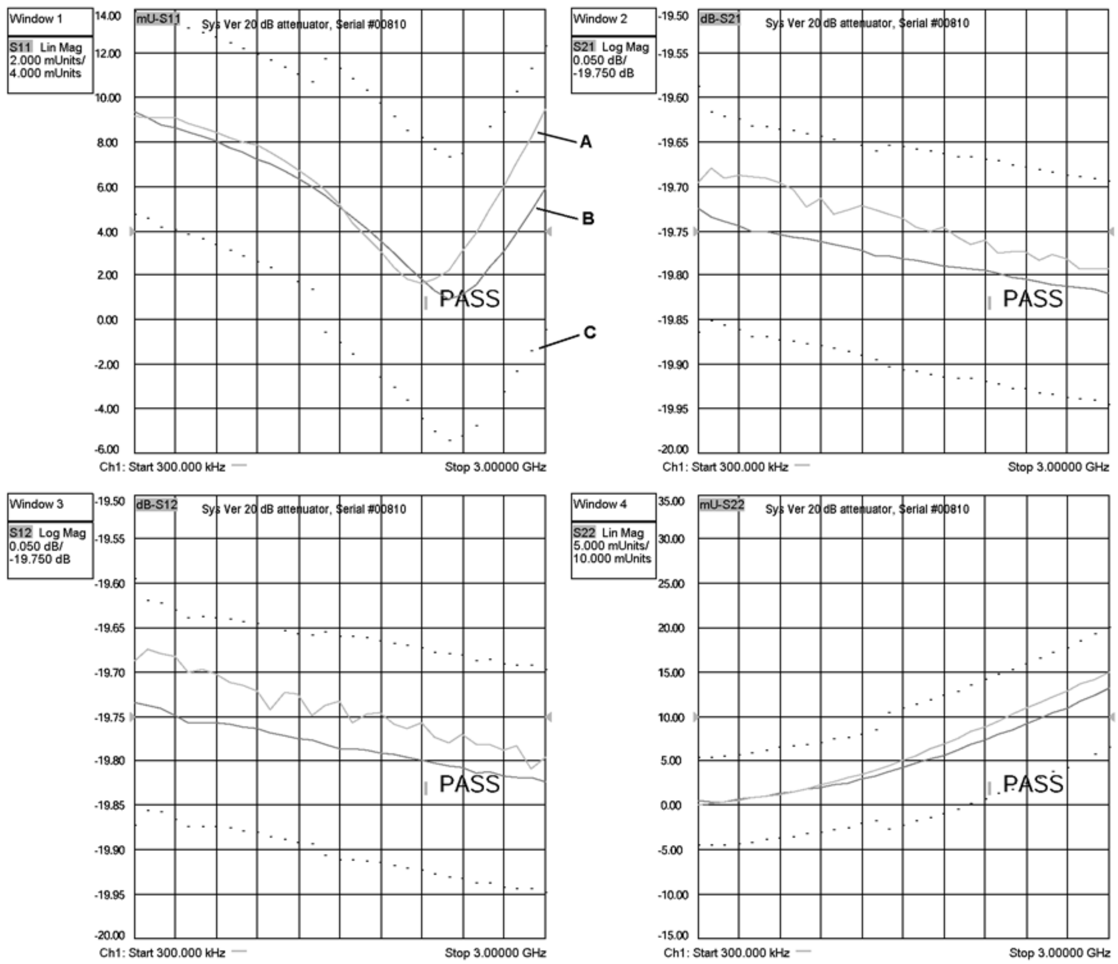
Device: 20 dB Attenuator, Serial #02743   S11 Results   PASS

	S11 MAGNITUDE (lin)				S11 PHASE (deg)			
Freq [GHz]	Lower Limit (lin)	Meas'd Data (lin)	Upper Limit (lin)	Total Uncert +/-	Lower Limit (deg)	Meas'd Data (deg)	Upper Limit (deg)	Total Uncert +/-
0.045	0.0067	0.0045	0.0113	0.0090	n/a	177.46	n/a	n/a
0.50	0.0067	0.0046	0.0114	0.0091	n/a	155.77	n/a	n/a
1.00	0.0057	0.0047	0.0125	0.0091	n/a	127.90	n/a	n/a
1.50	0.0043	0.0050	0.0139	0.0091	n/a	99.52	n/a	n/a
2.00	0.0034	0.0055	0.0148	0.0091	n/a	72.43	n/a	n/a
2.50	0.0076	0.0061	0.0208	0.0142	n/a	46.58	n/a	n/a
3.00	0.0068	0.0067	0.0216	0.0142	n/a	21.57	n/a	n/a
3.50	0.0066	0.0075	0.0227	0.0146	n/a	-0.45	n/a	n/a
4.00	0.0060	0.0086	0.0233	0.0146	n/a	-20.94	n/a	n/a
4.50	0.0056	0.0098	0.0237	0.0147	n/a	-39.48	n/a	n/a
5.00	0.0053	0.0109	0.0241	0.0147	n/a	-56.13	n/a	n/a
5.50	0.0051	0.0118	0.0242	0.0147	n/a	-71.75	n/a	n/a
6.00	0.0050	0.0125	0.0244	0.0147	n/a	-86.47	n/a	n/a
6.50	0.0049	0.0131	0.0244	0.0147	n/a	-100.81	n/a	n/a
7.00	0.0057	0.0136	0.0236	0.0147	n/a	-113.94	n/a	n/a
7.50	0.0061	0.0138	0.0232	0.0147	n/a	-125.68	n/a	n/a
8.00	0.0059	0.0138	0.0234	0.0147	n/a	-135.63	n/a	n/a
8.50	0.0110	0.0136	0.0287	0.0198	n/a	-144.53	n/a	n/a
9.00	0.0107	0.0133	0.0290	0.0199	n/a	-152.31	n/a	n/a
9.50	0.0101	0.0130	0.0297	0.0199	n/a	-159.32	n/a	n/a
10.00	0.0092	0.0129	0.0305	0.0199	n/a	-165.12	n/a	n/a
10.50	0.0080	0.0129	0.0317	0.0199	n/a	-169.47	n/a	n/a
11.00	0.0066	0.0130	0.0332	0.0199	n/a	-172.95	n/a	n/a
11.50	0.0051	0.0135	0.0347	0.0199	n/a	-176.46	n/a	n/a
12.00	0.0035	0.0140	0.0364	0.0199	n/a	-179.98	n/a	n/a

Figure 3-12 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. Labeled as A in Figure 3-12.
- Data measured at the factory from the verification kit. Labeled as B in Figure 3-12.
- Upper and lower limit points as defined by the total system uncertainty system. Labeled as C in Figure 3-12.

Figure 3-12 Example of Printed Graphical Verification Results



Performance Tests

The performance tests verify the electrical performance of your PNA. These performance tests are included in the analyzer's firmware with Option 897 and Option 898. Your analyzer is automatically configured for each individual test.

The model numbers of the equipment used by these performance tests are specified under "Required Service Test Equipment" on page 2-4.

There are nine tests in the Option 897 or 898 performance test package:

- Source Power Accuracy Test
- Source Maximum Power Output Test
- Source Power Linearity Test
- Frequency Accuracy Test
- Trace Noise Test
- Receiver Compression Test
- Noise Floor Test
- Calibration Coefficients Test
- Dynamic Accuracy Test

Source Power Accuracy Test

Function of the Test: To confirm the accuracy of the source output power of your network analyzer over its full frequency range.

Specification Tested: Test Port Output–Power Level Accuracy

Equipment Used:

- Power meter
- Power sensors
- Any necessary adapters

Description of the Test:

1. The analyzer is Preset.
2. The analyzer is set up for a CW reflection measurement on the test port to be measured.
3. A power sensor is connected to the test port, using any necessary adapters.
4. The analyzer frequency is set to the desired value.
5. The power meter correction table is set to the same frequency.
6. The output power is measured, and the value is compared to the Preset setting.
7. This process is repeated at hundreds of frequencies across the analyzer's full range. The difference between the measured power and the output setting must fall within the specified accuracy range at all points for the test to pass.

If the Analyzer Fails this Test:

- Perform the "Source Adjustment" on page 3-43 and repeat this test.
- If the analyzer still fails this test, troubleshoot the source section of the analyzer and then repeat this test. Refer to "Checking the Source Group" on page 4-31.

Source Maximum Power Output Test

Function of the Test: To confirm the maximum source output power of your network analyzer over its full frequency range.

Specification Tested: Test Port Output–Maximum Leveled Power

Equipment Used:

- Power meter
- Power sensors
- Any necessary adapters

Description of the Test:

1. The analyzer is Preset.
2. The analyzer is set up for a CW reflection measurement on the test port to be measured.
3. A power sensor is connected to the test port, using any necessary adapters.
4. The analyzer frequency is set to the desired value.
5. The power meter correction table is set to the same frequency.
6. The analyzer's output power is increased until a "Source Unleveled" error is detected. The output power is then decreased in increments of 0.01 dB until the error goes away. if the output power reaches +18 dBm without any error, the power is left at this level.
7. The power level at this point is measured and compared to the maximum output power specification.
8. This process is repeated at hundreds of frequencies across the analyzer's full range in every specified path configuration.

If the Analyzer Fails this Test:

Troubleshoot the source section of the analyzer and then repeat this test. Refer to "Checking the Source Group" on page 4-31.

Source Power Linearity Test

Function of the Test: To verify that the power level is linear over the analyzer's frequency range and to check the linearity of the automatic leveling control (ALC).

Specification Tested: Power Sweep Range and Power Level Linearity

Equipment Used:

- Test cable
- 20 dB attenuator if the analyzer does not have an internal step attenuator

Description of the Test:

Ports 1 and 2 are tested as a pair. The Port 2 receiver is used to test the linearity of the source power out of Port 1, and vice versa. Ports 3 and 4 are similarly tested as a pair on 4-Port analyzers. The receiver linearity is the standard against which the source linearity is checked.

1. The analyzer is Preset.
2. The analyzer is set up for a CW transmission measurement on the test port pair to be measured.
3. A test cable is connected between the port pair to be tested with 20 dB of attenuation in series with the cable. This is done with an internal source step attenuator or an external 20 dB attenuator. This attenuation ensures that the receiver remains in its linear range.
4. The receiver measurement is normalized at this Preset power level.
5. The source setting is then stepped from the minimum to the maximum ALC power setting range in 1 dB steps, and the receiver power is measured at each setting.
6. The non-linearity in dB at each frequency point is calculated as the difference between the change in the source power setting away from Preset and the change in the receiver power reading.
7. This power linearity measurement is repeated at several CW frequencies across the full frequency range of the analyzer.

If the Analyzer Fails this Test:

- Perform the "Source Adjustment" on page 3-43 and repeat this test.
- If the analyzer still fails this test, troubleshoot the source section of the analyzer and then repeat this test. Refer to "Checking the Source Group" on page 4-31.

Frequency Accuracy Test

Function of the Test: To verify the frequency accuracy and range of the analyzer's source output.

Specification Tested: Test Port Output–CW Accuracy

Equipment Used:

- Frequency counter
- Test cable
- Adapters

Description of the Test:

This test is performed over the full frequency range of the source synthesizer board, not the full frequency range of the analyzer. To generate the higher frequencies, the analyzer passes the synthesizer signal through a series of frequency doublers. These doublers exactly double the source frequency, so the deviation from a perfectly accurate frequency is exactly doubled. The frequency accuracy is specified as the ratio parts per million (ppm), so this ratio is unaffected by the signal doubling. Therefore, only the frequency accuracy of the synthesizer board needs to be tested.

1. The analyzer is Preset.
2. The analyzer is set up for a CW measurement on Port 1.
3. A test cable is connected between Port 1 and a frequency counter with any necessary adapters.
4. The signal frequency is measured and compared with the analyzer source frequency setting. The difference must be less than the source frequency divided by 1^6 for a 1 part per million (ppm) specification.
5. This test is repeated at several frequencies across the range of the source synthesizer board.

If the Analyzer Fails this Test:

- Verify the accuracy of the 10 MHz OCXO by using a frequency counter to measure the rear-panel 10 MHz REF OUT. If the 10 MHz reference is off by more than 10 Hz, perform the "10 MHz Frequency Reference Adjustment" on page 3-41 and then repeat this test.

Trace Noise Test

Function of the Test: To measure the stability of a signal in the internal source and receiver system of your analyzer.

Specification Tested: Test Port Input–Trace Noise Magnitude and Trace Noise Phase

Equipment Used: A test cable.

Description of the Test:

Trace Noise is a calculation of the standard deviation of a 201 point CW measurement. In a healthy analyzer, this measurement is only affected by the sampling error of the analog to digital converters on the SPAM board.

Ports 1 and 2 are tested as a pair using S_{21} and S_{12} measurements. Ports 3 and 4 are similarly tested as a pair on 4-port analyzers using S_{43} and S_{34} measurements.

1. The analyzer is Preset.
2. The analyzer is set up for a 201 point CW transmission measurement for the port pair to be tested with the specified IF bandwidth (typically 1 kHz). Both a magnitude and a phase trace are displayed.
3. A test cable is connected between the port pair to be tested.
4. The analyzer is set to a series of CW frequencies across its full frequency range. The analyzer’s trace statistics function is used to calculate the standard deviation of both the magnitude trace and the phase trace.
5. These standard deviation values are reported as the analyzer’s trace noise and are compared with the Trace Noise magnitude and phase specifications.

If the Analyzer Fails this Test:

A failure of this test indicates a fault in the receiver’s IF chain between the mixer and the A9 SPAM board. This can indicate a faulty assembly or a loose cable.

- Check for proper torquing of all semi-rigid cables in the receiver chain, and then repeat this test.
- If the analyzer still fails this test, replace the A9 SPAM board and repeat this test. Most failures are due to this board. Refer to “Removing and Replacing the A4, A7, A9, and A10 Boards” on page 7-16.
- If the analyzer still fails this test, replace the mixer module for the failing receiver, and then repeat this test.

Receiver Compression Test

Function of the Test: To measure the compression at the analyzer's specified maximum power level for the receivers.

Specification Tested: Test Port Input–Maximum Test Port Input Level

Equipment Used:

- U3070AK01 or Z5623A Option K01 Compression Test Set
- Power meter
- Power sensors
- Two test cables
- Calibration kit
- 10-dB and 20-dB pads if the analyzer does not have an internal step attenuator

Description of the Test:

For most analyzer models, the receiver compression level is higher than the maximum source output power. Therefore, an external amplifier is required. This test also requires that two attenuators be switched in and out of the RF path. These requirements are met with the use of the Compression Test Set. The procedure outlined here is for those models which require the test set.

1. The analyzer is Preset. The two test set output attenuators are set to 0 dB.
2. The analyzer is set up for a 201 point CW transmission measurement for the port pair to be tested with the specified IF bandwidth (typically 1 kHz).
3. A test cable is connected between the analyzer source port and the test set input port. A test cable is connected to the test set output port.
4. A power sensor is connected to the end of the test cable.
5. For a series of CW frequencies across the analyzer's full frequency range, the source output level is adjusted to achieve the specified receiver compression power level (typically the receiver's maximum input power level).
6. The power sensor is disconnected from the test cable and the cable is connected to the port to be tested.
7. The analyzer steps through each CW frequency as the absolute log magnitude value (dBm) and the relative phase for the receiver under test is read (P_a).
8. The first test set output attenuator is set to 20 dB.
9. The magnitude and phase measurements using the receiver under test are read: (P_b).
10. The second test set output attenuator is set to 20 dB.
11. The magnitude and phase measurements using the receiver under test are read: (P_c).
12. The first test set output attenuator is set to 0 dB.
13. The magnitude and phase measurements using the receiver under test are read: (P_d).
14. The compression for each point is calculated as $(P_a – P_b) – (P_d – P_c)$.

If the Analyzer Fails this Test:

- Run the Receiver Characterization adjustment, and repeat this test.
- If the analyzer still fails this test, replace the A24 mixer brick, then repeat this test. Refer to "Removing and Replacing the A24 Mixer Brick (QuintBrick)" on page 7-26.

Noise Floor Test

Function of the Test: To measure the absolute power level of the noise floor for the analyzer's receivers.

Specification Tested: Test Port Input–Test Port Noise Floor

Equipment Used:

- Power meter
- Power sensors
- Test cable
- Calibration kit

Description of the Test:

This test uses the source signal out of one analyzer test port as part of the noise floor measurement on another test port. Port 2 is the source port when measuring the noise floor of Port 1. Port 1 is the source port when measuring the noise floor of Ports 2, 3, and 4.

1. The analyzer is Preset.
2. The analyzer is set up for a CW transmission measurement between the source port and the test port to be measured. The analyzer is set to an IF bandwidth of 1 kHz and 801 points per sweep.
3. A test cable is connected to the source port.
4. A power sensor is connected to the end of the test cable with any necessary adapters.
5. For hundreds of frequencies across the analyzer's full range, a source power calibration is performed to ensure a flat power response at the end of the cable at the Preset power level.
6. The power sensor is disconnected and the cable is connected to the port to be tested.
7. A CW linear measurement sweep is measured for each test point. The receiver reference power level, P_{ref}, in dBm is calculated for each point from the mean of each sweep.
8. The test cable is removed and loads are connected to both ports.
9. A CW linear measurement sweep is measured for each test point. The receiver test power level, P_{test}, in dBm is calculated for each point from the mean of each sweep.
10. The corrected noise floor in dBm is calculated for a 10 Hz IF bandwidth using: $P_{NoiseFloor} = P_{test} - 19.96$ dB – (Preset Power – P_{ref}).

If the Analyzer Fails this Test:

- If the analyzer fails this test, replace the A24 mixer brick, then repeat this test. Refer to "Removing and Replacing the A24 Mixer Brick (QuintBrick)" on page 7-26.
- If the analyzer still fails this test, replace the A9 SPAM board and then repeat this test. Refer to "Removing and Replacing the A4, A7, A9, and A10 Boards" on page 7-16.

Calibration Coefficients Test

Function of the Test: To verify the uncorrected calibration coefficients of your analyzer. The calibration coefficients are specified at the test port without any cables, so calibrations must be performed in both the forward and reverse directions to eliminate the effects of the test cable.

Specification Tested: Uncorrected System Performance

Equipment Used:

- Calibration kit
- Test cable

Description of the Test:

Two full SOLT 2-port calibrations are performed on each port pair. Ports 1 and 2 are tested as a pair. Ports 3 and 4 are tested as a pair on 4-port analyzers. Isolation is turned off during each calibration.

1. A test cable is connected to Port 1.
2. A calibration is performed between the end of the test cable and Port 2. The Port 2 directivity and source match and the S_{21} load match are retrieved from the analyzer.
3. The test cable is moved to Port 2.
4. A calibration is performed between the end of the test cable and Port 1. The Port 1directivity and source match and the S_{12} load match are retrieved from the analyzer.
5. On some older analyzer models, the reflection tracking and transmission tracking error terms were also specified. For those models, these error terms are also retrieved from the analyzer.
6. This process is repeated for Ports 3 and 4 on 4-port analyzers.

If the Analyzer Fails this Test:

- Failure of the directivity error term is often due to a faulty test port coupler. Replace the coupler and repeat this test.
- Failure of the source or load match error terms is due to faulty hardware between the test port and the internal source. Refer to Chapter 7, “Repair and Replacement Procedures” for instructions on replacing the suspected faulty component or assembly.

Dynamic Accuracy Test

This description applies to all N522xA, N5231A/32A/34A/35A/39A, and N5247A instruments.

Function of the Test: To measure the relative power linearity of the analyzer's receivers.

Specification Tested: Test Port Input–Dynamic Accuracy

Equipment Used:

- U3020AD01 dynamic accuracy test set
- Signal generator
- Power meter
- Power sensor
- Two test cables

Description of the Test:

1. The analyzer's test ports are tested separately at a specific CW frequency and a reference power level of -20 dBm.
2. A test cable is connected between the analyzer's source port and the dynamic accuracy test set's Source 1 In port. A test cable is connected between the signal generator and the test set's Source 2 In port. A test cable is connected to the test set's Receiver Out port, and the power sensor is connected to the end of this cable.
3. The test set's output attenuator is set to 20 dB. With the signal generator RF turned off, the PNA source power is adjusted until the power sensor reads -20 dBm. The PNA source is then turned off, the signal generator RF is turned on, and the signal generator power is adjusted until the power sensor reads -20 dBm.
4. The power sensor is disconnected and the test cable is attached to the analyzer port under test.
5. Both sources are turned on and the signal generator's frequency is set to 2 Hz above the analyzer's frequency. By combining these two signals together, the resultant signal will be a perfect sine wave with a magnitude which varies from -17 dBm to -23 dBm at a rate of 2 Hz.
6. The analyzer's receiver measurement is retrieved and compared with a perfect sine wave. Any deviation is due to receiver non-linearity.
7. The test set's output attenuator is changed in 5 dB steps from 0 to 60 dB, and this measurement is repeated.
8. With the 1 dB of overlap in each measurement, the data for each attenuator setting can be stitched together to provide a complete receiver linearity profile from +3 dBm to -63 dBm.
9. This test is repeated for each receiver.

If the Analyzer Fails this Test:

- If the analyzer fails this test, rerun the test.
- If the analyzer fails this test repeatedly, replace the A24 mixer brick, then repeat this test. Refer to "Removing and Replacing the A24 Mixer Brick (QuintBrick)" on page 7-26.
- If the analyzer still fails this test, replace the A9 SPAM board and repeat this test. Refer to "Removing and Replacing the A4, A7, A9, and A10 Boards" on page 7-16.

Adjustments

These adjustments are firmware-driven tests that are used to fine-tune your analyzer.

If multiple adjustments are to be performed, perform them in the order listed.

- "10 MHz Frequency Reference Adjustment" on page 3-41
- "IF Gain Adjustment" on page 3-42
- "Synthesizer Bandwidth Adjustment" on page 3-42
- "Source Adjustment" on page 3-43
- "Receiver Adjustment" on page 3-44
- "EE Default Adjustment" on page 3-46

These adjustments are described on the following pages.

10 MHz Frequency Reference Adjustment

The 10 MHz frequency adjustment is used to adjust the frequency accuracy of the network analyzer's 10 MHz frequency reference on the A7 frequency reference board assembly.

Equipment Used for the 10 MHz Frequency Reference Adjustment

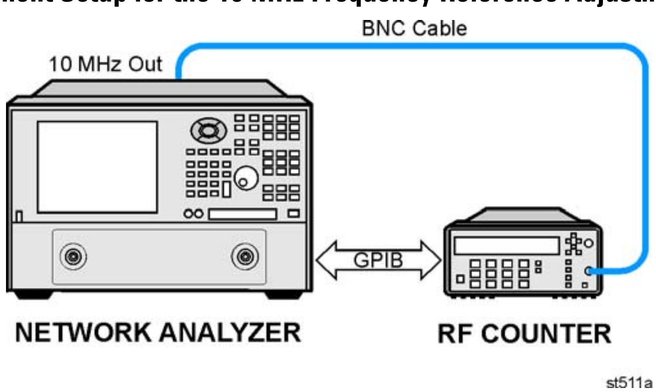
Equipment Type	Model or Part Number	Alternate Model or Part Number
Cable, BNC, 50Ω, 24 inch	8120-1839	Any
Frequency counter	53151A, Option 001	Any that will measure a signal at 10 MHz.

Procedure

NOTE This adjustment typically adjusts to within ±0.01 ppm.

1. Connect the equipment as shown in Figure 3-13. Connect a GPIB cable between the network analyzer and the frequency counter.

Figure 3-13 Equipment Setup for the 10 MHz Frequency Reference Adjustment



2. Press UTILITY System, then Service, then Adjustments, then click **10 MHz Freq Adjustment**.
3. Ensure the GPIB settings are correct.
4. Follow the instructions and prompts as they are displayed.

IF Gain Adjustment

The IF gain adjustment is used to adjust the IF gain of the network analyzer.

Procedure

1. Press UTILITY System, then Service, then Adjustments, then click **IF Gain Adjustment**.
2. Follow the instructions and prompts as they are displayed.

Synthesizer Bandwidth Adjustment

This adjusts the bandwidth of the 13.5 GHz synthesizers.

Procedure

1. Press UTILITY System, then Service, then Adjustments, then click **Synthesizer Bandwidth Adj**.
2. Follow the instructions and prompts as they are displayed.

Source Adjustment

The source calibration is used to adjust your network analyzer for a flat source power across its full frequency range. There are differences between each test port; therefore, an adjustment is required for each port.

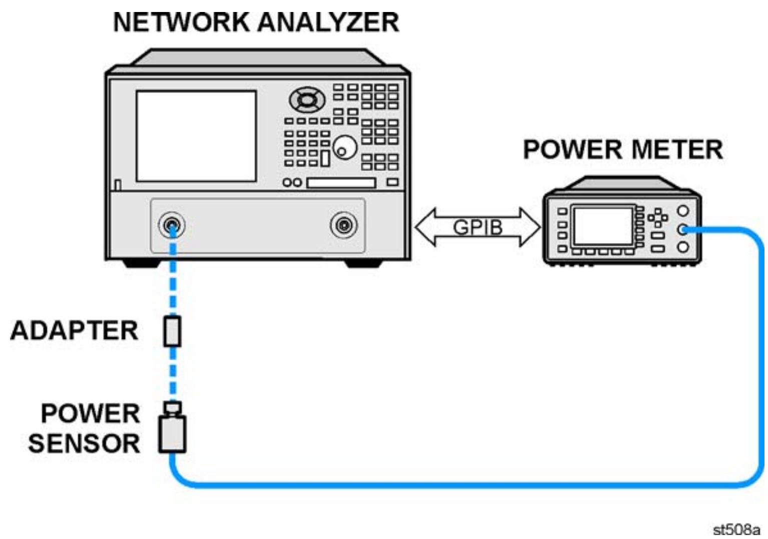
Equipment Used for the Source Adjustment

Equipment Type	Model or Part Number	Alternate Model or Part Number
Power meter	E4418B/E4419B	E4418A/E4419A
Power sensor, 3.5 mm	E4413A	8485A
Adapter, 3.5 mm (f) to 3.5 mm (f)	83059B	85052-60012

Procedure

1. Connect the equipment as shown in Figure 3-14. Connect a GPIB cable between the network analyzer and the power meter.

Figure 3-14 Equipment Setup for the Source Adjustment



2. .Press UTILITY System, then Service, then Adjustments, then click **Source Adjustment**.
3. Ensure the GPIB settings are correct.
4. Follow the instructions and prompts as they are displayed.

Receiver Adjustment

The receiver calibration is used to adjust the network analyzer receivers for a flat response across its full frequency range:

1. A power meter/sensor is connected to Port 1, as shown in Figure 3-15, to establish a reference for flatness.
2. A cable is inserted between the power sensor and the test port, as shown in Figure 3-16, to establish a reference for the cable.
3. The same cable is connected between test port 1 and test port 2, as shown in Figure 3-17, and a signal from Port 1 is used to adjust the "B" receiver at Port 2.

   The adjustment is repeated using a signal from Port 2 to adjust the "A" receiver at Port 1.

Data obtained during this adjustment are stored in the mxcalfile_pxx files in flash memory on the test set motherboard, with a backup copy stored on the hard disk drive. The data are used in subsequent measurements.

Solid state drives can be swapped or replaced without concern for the mxcalfile_pxx files. If the test set motherboard is replaced, the PNA firmware will automatically create new primary mxcalfile_pxx files from the backup copies on the hard drive.

These files can be recreated by performing another receiver calibration adjustment.

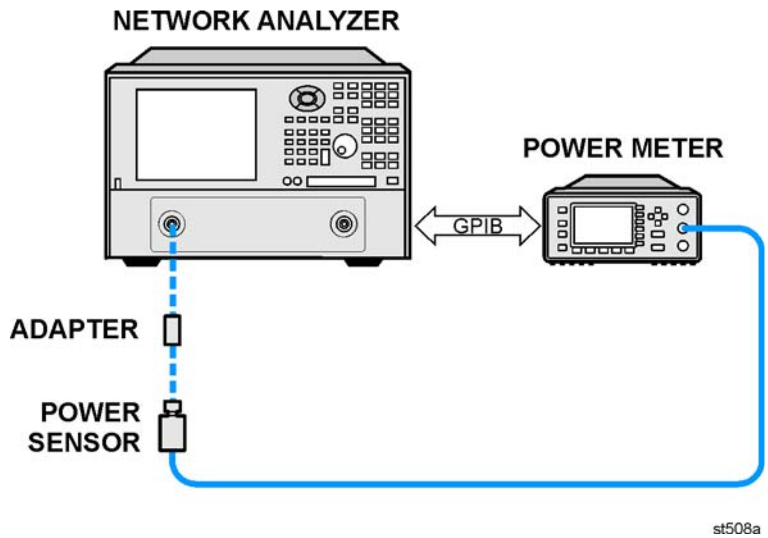
Equipment Used for the Receiver Adjustment

Equipment Type	Model or Part Number	Alternate Model Part Number
Power meter	E4418B/E4419B	E4418A/E4419A
Power sensor, 3.5 mm	E4413A	8485A
Adapter, 3.5 mm (f) to 3.5 mm (f)	83059B	85052-60012
RF Cable, 3.5 mm (f) to 3.5 mm (f)	85131C	85131E

Procedure

1. Connect the equipment as shown in Figure 3-15. Connect a GPIB cable between the network analyzer and the power meter.

Figure 3-15 Equipment Setup 1 for the Receiver Adjustment



2. Press UTILITY System, then Service, then Adjustments, then click **Receiver Adjustment**.
3. Ensure the GPIB settings are correct.
4. Follow the instructions and prompts as they are displayed.

Figure 3-16 Equipment Setup 2 for the Receiver Adjustment

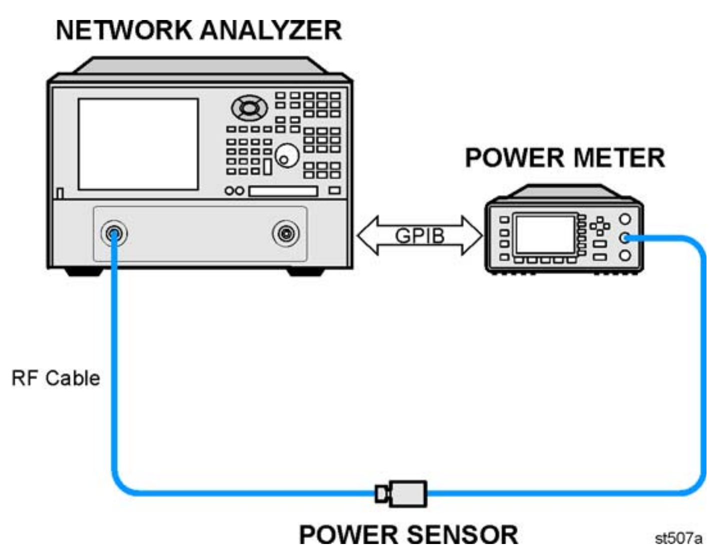
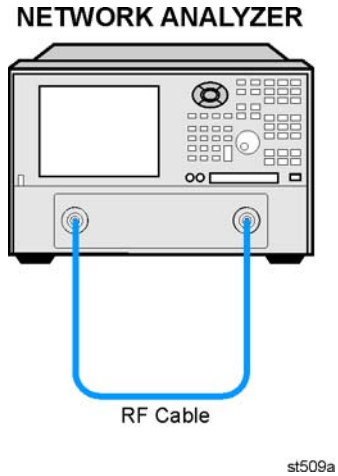


Figure 3-17 Equipment Setup 3 for the Receiver Adjustment



EE Default Adjustment

This sets the EEPROM data to their default values.

Procedure

1. Press UTILITY System, then Service, then Adjustments, then click **EE Default Adjustment**.
2. On the dialog box, select **Initialize** rather than **Adjust/Verify** because an adjustment is typically unnecessary.
3. Follow the instructions and prompts as they are displayed.

4 Troubleshooting

Information in This Chapter

The information in this chapter helps you:

- Identify the portion of the analyzer at fault.
- Locate the specific troubleshooting procedure to identify the assembly or peripheral at fault.

The sections in this chapter are arranged in a logical troubleshooting order. The following table lists the sections and a brief summary of what to look for in that section.

Chapter Four at-a-Glance

Conventions Used for Hardkeys, Softkeys, and Menu Items

The following conventions are used in this document:

Hardkey	This represents a "hardkey", a key that is physically located on the instrument.
Softkey	This represents a "softkey", a key whose label is determined by the instrument firmware.
Menu Item	This represents an item in a drop-down or pop-up menu.

Operating the Analyzer With Covers Removed

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.

Protect Against Electrostatic Discharge (ESD)

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

CAUTION To reduce the chance of electrostatic discharge, follow all of the recommendations outlined in "Electrostatic Discharge Protection" on page 1-6, for all of the procedures in this chapter.

Assembly Replacement Sequence

After identifying the problem requiring an assembly to be replaced, follow these steps:

Step 1. Order a replacement assembly. Refer to Chapter 6, "Replaceable Parts."

Step 2. Replace the faulty assembly and determine what adjustments are necessary. Refer to Chapter 7, "Repair and Replacement Procedures."

Step 3. Perform the necessary adjustments. Refer to Chapter 3, "Tests and Adjustments."

Step 4. Perform the necessary performance tests. Refer to Chapter 3, "Tests and Adjustments."

Getting Started with Troubleshooting

Where you begin troubleshooting depends upon the symptoms of the failure. Start by checking the basics as outlined in the following section. Also review the flowchart in Figure 4-1 on page 4-5. You should then be able to determine where in the troubleshooting procedure to begin, to locate the failed assembly.

Check the Basics

A problem can often be solved by repeating the procedure you were following when the problem occurred. Before calling Keysight Technologies or returning the instrument for service, please perform the following checks:

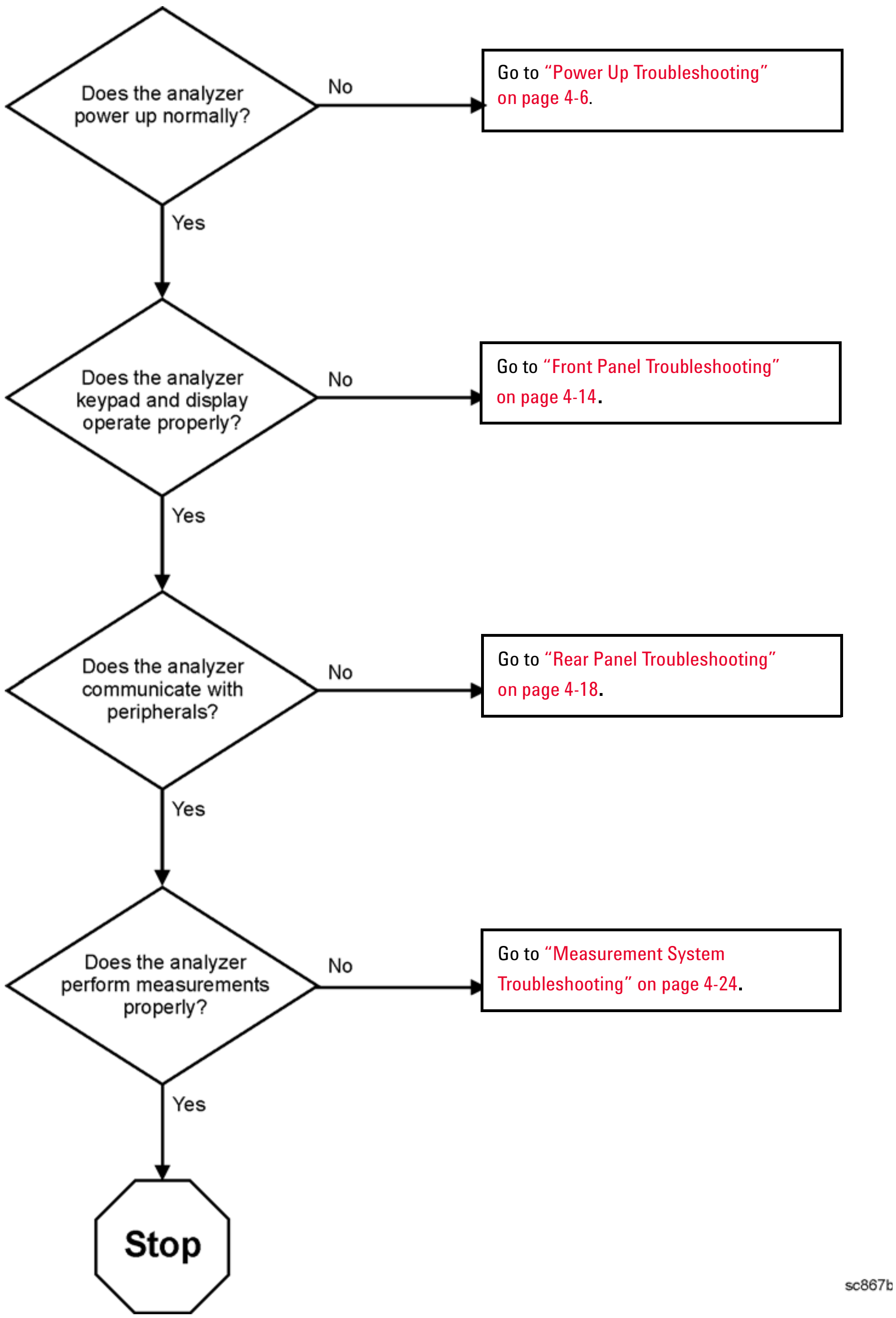
1. Is there power at the mains receptacle? If not, correct this situation and proceed.
2. Is the instrument turned on? Check to see if the front panel line switch glows. This indicates the power supply is on. If the front panel line switch is on but the power supply does not appear to be on, go to "Power Up Troubleshooting" on page 4-6.
3. Is the Windows® operating system running? If not, refer to "Operating System Recovery" in Chapter 8 for instructions.
4. If other equipment, cables, and connectors are being used with the instrument, make sure they are clean, connected properly and operating correctly.
5. Review the procedure for the measurement being performed when the problem appeared. Are all the settings correct? If not, correct them.

   If the instrument is not functioning as expected, return the unit to a known state by pressing the UTILITY Preset key.
6. Is the measurement being performed, and the results that are expected, within the specifications and capabilities of the instrument? Refer to the embedded help in the analyzer for instrument specifications.
7. If the problem is thought to be due to firmware, check to see if the instrument has the latest firmware before starting the troubleshooting procedure. Refer to "Firmware Upgrades" in Chapter 8 for instructions.
8. If the necessary test equipment is available, perform the operator's check and system verification in Chapter 3, "Tests and Adjustments."

Troubleshooting Organization

Follow the flowgraph in Figure 4-1 to help direct you to the correct section for troubleshooting the analyzer.

Figure 4-1 Troubleshooting Organization Flowchart



Power Up Troubleshooting

WARNING **Immediately unplug the instrument from the ac power line if the unit shows any of the following symptoms:**

- **Smoke, arcing, or unusual noise from inside the analyzer.**
- **A circuit breaker or fuse on the main ac power line opens.**

Check your network analyzer for evidence that it is powering up correctly. Perform the following steps and make sure that the analyzer is displaying correct behavior as noted in the following steps.

Step 1. Disconnect all peripherals and plug in the network analyzer. Before the analyzer is powered on, the line switch should glow yellow and no other lights should be on.

Step 2. Turn on the network analyzer.

- The line switch should glow green.
- The fans should be audible.
- The display should flash and then show the hardware boot-up sequence. This process checks the RAM and communication with the hard disk drive. These checks return an error message if a problem is detected.
- The Windows operating system should start.
- The network analyzer measurement interface should open with an S_{11} measurement displayed.

Step 3. If the analyzer powers up correctly, continue troubleshooting with "Front Panel Troubleshooting" on page 4-14.

Step 4. If the analyzer does not power up correctly, follow these troubleshooting steps:

- If the line switch does not glow, go to "Power Supply Check" on page 4-7.
- If you cannot hear the fans operating, go to "If the Fans Are Not Operating" on page 4-11.
- If the line switch glows green and the fans are operating (audible), but the display remains dark, go to "Troubleshooting LCD Display Problems" on page 4-12.

If the instrument appears to abort the network analyzer measurement interface process, contact Keysight. Refer to "Contacting Keysight" on page 2-7.

Power Supply Check

NOTE There are no fuses to replace within the power supply. If you determine that the power supply is the failed assembly, replace the power supply.

A catastrophic failure in the power supply can be determined by observing the line switch and the power supply LED indicators:

1. Ensure that the instrument is plugged in with the power switch in the standby position (power not switched on). Verify that the line switch displays a yellow light. A line switch that displays a yellow light indicates that the power supply standby line is active and functional)
2. Turn on the instrument power and verify that the line switch now displays a green light. When the line switch displays a green light, it is an indication that the power supply is active and does not sense an over-current condition.
3. You can determine which power supplies are functioning by viewing the LED indicators on the A15 midplane board. Refer to Figure 4-2.

   To view the LED indicators, it is necessary to remove the instrument's outer and inner covers. Refer to "Removing the Covers" on page 7-8 for removal procedures. To determine the location of the A15 midplane board, refer to "Top Assemblies, All Models" on page 6-16.

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.

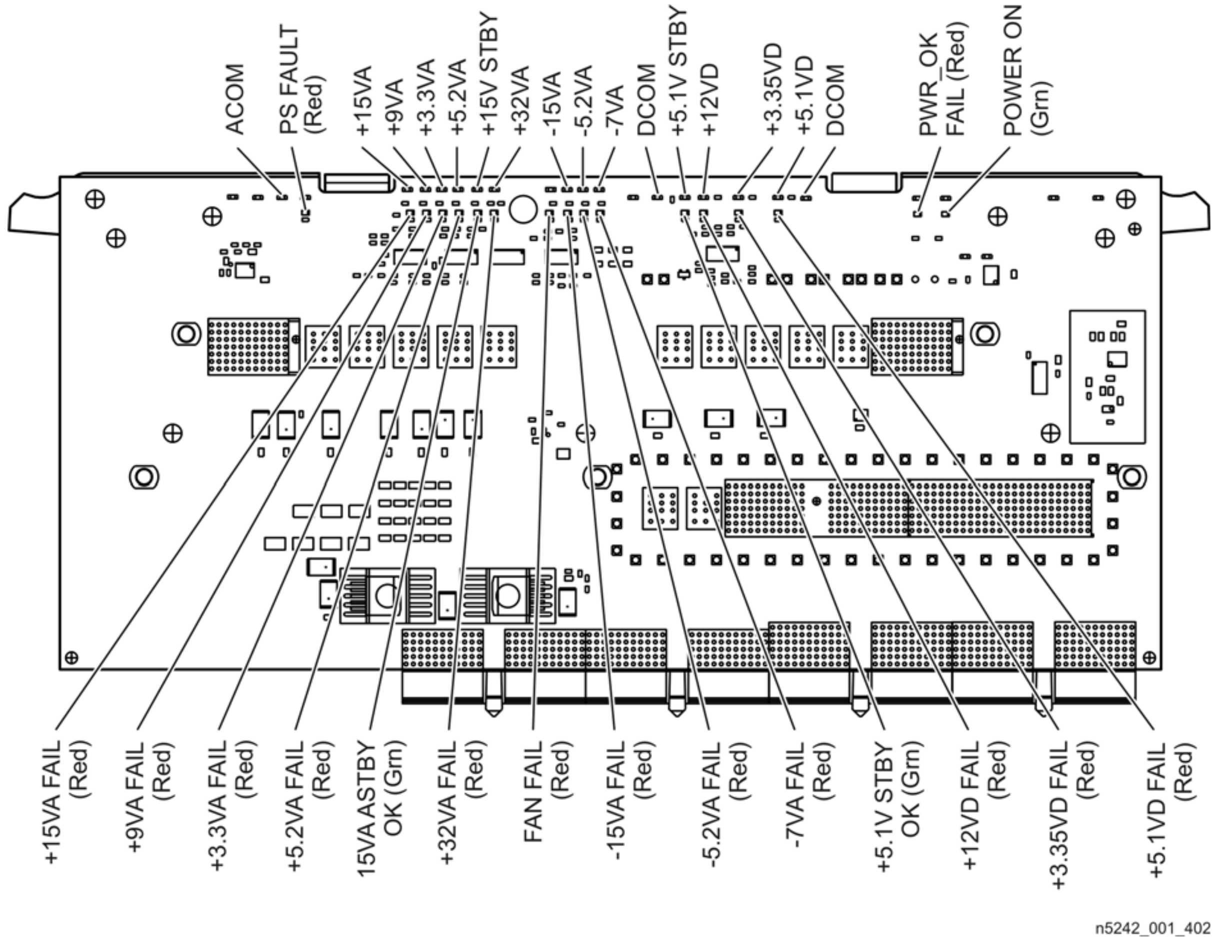
4. If any power supply voltage is missing, it is likely that the problem is a defective A16 power supply, the A15 midplane board, or another assembly that is loading down the A16 power supply. Continue with "If Any Supply Voltage Is Missing" on page 4-9 to determine the cause of the problem.
5. If the line switch is lit correctly, and all the power supply voltages appear to be present, as indicated by the LEDs as shown in Figure 4-2, the power supply has not suffered a catastrophic failure. However, the power supply could still be at fault. Continue at "Measure the Individual Supply Voltages" to verify that the actual supply voltages are correct.

Measure the Individual Supply Voltages

Measure the power supply voltages using a digital multi-meter. Use the point labeled ACOM as ground reference for analog supplies and the point marked DCOM as ground reference for digital supplies.

Refer to Figure 4-2 for the power supply measurement points on the A15 midplane board. Refer to Table 4-1 on page 9 for the correct voltages.

Figure 4-2 A15 Midplane Board Power Supply LED Indicators and Measurement Points



WARNING **The instrument contains potentially hazardous voltages. Refer to the safety symbols provided on the instrument and in “General Safety Considerations” on page 1-3 before operating the unit with the cover removed. Make sure that the safety instructions are strictly followed. Failure to do so can result in personal injury or loss of life.**

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.

NOTE If any one individual voltage supply from the A16 power supply develops an over-voltage or over-current problem, all supplies are affected. The cause of the over-voltage or over-current condition can be the A16 power supply itself, or any assembly to which the A16 power supply provides voltage. To isolate the cause, continue to the assembly removal process as described in the section titled “If Any Supply Voltage Is Missing” on page 4-9.

Table 4-1Power Supply Measurement Points

Test Point	Supply Name	Expected Level (Vdc)	Test Point	Supply Name	Expected Level (Vdc)
TP517	Analog Ground	0 V	TP516	–5.2 V analog	–5.2 ±0.1
TP509	+15 V analog	+15.0 ±0.1	TP514	–7 V analog	–7.0 ±0.1
TP511	+9 V analog	+9.0 ±0.1	TP500	Digital Ground	0 V
TP515	+3.3 V analog	+3.3 ±0.1	TP502	+5.1 V standby	+5.1 ±0.1
TP513	+5.2 V analog	+5.2 ±0.1	TP503	+12 V digital	+12.0 ±0.1
TP501	+15 V standby	+15.0 ±0.1	TP507	+3.35 V digital	+3.35 ±0.1
TP504	+32 V analog	+32.0 ±0.1	TP505	+5.1 V digital	+5.1 ±0.1
TP512	–15 V analog	–15.0 ±0.1	TP519	Digital Ground	0 V

If All Supply Voltages are Present

If all of the supplies have measured within tolerances, and the instrument still is not functioning properly, refer to “Front Panel Troubleshooting” on page 4-14.

If Any Supply Voltage Is Missing

WARNING **Disconnect the line-power cord before removing any assembly. Procedures described in this document may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury or loss of life.**

You must sequentially remove all of the assemblies, taking care to disconnect the line power cord before each removal, and then measure the supply voltages after each removal.

If the missing supply voltages return to a “power on” condition after removal of an assembly, suspect that assembly as being defective.

Remove the network analyzer assemblies in the order specified in the following steps (refer to Chapter 7 for removal instructions).

1. Unplug the A19 test set motherboard ribbon cable from the A19 test set motherboard (refer to “Removing and Replacing the A19 Test Set Motherboard” on page 7-23).
2. Unplug the front panel interface cable from the A1 front panel interface board (refer to “Removing and Replacing the Front Panel Assembly” on page 7-10).
3. Remove the A9 SPAM board (refer to “Removing and Replacing the A4, A7, A9, and A10 Boards” on page 7-16
4. Remove the A10 13.5 GHz LO synthesizer board (refer to “Removing and Replacing the A4, A7, A9, and A10 Boards” on page 7-16).
5. Remove the A4 13.5 GHz source synthesizer board (refer to “Removing and Replacing the A4, A7, A9, and A10 Boards” on page 7-16).
6. Remove the A7 frequency reference board (refer to “Removing and Replacing the A4, A7, A9, and A10 Boards” on page 7-16).

7. Remove the A18 GPIB board (refer to "Removing and Replacing the A18 GPIB Board" on page 7-22). Reinstall the A16 power supply assembly and the A17 CPU board assembly.
8. Unplug the A51 hard disk drive from the A17 CPU board (refer to "Removing and Replacing the A51 Solid State Drive (SSD)" on page 7-29).

The minimum required assemblies to power up the analyzer are:

- A16 power supply
- A15 midplane board
- A14 system motherboard
- A17 CPU board

To further isolate the failure in the three remaining assemblies, measure the resistance (with the power turned off) from the power supply test points to either ACOM or DCOM.

NOTE	Make sure that the only assemblies plugged in are the four minimum required assemblies listed above.

Check for shorts (zero Ω) or very low resistance (approximately 1 Ω). If a short or low resistance is measured, isolate each of the remaining four boards in the following order, and recheck the shorted test point after each board is removed. You should be able to determine if the shorted condition has changed.

Isolate the remaining three assemblies:

- remove the A17 CPU board
- remove the A16 power supply
- remove the A15 midplane board
- This leaves only the A14 system motherboard installed. If the resistance measurements are still incorrect, this is the suspected faulty assembly.

If the Fans Are Not Operating

CAUTION The power supply may be in thermal shutdown if the instrument has been operating without the fans running. Allow the instrument to cool down before troubleshooting.

If all three fans are not operating, suspect a power supply problem or a defective A14 system motherboard. Refer to "Power Supply Check" on page 4-7 to check the individual supplies. If the supplies are within specifications, the most probable cause is a defective A14 system motherboard. Refer to "Removing and Replacing the A14 System Motherboard" on page 7-17.

If only one or two fans are not functioning, and the power supplies are within specifications, suspect the A14 system motherboard or defective fan(s). Perform the following procedure.

1. Remove the fan bracket, with fans attached, from the analyzer to expose the fan power cable connections on the A14 system motherboard. Refer to Figure 4-3 and Figure 4-4 for location of these connections. Refer to "Removing and Replacing the Fans" on page 7-33.
2. Plug in the power cord and measure the fan voltages at all three connectors on the A14 system motherboard. THIS MUST BE DONE QUICKLY AS THE ANALYZER WILL RAPIDLY OVERHEAT WITHOUT THE COOLING EFFECT OF THE FANS. DO NOT PLUG IN THE POWER CORD UNTIL READY TO PERFORM MEASUREMENTS.

Figure 4-3 Fan Power Cable Connections (Right Side of Analyzer)

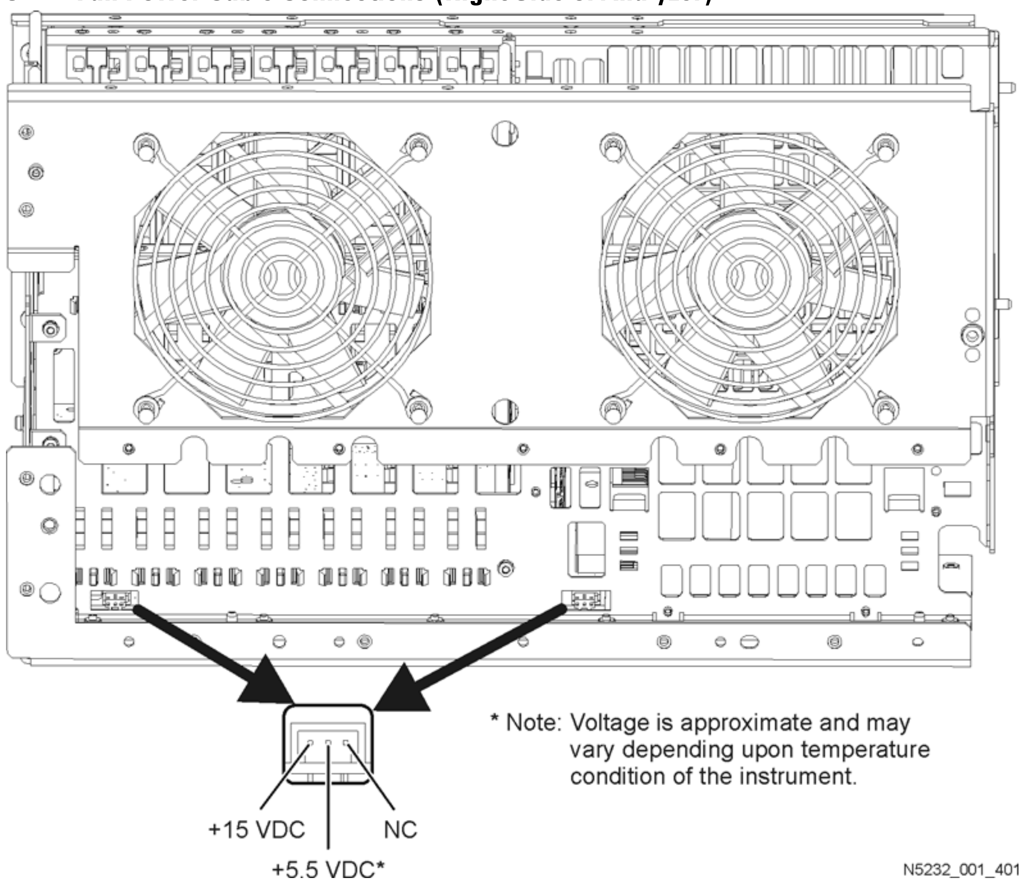
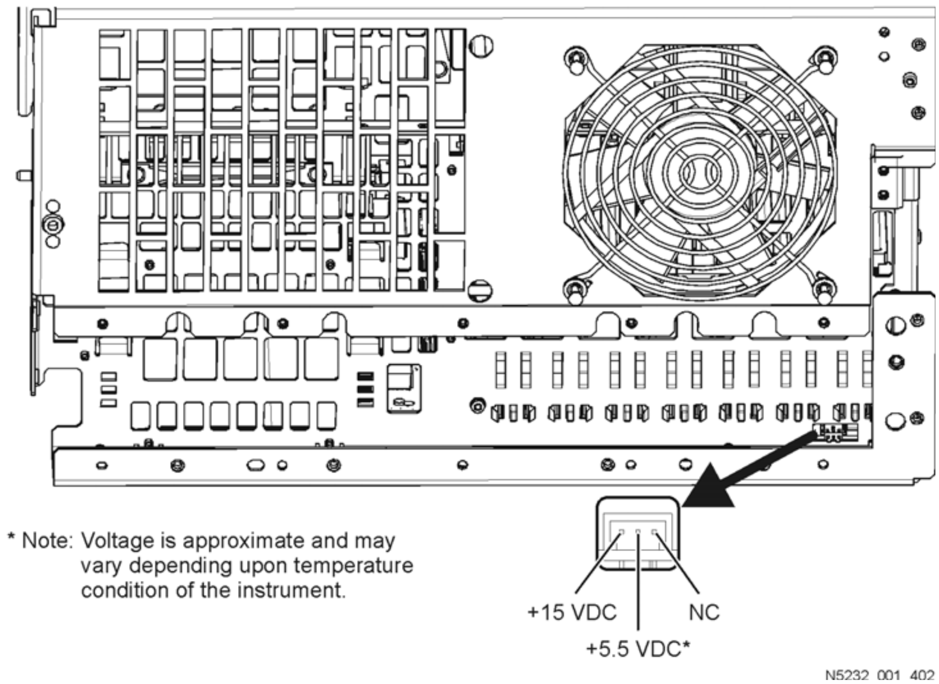


Figure 4-4 Fan Power Cable Connections (Left Side of Analyzer)



3. If the correct voltage is present at each connection and the fan connectors are in good mechanical condition, suspect a defective fan. Refer to "Removing and Replacing the Fans" on page 7-33.

   If the correct voltage is not present, suspect a defective A14 system motherboard. Refer to "Removing and Replacing the A14 System Motherboard" on page 7-17.

Troubleshooting LCD Display Problems

This procedure is intended to isolate the faulty assembly when the display is dark. If the display is lit, but the color mix is faulty, refer to "A3 Display Test" on page 4-16.

NOTE There are no front panel adjustments for intensity and contrast of the LCD.

1. If the display is dim, the A3 display assembly is defective. Refer to "Removing and Replacing the Front Panel Assembly" on page 7-10.

   If the display is dark (not visible), connect an external VGA monitor to the rear panel Monitor output connector. (Be aware that some multisync monitors might not be able to lock to a 60 Hz sync pulse.) If the video information is not present on the external VGA monitor, the most probable cause is the A17 CPU board. Refer to "Removing and Replacing the A17 CPU Board" on page 7-21.

2. If the external VGA monitor displays the correct information, verify that the front panel interface ribbon cable is properly plugged into the motherboard connector. Refer to "Removing and Replacing the Front Panel Assembly" on page 7-10.

3. If the front panel interface ribbon cable is properly connected, suspect that one or more of the following is defective:

   - inverter board (mounted on the display assembly)

- A1 front panel interface board
- A3 display assembly

Front Panel Troubleshooting

The front panel assembly consists of the A1 front panel interface board, the keypad, the A2 USB board, and the A3 display assembly. The following tests verify the operation of the front panel assembly when the analyzer is in the measurement mode. If the instrument fails to power up correctly, or it is difficult to verify due to a faulty display, refer to "Power Up Troubleshooting" on page 4-6.

Refer to the following sections to verify the operation of the noted assemblies.

- "Front Panel Keypad and RPG Test" on this page
- "A3 Display Test" on page 4-16
- "Checking the A2 USB Board" on page 4-17
- "A1 Front Panel Interface Board" on page 4-17

If all assemblies are working correctly, continue troubleshooting with "Rear Panel Troubleshooting" on page 4-18.

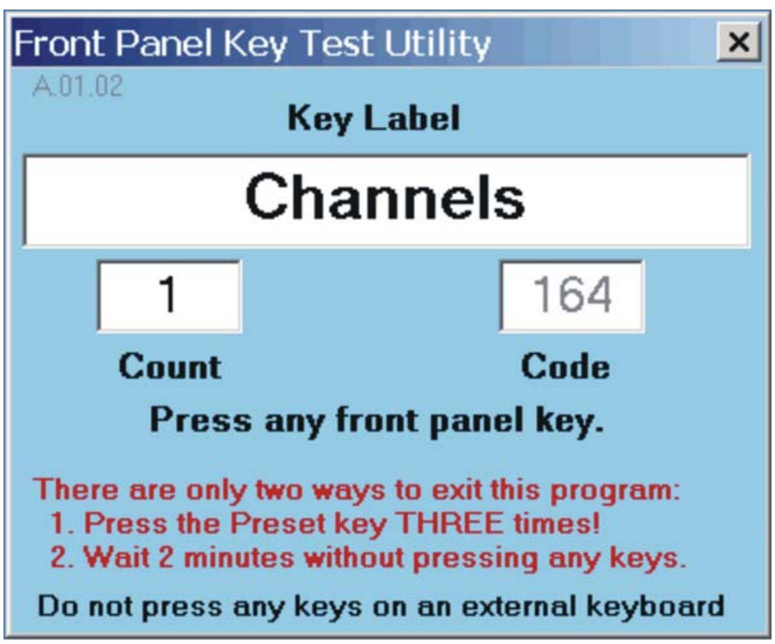
Front Panel Keypad and RPG Test

Test the front panel keypad by running the front panel test. To run the front panel test, perform the following:

Press UTILITY [System], then Service, then More, then Front Panel Test.

A **Front Panel Key Test Utility** dialog box will be displayed, as shown in Figure 4-5.

Figure 4-5 Front Panel Key Test Utility Dialog Box



n5242_001_403

Checking the Front Panel Keys

To check the front panel keys, push each key and compare the name in the Key Label box to the name physically labeled on the key cap. These names are also in Table 4-2 below.

- If all the key names are correct, then the front panel keypad is working. If some of the keys are not working, suspect a faulty keypad. To replace the keypad, refer to "Removing and Replacing the A1–A3 and Other Front Panel Subassemblies" on page 7-12.
- If none of the keys are working correctly, suspect a faulty A1 front panel interface board. To replace the A1 front panel interface board, refer to "Removing and Replacing the A1–A3 and Other Front Panel Subassemblies" on page 7-12.

Table 4-2Front Panel Keyboard Key Names

TRACE/CHAN Keys	RESPONSE Keys	ENTRY Keys	ENTRY Keys (Cont'd)
Trace 1	Meas	OK	k/m
Trace 2	Format	Cancel	Enter Off
Trace 3	Scale	Help	. (decimal point)
Trace 4	Display	Bk Sp	+/-
Traces	Avg	0	**STIMULUS Keys**
Channel	Cal	1	Freq
Navigation Keys	**MARKER/ ANALYSIS Keys**	2	Power
←	Marker	3	Sweep
→	Search	4	Trigger
↑	Memory	5	**UTILITY Keys**
↓	Analysis	6	Save
Click		7	Print
		8	Macro
		9	Recall
		G/n	System
		M/u	Preset

Checking the RPG (Front Panel Knob)

To check the RPG knob:

1. Press the UTILITY Preset key.
2. Rotate the knob and check for a fluid movement of numbers on the analyzer display.

- If the movement of numbers is not smooth or no numbers appear at all, suspect a faulty A1 front panel interface board. To replace the A1 front panel interface board, refer to “Removing and Replacing the A1–A3 and Other Front Panel Subassemblies” on page 7-12.

A3 Display Test

The display should be bright with all annotations and text readable. The display test allows you to check for non-functioning pixels and other problems.

NOTE If the display is dim or dark, refer to “Troubleshooting LCD Display Problems” on page 4-12.

What Is a Damaged Pixel?

A pixel is a picture element that combines to create the image on the display. A pixel is about the size of a small pin point.

A damaged pixel is pixel that has a constant blue, green, red, or black appearance that will not change.

How to Run the Display Test

To run the display test, perform the following:

Press UTILITY System, then Service, then More, then Display Test.

A multi-color screen is displayed. Be prepared to look for the symptoms described in “How to Identify a Faulty Display.” Follow the instructions on the screen.

How to Identify a Faulty Display

A display is considered faulty if:

- More than 0.002% of the total pixels have a constant blue, green, red, or black appearance that will not change.
- Three or more consecutive pixels have a constant blue, green, red, or black appearance that will not change.
- If the A3 display assembly is determined to be faulty, replace it. Refer to “Removing and Replacing the A1–A3 and Other Front Panel Subassemblies” on page 7-12.

Checking the A2 USB Board

To verify proper operation of the USB board:

- Connect a known good USB device, such as a USB mouse, to a front panel USB port.
- Wait 15 seconds for the analyzer to verify the device connection, and then check the operation of the USB device.
- If the device performs correctly, the USB board is functioning properly.
- If the device does not perform correctly, the USB board is faulty. Refer to "Removing and Replacing the A1–A3 and Other Front Panel Subassemblies" on page 7-12.

A1 Front Panel Interface Board

This assembly performs the following functions:

- It routes USB signals between the front-panel USB connector and the A17 CPU board.
- The speaker produces the audio output from signals supplied by the A17 CPU board.
- It routes key pad commands from the keypad to the A17 CPU board.
- It routes display signals from the A17 CPU board to the A3 display assembly.

Checking the Speaker

If no audio is heard:

- Verify that the volume is set correctly and the proper sound driver is loaded; do the following:
  — Press UTILITY System, then Configure, then Control Panel... .
- Click on the **Sounds and Audio Devices** entry. Follow the normal Windows procedure to check the sound drivers and volume. If the audio is still not heard, suspect a faulty speaker. Refer to "Removing and Replacing the A1–A3 and Other Front Panel Subassemblies" on page 7-12.

Checking the Operation of the Key Pad Commands

To verify the key pad functionality, refer to "Front Panel Keypad and RPG Test" on page 4-14.

Checking the Display

To verify the display functionality, refer to "A3 Display Test" on page 4-16.

Rear Panel Troubleshooting

Each rear panel connector is associated with a hardware group in the analyzer. You can use the data at these rear panel connectors to help troubleshoot these hardware groups in addition to testing the connectors.

The connectors discussed in this section are:

- USB x 4
- Monitor (VGA)
- GPIB (0) CONTROLLER
- GPIB (1) TALKER/LISTENER
- LAN

Checking the USB Ports

To verify proper operation of any rear panel USB port:

- Connect a known good USB device, such as a USB mouse.
- Wait 15 seconds for the analyzer to verify the device connection, and then check the operation of the USB device.
- If the device performs correctly, the USB port is functioning properly.
- If the device does not perform correctly, remove the non-working USB device, wait 15 seconds, and then reconnect the device to the rear panel USB port.
- If the USB device still does not work and has been verified to work elsewhere, then the A17 CPU board is faulty. Refer to "Removing and Replacing the A17 CPU Board" on page 7-21.

Checking the CONTROLLER Port

The network analyzer uses a National Instruments 488.2 GPIB controller and associated driver software. This software includes a test utility that scans the GPIB bus and returns the status of all the connected peripherals.

To run the test utility software and check the GPIB status:

1. Connect a known good peripheral to the analyzer using a known good GPIB cable.
2. Press UTILITY System, then Configure, then SICL/GPIB... . A **SICL/GPIB/SCPI** dialog box is displayed.
3. In the **GPIB** block, click **System Controller** to establish the analyzer as a controller. Wait for the analyzer to configure, and then click **OK**.
4. If the Window Desktop is not displayed, press UTILITY System, then Configure, then Control Panel... to view the **Windows Taskbar** menu at the bottom of the display.
5. On the **Windows Taskbar** menu, click **Start** then point to **Programs, National Instruments NI-488.2,** and then click **Explore GPIB** to open the **Measurement & Automation** window.

6. On the left side of the **Measurement & Automation** window under folders:
   a. Click the plus sign to expand the **Measurement & Automation** folder.
   b. Click the plus sign to expand the **Devices and Interfaces** folder.
   c. Right click **GPIB0 (AT-GPIB/TNT)** to open a submenu.
7. On the submenu, click **Scan for Instruments** to run the test.
8. The state of all the peripherals found on the bus is returned.
9. If problems are detected, check the connections of all GPIB cables, and check all the GPIB addresses of the instruments on the bus.

NOTE Address Information

- Each device must have its own unique address.
- The network analyzer's default GPIB address in the controller mode is 21.
- The address set on each device must match the one recognized by the analyzer (and displayed).

Refer to the manual of the peripheral to read or change its address.

Troubleshooting Systems with Controllers

Passing the preceding test indicates that the analyzer's peripheral functions are operating normally. Therefore, if the analyzer has not been operating properly with an external controller, check the following:

- The GPIB interface hardware is incorrectly installed or not operational. (Refer to the embedded help in your analyzer.)
- The programming syntax is incorrect. (Refer to the embedded help in your analyzer.)

LAN Troubleshooting

Problems with the Local Area Network (LAN) can be difficult to solve. Software and protocol problems can make it difficult to determine whether the analyzer's hardware is working properly, or if there is a problem with the LAN or cabling.

The purpose of this section is to determine if the analyzer's hardware is functioning properly. While the turn-on self-test verifies some LAN hardware functionality, it is limited to internal testing only. Incorrect IP addresses will prevent proper operation. Improper subnet masks may allow only one-way communication, while improper gateway addresses may exclude outside LAN access.

Ping Command

The analyzer has the built-in capability of performing a “ping” operation. Ping will request the analyzer to send a few bytes of information to a specific LAN device. That device will then signal the analyzer that it has received the information. The analyzer computes the approximate round trip time of the communication cycle and displays it. For a full test of two-way communications, a ping test should be performed in two directions.

- **First**: you should ping from the analyzer to the local area network.
- **Second**: you should ping from the local area network to the analyzer.

NOTE In the second case, any other network device capable of sending a ping command could be used, assuming it is connected to the same network. This could be a computer or even another analyzer.

How to Ping from the Analyzer to the Local Area Network (LAN)

Follow the steps below to verify proper LAN operation (assuming you have a functioning LAN). If no network LAN is available, see “Testing Between Two Analyzers” on page 4-21.

1. Make sure the IP address on the analyzer is set properly and that it is unique. If unsure how to check the IP address, refer to the embedded help in the analyzer.
2. Make sure the subnet mask is 0.0.0.0. If not, note the current setting (to allow setting it back later) and then set it to 0.0.0.0.
3. Find and note the IP address of another working LAN device on the same network. Make sure this device is turned on, connected, and is functioning properly.
4. To ping the network device:
   a. If the Windows Desktop is not displayed, press UTILITY System, then Configure, then Control Panel... to view the **Windows Taskbar** menu at the bottom of the display.
   b. On the **Windows Taskbar** menu, click **Start,** point to **Programs**, **Accessories,** and then click **Command Prompt.**
   c. The command prompt window is displayed.
   d. At the prompt, type ping xxx.xxx.xxx.xxx[1] and press ENTRY Enter on the front panel. Refer to Step 5 for the results of a successful ping.
5. The analyzer attempts four cycles of communications with the indicated LAN device.
   - It displays the time it took to complete each cycle.
   - Each cycle times-out after one second if no communication is established and the message, Request timed out, is displayed.
   - It is common for the first of the four cycles to time-out even though subsequent cycles pass.
   - See below for an example output of a successful ping.

```
C:>ping 141.121.69.162
```

1. The letters x represent the IP address of the other device on the network.

Pinging 141.121.69.162 with 32 bytes of data:

Reply from 141.121.69.162: bytes=32 time<10ms TTL=127
Reply from 141.121.69.162: bytes=32 time<10ms TTL=127
Reply from 141.121.69.162: bytes=32 time<10ms TTL=127
Reply from 141.121.69.162: bytes=32 time<10ms TTL=127

Ping statistics for 141.121.69.162:

Packets: Sent = 4, Received = 4, lost = 0 <0% loss>.

Approximate round trip times in milli-seconds:

Minimum = 0ms, Maximum = 0ms, Average = 0ms

6. The above message verifies that one way communication from the analyzer to the network has been established
7. If the subnet mask was changed in step 2, set it back at this time.

How to Ping from the Local Area Network (LAN) to the Analyzer

Reverse communication should also be verified. Determining this, though, is dependent upon your network setup and software. Generally, you need to issue a ping command using the IP address of the analyzer to be tested. For example, using Windows 95, 98, 2000, XP or 7 and while at a DOS prompt, type in ping xxx.xxx.xxx.xxx[1]. Then press ENTRY Enter on the front panel. If full communication can be established, then the computer display shows the cycle time for each of four cycle attempts (similar to that in step 5). Other software may behave somewhat differently, but basically the same.

If the analyzer can talk to the network, but the network can not talk to the analyzer, then the computer or device used from the network may have a subnet mask that excludes communication with the IP address chosen for the analyzer. Any subnet mask other than 0.0.0.0 will exclude operation from some addresses. Changing the subnet mask of a computer or other device should only be attempted by a qualified network administrator. Failure to communicate due to a subnet mask incompatibility does not indicate any failure of the analyzer.

If the analyzer fails to ping in either direction, and assuming the subnet masks are set properly, then the fault must be isolated to the analyzer or to the network. Contact a qualified network administrator.

Testing Between Two Analyzers

The ability of the analyzer's LAN to function can be easily tested by connecting two analyzers together using a “crossover cable” (a short length of cable with an RJ-45 connector on each end).

Some network hubs have the capability to make a crossover connection using two normal, or straight-through, cables. If this capability is not available and a crossover cable is not available, a crossover cable can be made by following the directions in “Constructing a Crossover Cable” on page 4-22.

Set the IP addresses on two analyzers. The addresses can be set to anything, but they must be different. Make sure the subnet mask and gateway addresses are set to 0.0.0.0 and that the LAN is active on both analyzers. Connect the two analyzers together using either a crossover cable or a crossover hub.

Now follow the steps in “How to Ping from the Analyzer to the Local Area Network (LAN)” on page 4-20 to have the first analyzer ping the second analyzer. When done, repeat the procedure having the second analyzer ping the first. If both procedures function properly, the LAN circuitry on both analyzers is verified.

1. The letters x represent the IP address of the analyzer.

If neither function properly:

- One or both IP addresses could be wrong.
- One or both LAN states could be set to off.
- The crossover cable could be miswired.
- One or both analyzers could be defective.

If possible, eliminate the possibility of a defective analyzer by substitution of a known working unit. Once the analyzer has been proven to be working properly, concentration can be placed on the network itself to determine the cause of the failure.

Constructing a Crossover Cable

A crossover cable can be made from a standard LAN cable by connecting pin 1 from each connector to pin 3 of the other connector, and pin 2 from each connector to pin 6 of the other connector.

1. Strip away a few inches of the outside jacket insulation from the middle of a standard LAN cable that has an RJ-45 connector on each end.

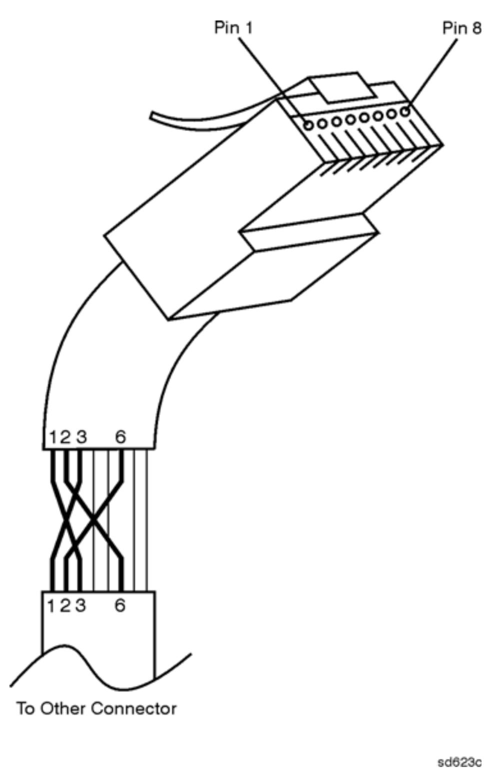
NOTE Pins 1, 2, 3, and 6 of the connectors must be located to determine which wires to cut in the following steps. Most, but not all, LAN cables use the color coding listed in Table 4-3. If your cable does not use this color scheme, you will have to determine the locations of the appropriate wires before proceeding with this procedure.

Table 4-3LAN Pin Definitions and Wire Color Codes

Pin Number	Color	Pin Number	Color
1 (transmit +)	White/orange	5	White/blue
2 (transmit –)	Orange	6 (receive –)	Green
3 (receive +)	White/green	7	White/brown
4	Blue	8	Brown

2. Cut the wires going to pins 1, 2, 3, and 6. Strip away a small amount of insulation from each of the eight cut ends.
   a. Connect the wire from pin 1 on one end of the cable to the wire from pin 3 on the other end of the cable.
   b. Connect the wire from pin 3 on one end of the cable to the wire from pin 1 on the other end of the cable.
   c. Connect the wire from pin 2 on one end of the cable to the wire from pin 6 on the other end of the cable.
   d. Connect the wire from pin 6 on one end of the cable to the wire from pin 2 on the other end of the cable.
3. Insulate all exposed wires so that they cannot short together.
4. Label this as a crossover cable so that it cannot be confused with a standard cable.

Figure 4-6 Construction of a Crossover Cable



Measurement System Troubleshooting

This section provides troubleshooting procedures for the measurement portion of the PNA. In this section, the analyzer is used as a tool to help isolate the suspected faulty functional group. Once the faulty functional group is determined, troubleshooting steps are provided to help you isolate the faulty assembly or part.

Before you begin—consider: Where do you see a problem?

If you are seeing a problem at **Preset**, perform the standard S-parameter test set troubleshooting procedure, starting with: "Verifying the A, B, C, D, and R Traces (Standard S-Parameter Mode)" on page 4-27.

You should also consider the problem indications that are observed and whether the observed condition is a soft failure or a hard failure.

Soft Failure

With a *soft* failure, the network analyzer's performance has degraded to an unacceptable level, yet it continues to operate and displays no error messages. For this type of failure, performance tests must be conducted to isolate the problem. Begin with viewing the error terms as described in "Error Terms" on page 8-3. This will help to isolate most problems. If additional tests are required, refer to "Performance Tests" on page 3-29.

Hard Failure

With a *hard* failure, the PNA does not perform well and displays one or more error messages. To diagnose and repair a hard failure:

- Check "Help About" to verify that the model number and options listed match the actual analyzer model and options.
- Check "EEPROM Headers" to verify that the data there is correct.
- Check error messages. Refer to "Error Messages" and follow the suggestions outlined there for each applicable error message.

Help About

Go to the Help About screen by pressing UTILITY System , then Help , then About NA... . Verify that the information displayed in this screen is correct for your analyzer. If any of the information is incorrect, contact Keysight Technologies. Refer to "Contacting Keysight" on page 2-7.

EEPROM Headers

The network analyzer application uses the firmware revision information stored in the pc board header EEPROM. If the information stored in any EEPROM is incorrect, the network analyzer may not operate properly.

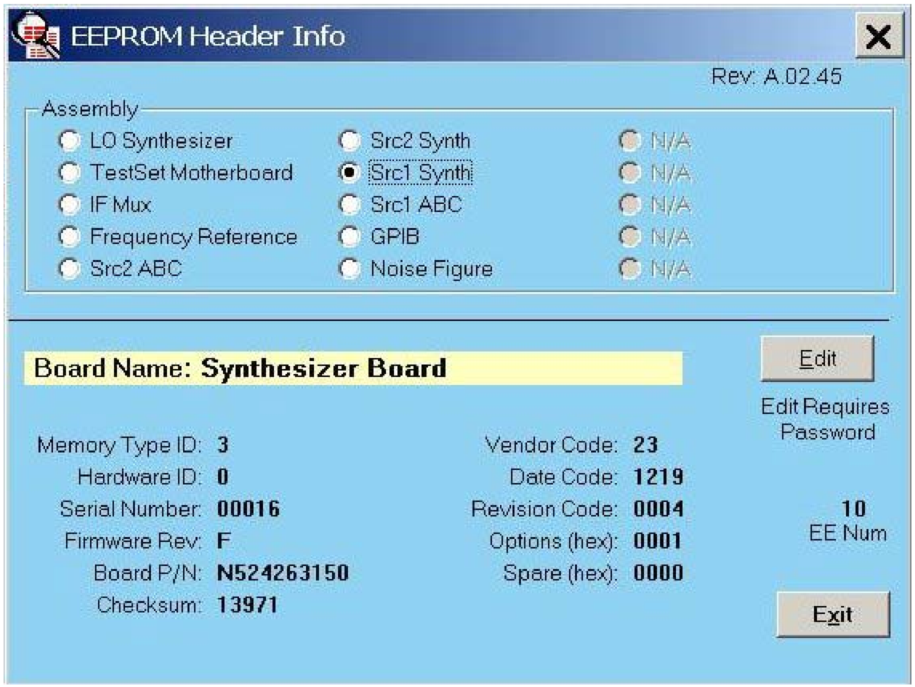
The following table lists the pc boards in your network analyzer that contain EEPROM headers. The pc boards are listed by name and part number and the correct firmware revision code is given for each.

PC Board Name	PC Board Part Number	Hardware ID	Firmware Revision
SPAM	N5240-60077 Was N5240-60056	A9	--
Test Set Motherboard	N5230-60134	A19	H
Frequency Reference	N5240-60069	A7	C
13.5 GHz LO synthesizer	N5240-60074 Was N5242-60150	A10	F
13.5 GHz source synthesizer	N5240-60074 Was N5242-60150	A4	F
GPIB	N5240-60059	A18	A

To view this EEPROM header information on the network analyzer display: press UTILITY System, then Service, then Utilities, then View EEPROM Headers. Refer to Figure 4-7.

If the information is incorrect for any of the pc boards, contact Keysight Technologies. Refer to "Contacting Keysight" on page 2-7.

Figure 4-7 EEPROM Header Info Dialog Window



Error Messages

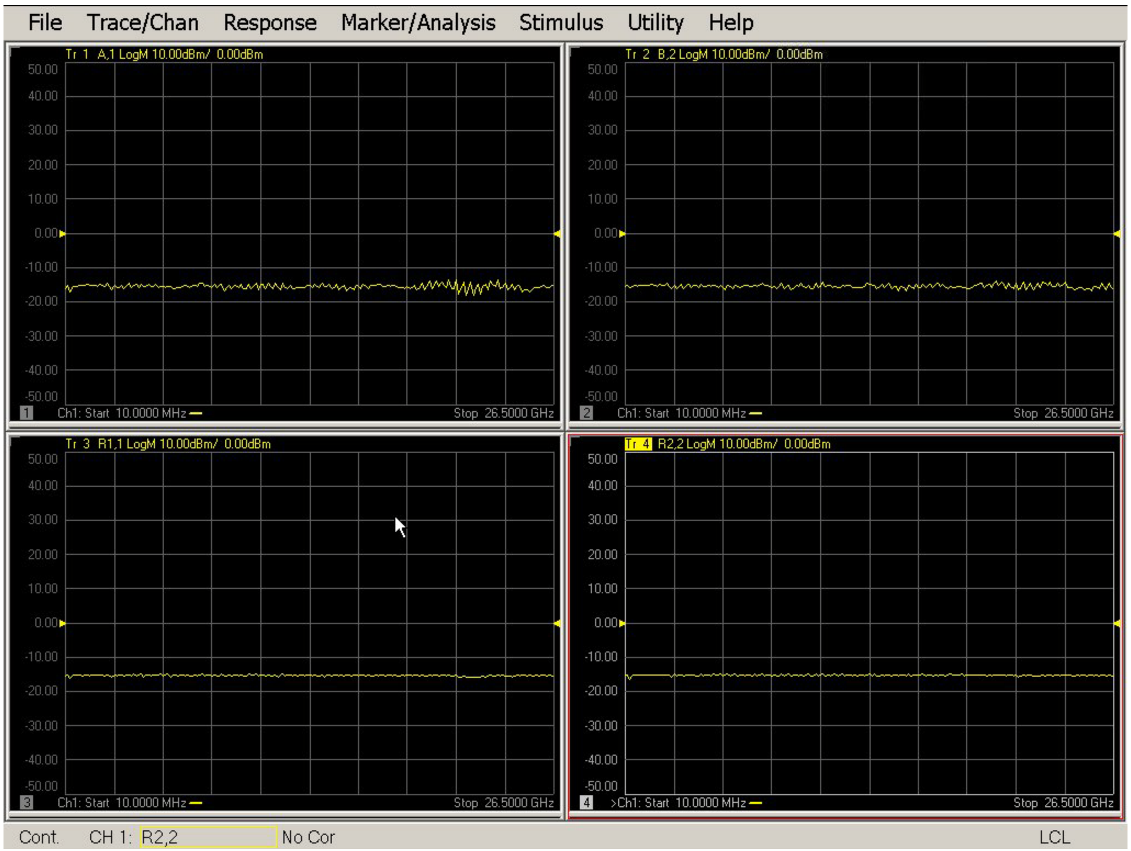
SOURCE UNLEVELED: The source ALC circuit on the A19 test set motherboard is running open-loop. Check the cable connections for the A21 MASSY (2-port) or A20 MASSQuad (4-port) and the A19 test set motherboard.

Verifying the A, B, C, D, and R Traces (Standard S-Parameter Mode)

The first step is to verify that the A, B,C, D, and R traces are present and that they are approximately level:

- Connect an Open or Short standard from a mechanical calibration kit to each test port (use adapters if necessary).
- Press UTILITY System, then Service, then Utilities, then Receiver Display.
- For 2-port analyzer models, traces A, B, R1, and R2 are displayed in four separate data windows as shown in Figure 4-8. Identifying discrepancies of the traces in these windows can help you to isolate the faulty assembly.

Figure 4-8 Typical 4-Receiver Display for 2-Port Models



- For 4-port analyzer models, traces A, B, C, D, and R are displayed in five separate data windows as shown in Figure 4-9. Identifying discrepancies of the traces in these windows can help you to isolate the faulty assembly.

Figure 4-9 Typical 5-Receiver Display for 4-Port Models

- If all traces are present and are similar to the traces in Figure 4-8 or Figure 4-9, then there are no major problems with the analyzer's measurement system. There may, however, be a minor failure in the analyzer.

  To test further:

  — Go to Chapter 3, "Tests and Adjustments" and perform all the tests in that section.

  — If a problem still exists, contact Keysight. Refer to "Contacting Keysight" on page 2-7.

- If any of the traces are not present, are noisy or distorted, or are at an incorrect level, then there is a problem with the analyzer's measurement system. Proceed to "Where to Begin Troubleshooting."

Where to Begin Troubleshooting

For the purposes of troubleshooting, the analyzer block diagram is divided into the following functional groups:

- **the source and LO group**
  - A7 frequency reference
  - A10 13.5 GHz LO synthesizer
  - A4 13.5 GHz source synthesizer
  - A21 MASSY (2-port) or A20 MASSQuad (4-port)
  - A19 test set motherboard
- **the signal separation group**
  - A29 and A30 60 dB step attenuators (Option 216)
  - A29 60 dB step attenuator (Option 416)
  - A25, A26, A27, and A28 test port couplers
  - A19 test set motherboard
- **the receiver group**
  - A24 mixer brick
  - A9 SPAM board
  - A19 test set motherboard

Use the list on the following pages to help you determine in which analyzer functional group to begin troubleshooting.

This is by no means an exhaustive list of possible symptoms nor possible failures. It is recommended that you view the system block diagram, at the end of this chapter, as you review the entries in this list and perform any of the troubleshooting procedures listed.

Good judgement and established logical troubleshooting techniques must be used to complement the procedures contained in this section.

All Traces

- ***If all traces are missing in all bands***, the problem is most likely in the source group. However, a missing or disabled DSP driver may exhibit the same or similar symptoms. To verify that this DSP driver is present and enabled:

  1. Press UTILITY System, then Configure, then Control Panel... . In the **Address** box, click the down arrow and then click **My Computer.** In an open area of the My Computer window, click the right mouse button and then click **Properties** in the resulting pop-up menu.

     Click the **Hardware** tab, click **Device Manager**, and then expand **Keysight PNA DSP Device** in the resulting list. The following entry should be listed: **Keysight Technologies DSP Driver #2** and should be enabled.

  2. If the entry is not present or if the icon to the left of the name is a yellow box containing an exclamation mark (!), navigate the following directories and verify the presence of the following file: C:\WINNT\system32\drivers\spampnp.sys.

  3. If you have verified that the DSP driver is present and enabled, but all traces are still missing in all bands, go to "Checking the Source Group" on page 4-31.

- ***If the traces exhibit power drops in some frequency bands***, the problem is in the source group. Go to "Source Group Tests" on page 4-31 and perform the tests that correspond to the problems seen.

Single Trace (A, B, C, D, or R) Only

If the trace is missing in all bands or has notches or roll-off, go to "Checking the Signal Separation Group" on page 4-35.

Checking the Source Group

Source Group Tests

Before checking the source group assemblies, you must open the analyzer.

CAUTION Use an antistatic work surface and wrist strap to reduce the chance of electrostatic discharge for all of the procedures in this chapter.

1. Turn off the analyzer power.
2. Unplug the power to the analyzer and disconnect all front and rear panel connections except installed jumpers.
3. Remove the outer and inner covers from the analyzer. Refer to "Removing the Covers" on page 7-8.

WARNING **Procedures described in this document are performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.**

4. With the covers off, plug in the analyzer and turn on the power.

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.

Frequency Banded vs. Broadband Failure

There are two main types of failures that are related to the source group. Frequency banded failures are indicated by all receiver traces having partial dropouts across the frequency range. Broadband failures are indicated by all receiver traces being in the noise floor.

RF Signal Troubleshooting

Check the output power of the A, B, C, and D signals:

Equipment Used for This Check

Equipment Type	Model or Part Number	Alternate Model or Part Number
Power meter	E4418B/E4419B	E4418A/E4419A
Power sensor, 3.5 mm	N8485A	8485A
Adapter, 3.5 mm (f) to 3.5 mm (f)	83059B	85052-60012

Equipment Setup

1. Before starting these checks, zero and calibrate the power meter. (See the power meter user's guide for instructions on setting the calibration factor.)
2. If the **Receiver Display** (Figure 4-8 or Figure 4-9) is not on the analyzer screen, perform the following: Press UTILITY System, then Service, then Utilities, then Receiver Display.
3. Set the sweep speed for a 10 second sweep: Press STIMULUS Sweep, then Sweep Time. Set the time to 10.000 seconds in the **Sweep Time** box.

To isolate a broadband RF signal generation failure, check the test port output power:

4. Note the power reading displayed on the power meter; it should be the preset power level +/- 1 dB.
5. Connect the power sensor, in turn, to Ports 2, 3, and 4 and set trace to measure S_{22}, S_{33}, and S_{44} respectively. Note the power reading displayed on the power meter.

- If the power level is low or high on all test ports, the problem is LO signal related. Continue with "Checking the A7 50 MHz Reference Outputs".
- If the power level is low or high on only one of the test ports, the problem is either source group or in the signal separation group. Continue with "Checking the A7 50 MHz Reference Outputs" to check the source group.

Checking the A7 50 MHz Reference Outputs

1. Refer to the block diagram at the end of this chapter and to "Top Cables, All Models" on page 6-18. Locate flexible cables W76, W77, and W78, at the A7 frequency reference board.
2. Disconnect cables W76, W77, and W78, one at a time, from the A7 frequency reference board.
3. Connect the spectrum analyzer to the open connector on the A7 frequency reference board.
4. The spectrum analyzer should measure a signal at 50 MHz.
5. If any of the 50 MHz signals are not present, replace the A7 frequency reference board. Refer to "Removing and Replacing the A4, A7, A9, and A10 Boards" on page 7-16.
6. If the 50 MHz signals are present, reconnect the cables, and then:
   - for LO related problems, continue testing at "Checking the A10 13.5 GHz LO Synthesizer Output".
   - for source related problems, continue testing at "Checking the A4 Synthesizer Outputs" on page 4-33.

Checking the A10 13.5 GHz LO Synthesizer Output

1. Refer to the block diagram at the end of this chapter and to "Top Cables, All Models" on page 6-18. Locate the flexible cable W9 at the A10 LO synthesizer board.
2. Disconnect W9 from J1207.
3. Connect the spectrum analyzer to J1207.
4. Set the network analyzer for an 800 MHz CW frequency and observe the spectrum analyzer measurement. An 807.61 MHz signal should be present.
5. If the observed problem was frequency banded rather than broadband related, set the analyzer frequency

to the center of the problem band. The spectrum analyzer should measure a signal at 7.61 MHz above the network analyzer setting.

6. If the LO signal is not present and the 50 MHz reference signal is present from "Checking the A7 50 MHz Reference Outputs," replace the A10 LO synthesizer board. Refer to "Removing and Replacing the A4, A7, A9, and A10 Boards" on page 7-16.
7. If the signal is present, reconnect cable W9, and then continue with "Checking the A4 Synthesizer Outputs".

Checking the A4 Synthesizer Outputs

1. Refer to the block diagram at the end of this chapter and to "Top Cables, All Models" on page 6-18. Locate the flexible cable W1 at the A4 13.5 GHz source synthesizer board.
2. Disconnect W1 from J1207.
3. Connect the spectrum analyzer to J1207.
4. Set the network analyzer for a 800 MHz CW frequency and observe the spectrum analyzer measurement. The spectrum analyzer should measure a signal at 800 MHz.
5. If the observed problem was frequency banded rather than broadband related, set the analyzer frequency to the center of the problem band. The spectrum analyzer should measure a signal at 7.61 MHz above the network analyzer setting.
6. If the signal is not present and the 50 MHz reference signal is present from "Checking the A7 50 MHz Reference Outputs," replace the faulty synthesizer board. Refer to "Removing and Replacing the A4, A7, A9, and A10 Boards" on page 7-16.
7. If the signal is present, reconnect cable W1 and then continue with "Checking the Signal Separation Group".

Checking the A21 MASSY Outputs (2-Port Models)

1. Locate the following semirigid cable at the appropriate output of the A21 MASSY:
   - W3 for Port 1 of analyzers without Option 216 (no source attenuators)
   - W11 for Port 2 of analyzers without Option 216 (no source attenuators)
   - W4 for Port 1 of analyzers with Option 216 (includes source attenuators)
   - W12 for Port 2 of analyzers with Option 216 (includes source attenuators)
2. Disconnect the semirigid cables W3 and W11 or W4 and W12 on the A21 MASSY.
3. Connect the spectrum analyzer to the open connector. Set the spectrum analyzer to measure a signal at 800 MHz CW frequency.
4. If the signal is not present, replace the A21 MASSY. Refer to "Removing and Replacing the A21 MASSY".
5. If the signal is present, reconnect all cables and then continue with "Checking the Signal Separation Group" on page 4-35.

Checking the A20 MASSQuad Outputs (4-Port Models)

1. Locate the following semirigid cable at the appropriate output of the A20 MASSQuad:
   - W33 for Port 1 of analyzers without Option 416 (no source attenuators)

- W34 for Port 2 of analyzers without Option 416 (no source attenuators)
- W35 for Port 3 of analyzers without Option 416 (no source attenuators)
- W36 for Port 4 of analyzers without Option 416 (no source attenuators)
- W44 for Port 1 of analyzers with Option 416 (includes source attenuators)
- W45 for Port 2 of analyzers with Option 416 (includes source attenuators)
- W46 for Port 3 of analyzers with Option 416 (includes source attenuators)
- W47 for Port 4 of analyzers with Option 416 (includes source attenuators)

2. Disconnect the semirigid cables W33 – W36 or W44 – W47 on the A20 MASSQuad.
3. Connect the spectrum analyzer to the open connector. Set the spectrum analyzer to measure a signal at 800 MHz CW frequency.
4. If the signal is not present, replace the A20 MASSQuad. Refer to “Removing and Replacing the A20 MASSQuad”.
5. If the signal is present, reconnect all cables and then continue with “Checking the Signal Separation Group” on page 4-35.

Checking the Signal Separation Group

Before checking the signal separation group assemblies, you must open the analyzer.

CAUTION Use an antistatic work surface and wrist strap to reduce the chance of electrostatic discharge for all of the procedures in this chapter.

1. Turn off the analyzer power.
2. Unplug the power to the analyzer and disconnect all front and rear panel connections except installed jumpers.
3. Remove the outer cover from the analyzer. Refer to "Removing the Covers" on page 7-8.

WARNING **Procedures described in this document are performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.**

4. With the covers off, plug in the analyzer and turn on the power.

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.

Checking the Output Power of the A, B, C, and D Signals

Using a power meter, you can measure the outputs of the A, B, C, and D signals from the front panel. The measurement results will help you isolate a faulty assembly. The output of the R receiver cannot be measured because it would necessitate breaking the phase lock loop, causing all of the signals to be lost.

Equipment Used for This Check

Equipment Type	Model or Part Number	Alternate Model or Part Number
Power meter	E4418B/E441B	E4418A/E4419A
Power sensor, 3.5 mm	N8485A	8485A
Adapter, 3.5 mm (f) to 3.5 mm (f)	83059B	85052-60012

Equipment Setup

1. Before starting these checks, zero and calibrate the power meter. (See the power meter user's guide for instructions on setting the calibration factor.)
2. If the **Receiver Display** (Figure 4-8 or Figure 4-9) is not on the analyzer screen, perform the following:
   Press UTILITY [System], then Service, then Utilities, then Receiver Display.
3. Set the sweep speed for a 10 second sweep: Press STIMULUS [Sweep], then Sweep Time. Set the time to 10.000 seconds in the **Sweep Time** box.

Checking Port 1, 2, 3, or 4 Power Outputs (A, B, C, or D Signals)

The object of this check is to verify the power of the output signal across the entire frequency range. Perform this test if there is an observed problem only with one receiver trace. The ten second sweep is slow enough to allow you to observe the output power on the power meter as the sweep occurs.

1. Connect the power sensor to the suspect port.
2. Set the trace to measure S_{11}, S_{22}, S_{33}, or S_{44}, dependent on the suspect port.
3. Observe the power reading on the power meter as the sweep occurs on the analyzer.
4. The measured output power on the power meter should be at least the preset power level ±1 dB over the entire frequency range.
    - If the measured power is correct, go to "Checking the Receiver Group" on page 4-38.
    - If the measured power is not correct, go to "Checking the Signal through the Signal Separation Path" on page 4-36.

Checking the Signal through the Signal Separation Path

For all of the following checks, refer to the block diagrams at the end of this chapter and to any of the following that are appropriate:

- "Bottom Assemblies, N523xA, Option 200" on page 6-20
- "Bottom Cables, N523xA, Option 200" on page 6-22
- "Bottom Assemblies, N523xA, Option 216" on page 6-26
- "Bottom Cables, N523xA, Option 216" on page 6-28
- "Bottom Assemblies, N5231A and N5232A, Option 400" on page 6-32
- "Bottom Cables, N5231A and N5232A, Option 400" on page 6-34
- "Bottom Assemblies, N5231A and N5232A, Option 416" on page 6-38
- "Bottom Cables, N5231A and N5232A, Option 416" on page 6-40

Trace loss in the signal separation group is due to one or more of the following assemblies being defective:

- A29 or A30 60 dB step attenuator
- A25, A26, A27, or A28 test port coupler

Checking the A29 and A30 60 dB Step Attenuators

1. Locate the appropriate semirigid cable at the output of the source step attenuator to be checked:
   - Options 216 and 416
     — Port 1; W13 of A29 (Option 216)
     — Port 2; W14 of A30 (Option 216)
     — Port 1, 2, 3 and 4; W43 of A29 (Option 416)
2. Using a 5/16-inch torque wrench, disconnect the semirigid cable at the step attenuator.
3. Connect the spectrum analyzer to the open step attenuator connector. Set the spectrum analyzer to measure a signal at 800 MHz.
4. If the 800 MHz signal is not present, replace the source step attenuator. Refer to "Removing and Replacing the A29 and A30 60 dB Source Step Attenuators".

Checking the Receiver Group

Equipment Used for These Tests

Equipment Type	Model or Part Number	Alternate Model or Part Number
Spectrum analyzer	8565E	856xE[a]

a. Must be capable of measuring signals at 7.61 MHz and 1 GHz.

For all of the following checks, refer to the block diagrams at the end of this chapter and to any of the following that are appropriate:

- "Bottom Assemblies, N523xA, Option 200" on page 6-20
- "Bottom Cables, N523xA, Option 200" on page 6-22
- "Bottom Assemblies, N523xA, Option 216" on page 6-26
- "Bottom Cables, N523xA, Option 216" on page 6-28
- "Bottom Assemblies, N5231A and N5232A, Option 400" on page 6-32
- "Bottom Cables, N5231A and N5232A, Option 400" on page 6-34
- "Bottom Assemblies, N5231A and N5232A, Option 416" on page 6-38
- "Bottom Cables, N5231A and N5232A, Option 416" on page 6-40

Getting Ready to Test

Before checking the assemblies, you must open the analyzer.

CAUTION Use an antistatic work surface and wrist strap to reduce the chance of electrostatic discharge for all of the procedures in this chapter.

1. Turn off the analyzer power.
2. Unplug the power to the analyzer and disconnect all front and rear panel connections except installed jumpers.
3. Remove the outer and inner covers from the analyzer. Refer to "Removing the Covers" on page 7-8.

WARNING **Procedures described in this document are performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.**

4. With the covers off, plug in the analyzer and turn on the power.

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.

Checking the A24 Mixer Brick Receiver Outputs

Set the network analyzer for an S11 measurement with a CW frequency of 1 GHz.

1. Locate the following flexible cables at the receiver IF outputs of the mixer brick(s).

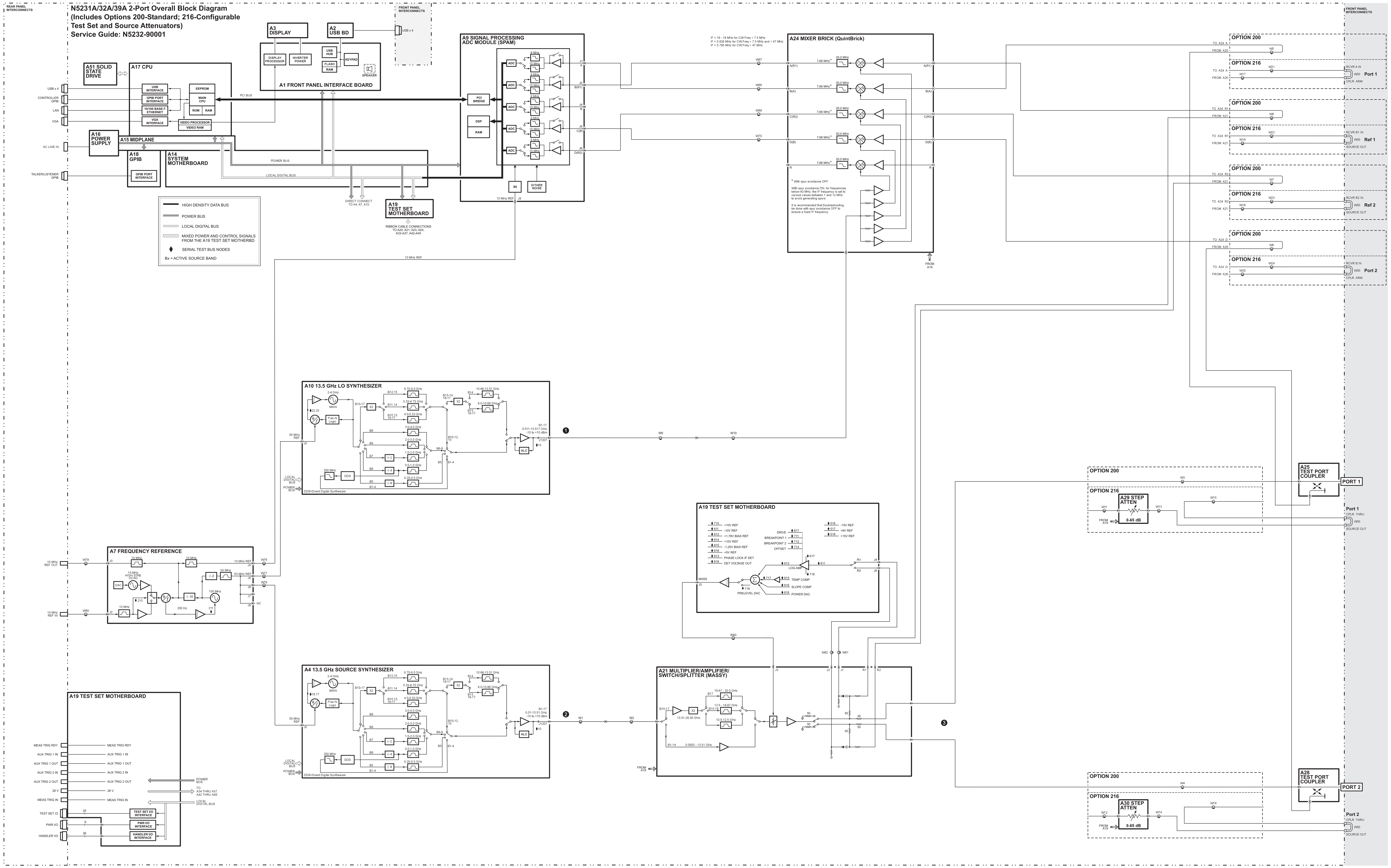
- 2-port models
  - Receiver R1; W67 of A24
  - Receiver A; W68 of A24
  - Receiver R2; W69 of A24
  - Receiver B; W70 of A24
- 4-port models
  - Receiver A; W71 of A24
  - Receiver B; W72 of A24
  - Receiver C; W73 of A24
  - Receiver D; W74 of A24
  - Receiver R; W75 of A24

2. Disconnect the flexible cable at the suspect receiver.
3. Connect the spectrum analyzer to the suspect receiver connector.
4. The measured signal on the spectrum analyzer should be at 7.61 MHz.

   If the measured signal is missing on any receiver, replace the A24 mixer brick. Refer to "Removing and Replacing the A24 Mixer Brick (QuintBrick)".

Band	Mixer Brick L.O. Harmonic Number	❶ A10 Synthesizer Frequency (GHz)	❷ A4 Synthesizer Frequency (GHz)	❸ A20 MASSQuad A21 MASSY Frequency (GHz)
1	1	0.00121 to 0.00133	0.0003 to 0.000425	0.0003 to 0.000425
2	1	0.00133 to 0.00211	0.000425 to 0.0012	0.000425 to 0.0012
3	1	0.00211 to 0.00841	0.0012 to 0.0075	0.0012 to 0.0075
4	1	0.00998 to 0.25744	0.0075 to 0.250	0.0075 to 0.250
5	1	0.25744 to 0.5074	0.250 to 0.500	0.250 to 0.500
6	1	0.5074 to 1.0074	0.500 to 1.000	0.500 to 1.000
7	1	1.0074 to 2.0074	1.000 to 2.000	1.000 to 2.000
8	1	2.0074 to 3.0074	2.000 to 3.000	2.000 to 3.000
9	1	3.0074 to 4.0074	3.000 to 4.000	3.000 to 4.000
10	1	4.0074 to 5.3394	4.000 to 5.332	4.000 to 5.332
11	1	5.3394 to 6.7594	5.332 to 6.752	5.332 to 6.752
12	1	6.7594 to 8.0074	6.752 to 8.000	6.752 to 8.000
13	1	8.0074 to 10.6714	8.000 to 10.664	8.000 to 10.664
14	1	10.6714 to 13.5174	10.664 to 13.510	10.664 to 13.510
15	3	4.5058 to 5.3358	6.755 to 8.000	13.510 to 16.000
16	3	5.3358 to 5.5591	8.000 to 8.335	16.000 to 16.670
17	3	5.5591 to 6.6691	8.335 to 10.000	16.670 to 20.000

Test Node	Error Description	Assembly	Frequency Band
10	Unleveled, Source 1 Synthesizer	A4	Full Range
15	Unleveled, LO Synthesizer	A10	Full Range
16	Unlocked, Source 1 Synthesizer, Integrator Low	A4	Full Range
17	Unlocked, Source 1 Synthesizer, Integrator High	A4	Full Range
22	Unlocked, LO Synthesizer, Integrator Low	A10	Full Range
23	Unlocked, LO Synthesizer, Integrator High	A10	Full Range
25	Unleveled, Doubler 1 Prelevel	A22	Full Range

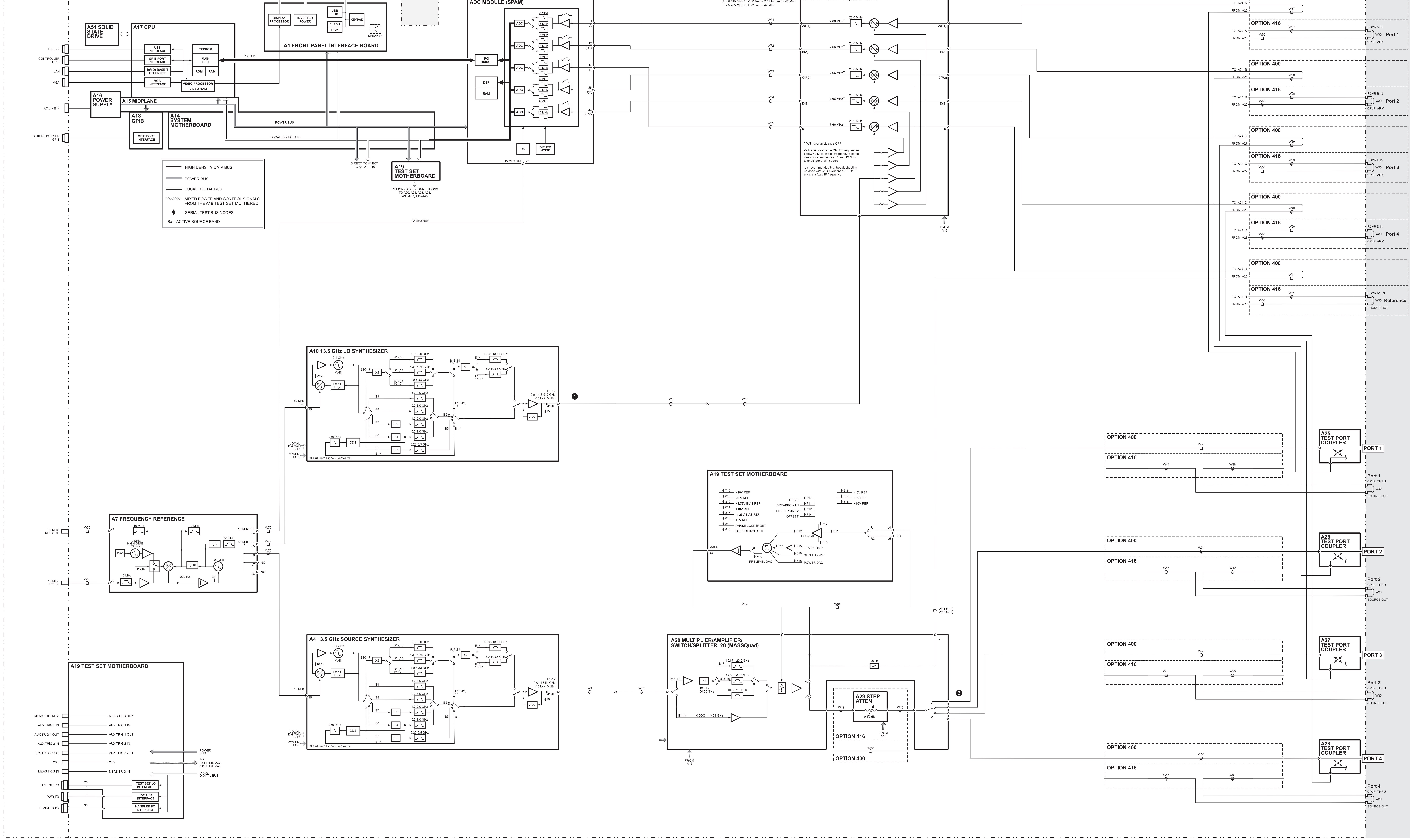


22 October 2013
N5232A_blk

N5231A/32A 4-Port Overall Block Diagram
(Includes Options 400-Standard; 416-Configurable Test Set and Source Attenuator)
Service Guide: N5232-90001

Band	Mixer Brick L.O. Harmonic Number	❶ A10 Synthesizer Frequency (GHz)	❷ A4 Synthesizer Frequency (GHz)	❸ A20 MASSQuad A21 MASSY Frequency (GHz)
1	1	0.00121 to 0.00133	0.0003 to 0.000425	0.0003 to 0.000425
2	1	0.00133 to 0.00211	0.000425 to 0.0012	0.000425 to 0.0012
3	1	0.00211 to 0.00841	0.0012 to 0.0075	0.0012 to 0.0075
4	1	0.00998 to 0.25744	0.0075 to 0.250	0.0075 to 0.250
5	1	0.25744 to 0.5074	0.250 to 0.500	0.250 to 0.500
6	1	0.5074 to 1.0074	0.500 to 1.000	0.500 to 1.000
7	1	1.0074 to 2.0074	1.000 to 2.000	1.000 to 2.000
8	1	2.0074 to 3.0074	2.000 to 3.000	2.000 to 3.000
9	1	3.0074 to 4.0074	3.000 to 4.000	3.000 to 4.000
10	1	4.0074 to 5.3394	4.000 to 5.332	4.000 to 5.332
11	1	5.3394 to 6.7594	5.332 to 6.752	5.332 to 6.752
12	1	6.7594 to 8.0074	6.752 to 8.000	6.752 to 8.000
13	1	8.0074 to 10.6714	8.000 to 10.664	8.000 to 10.664
14	1	10.6714 to 13.5174	10.664 to 13.510	10.664 to 13.510
15	3	4.5058 to 5.3358	6.755 to 8.000	13.510 to 16.000
16	3	5.3358 to 5.5591	8.000 to 8.335	16.000 to 16.670
17	3	5.5591 to 6.6691	8.335 to 10.000	16.670 to 20.000

Test Node	Error Description	Assembly	Frequency Band
10	Unleveled, Source 1 Synthesizer	A4	Full Range
15	Unleveled, LO Synthesizer	A10	Full Range
16	Unlocked, Source 1 Synthesizer, Integrator Low	A4	Full Range
17	Unlocked, Source 1 Synthesizer, Integrator High	A4	Full Range
22	Unlocked, LO Synthesizer, Integrator Low	A10	Full Range
23	Unlocked, LO Synthesizer, Integrator High	A10	Full Range
25	Unleveled, Doubler 1 Prelevel	A22	Full Range



5 Theory of Operation

Information in This Chapter

This chapter provides a general description of the operating theory of the N523xA 2-port and 4-port PNA microwave network analyzers.

- Theory of operation is explained to the assembly level only.
- Component-level circuit theory is not provided.
- Simplified block diagrams are included for each functional group.
- More detailed block diagrams are located at the end of Chapter 4, "Troubleshooting."

IMPORTANT Although simplified block diagrams are included within the description of each functional group, it is recommended that the more detailed block diagrams, located at the end of Chapter 4 , be available for reference, as you read the information in this chapter.

Chapter Five at-a-Glance

Section Title	Summary of Content	Start Page
Network Analyzer System Operation	A summary of the theory of operation for the analyzer. A summary of the operation of the major functional groups of the analyzer.	page 5-3
Synthesized Source Group Operation	Operation of the assemblies associated with the source group.	page 5-6
Signal Separation Group Operation	Operation of the assemblies associated with signal separation, including the operation of optional source attenuators, and bias tees.	page 5-15
Receiver Group Operation	Operation of the assemblies associated with the receiver group including the operation of optional receiver attenuators.	page 5-19
Digital Processing and Digital Control Group Operation	Operation of the assemblies associated with digital processing and digital control.	page 5-23
Power Supply Group Operation	Operation of the power supply assembly group.	page 5-28

Network Analyzer System Operation

The PNA network analyzer generates two (2-port models) or four (4-port models) phase-locked incident signals and an LO signal from the internal synthesized source. By means of signal separation, the incident signals are divided into reference signals and test signals.

The reference signals are applied to the receiver group, while the test signals are applied to the device under test (DUT) and then to the receiver group. The LO signal is applied directly to the receiver group where it is mixed with the test and reference signals to produce IF signals for each of the five receivers (A–D, R) for 4-port models or four receivers (A, B, R1, R2) for 2-port models. These IF signals are downconverted and then sampled and digitally processed.

Figure 5-1 is a simplified block diagram of the 4-port network analyzer system and Figure 5-2 is a simplified block diagram of the 2-port network analyzer system.

Figure 5-1 4-Port System Simplified Block Diagram

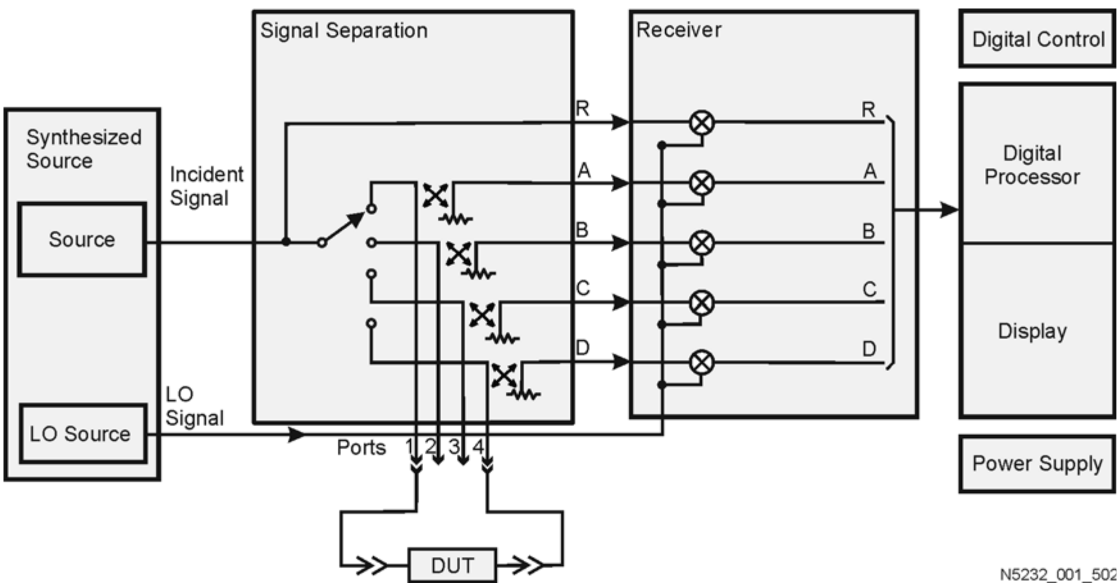
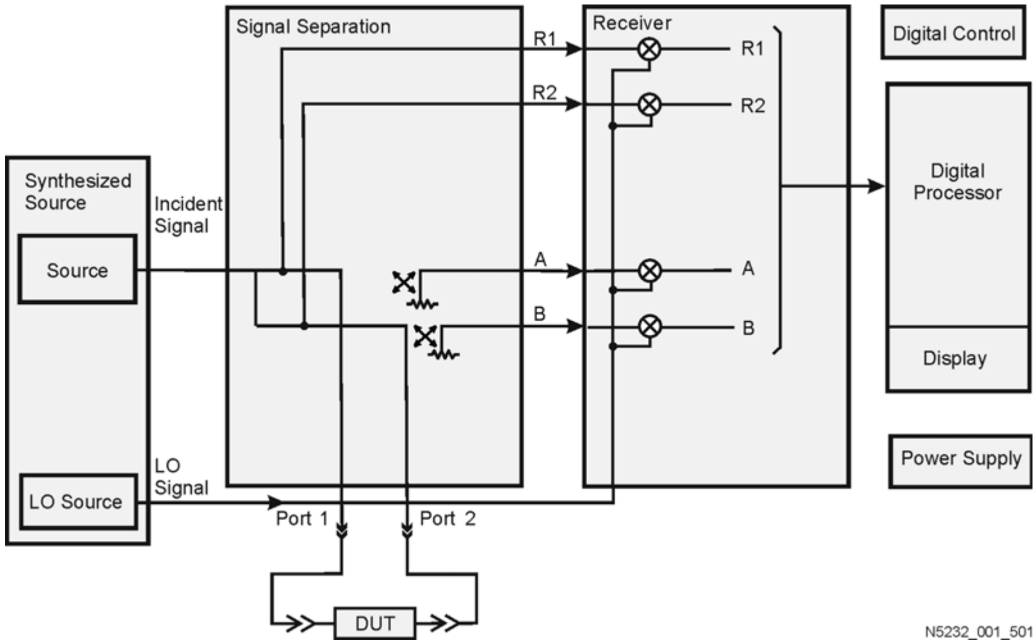


Figure 5-2 2-Port System Simplified Block Diagram



Functional Groups of the Network Analyzer

The operation of the network analyzer can be separated into major functional groups. Each group consists of assemblies that perform a distinct function in the instrument. Some of the assemblies are related to more than one group, and all of the groups, to some extent, are interrelated and affect each other's performance. The major functional groups are:

- Synthesized Source Group
- Signal Separation Group
- Receiver Group
- Digital Processor and Digital Control Group
- Power Supply Group

Synthesized Source Group

The built-in synthesized source generates a swept, stepped, or continuous wave (CW) signal in the frequency ranges as listed in Table 5-1. The source group provides five signals: an LO signal and four incident signals. The LO signal and the four incident signals are offset in frequency by the receiver IF of 5.785 MHz (at tuned frequencies between 7.5 MHz and 47 MHz the IF and the offset is 0.826 MHz).

The LO signal is sent directly to the mixers in the receiver group. The incident signals are routed to the front panel test ports and then to the device under test (DUT) as the test signal. A portion of each incident signal is coupled off (in the signal separation group) and sent to the mixers in the receiver group as reference signals. These reference signals are compared (mixed) with the LO signal in the receiver group to produce the 5.785 MHz (or 0.826 MHz at frequencies between 7.5 MHz and 47 MHz) IF signal.

The incident signal output power is leveled by an internal automatic leveling control (ALC) circuit. The maximum output power level of the network analyzer at the test ports can be found in the *"N523xA Data*

Sheet and Technical Specifications,"[1] available online at http://literature.cdn.keysight.com/litweb/pdf/N5235-90004.pdf.

Refer to "Synthesized Source Group Operation" on page 5-6.

Signal Separation Group

Each of the incident signals from the source group is separated into a reference path and a test path. The reference signal is transmitted to the receiver group. The test signal is transmitted through—and reflected from—the DUT and is then transmitted to the receiver group.

The signal separation group includes:

- RF path switching to allow forward and reverse measurements
- external connections for the DUT (configurable test set)
- optional step attenuators in the source paths

Refer to "Signal Separation Group Operation" on page 5-15.

Receiver Group

The receiver converts the test and reference signals to 5.785 MHz intermediate frequency (IF) signals for signal processing, retaining both magnitude and phase characteristics. The IF signals are converted to digital information by the digital processing group.

Refer to "Receiver Group Operation" on page 5-19.

Digital Processor and Digital Control Group

The digital processor and digital control group are divided into a front panel group and a data acquisition and processing group. The front panel group provides communication to the network analyzer. The data acquisition and processing group provides the output to the display, in addition to signal processing and analyzer control.

Refer to "Digital Processing and Digital Control Group Operation" on page 5-23.

Power Supply Group

The power supply functional group provides power for the other assemblies in the instrument.

Refer to "Power Supply Group Operation" on page 5-28.

1. For frequency ranges and maximum output power levels, refer to the section "Test Port Output" in the online Keysight document, *"N523xA Data Sheet and Technical Specifications."* See the hyperlink above.

Synthesized Source Group Operation

The source group produces a stable output signal by phase locking a synthesized voltage-controlled oscillator (VCO). Refer to Table 5-1 on page 12 for the full frequency range of the source. The outputs at the front panel test ports are swept, stepped or CW signals. For a simple block diagram of the source group, refer to Figure 5-3 on page 5-7 and Figure 5-4 on page 5-8.

In this section the following are described:

- Basic Operation
- A4 and A10 13.5 GHz Synthesizer Boards
- A20 MASSQuad (4-Port Models)
- A21 MASSY (2-Port Models)
- A7 Frequency Reference Board (including rear-panel interconnects)
- A19 Test Set Motherboard (including rear-panel interconnects)

Basic Operation

Figure 5-5. on page 5-9 lists the L.O. harmonic number and the synthesizer frequencies (A4 and A10) within the analyzer for each band. This table is referred to throughout this chapter and also appears on the overall block diagram at the end of Chapter 4, “Troubleshooting.”

The A7 frequency reference board produces a constant phase locked reference signal of 50 MHz that is sent to the A4 and A10 13.5 GHz synthesizer boards.

The A10 13.5 GHz LO synthesizer board produces an LO signal that is sent to the A24 mixer brick. The frequency is synthesized such that the mixing product of this LO signal with the test signal output is a constant 5.785 MHz IF; except for frequencies between 7.5 MHz and 47 MHz when the IF is 0.826 MHz. This IF signal is sent to the A9 SPAM board for digital processing.

The A4 and A10 13.5 GHz synthesizer boards each produce an incident signal that is sent to the front panel outputs. A portion of these signals are coupled off and sent to the A24 mixer brick (A–D and R) where they are mixed with the LO signal from the A10 13.5 GHz LO synthesizer to produce the 5.785 MHz (or 0.826 MHz) IF signal.

The A4 and A10 13.5 GHz synthesizer boards each contain their own phase lock circuitry. The A10 13.5 GHz LO synthesizer board is used to phase lock the LO signal while the A4 board is used to phase lock the test signal. This makes it possible for the LO signal to be tuned to a different frequency than the test signal, which is necessary since the LO signal is normally 5.785 MHz higher than the test signal. Since the A4 and A10 13.5 GHz synthesizer boards each receive their 50 MHz input reference signal from the exact same source, frequency drift error is eliminated.

Figure 5-3 2-Port Source Group

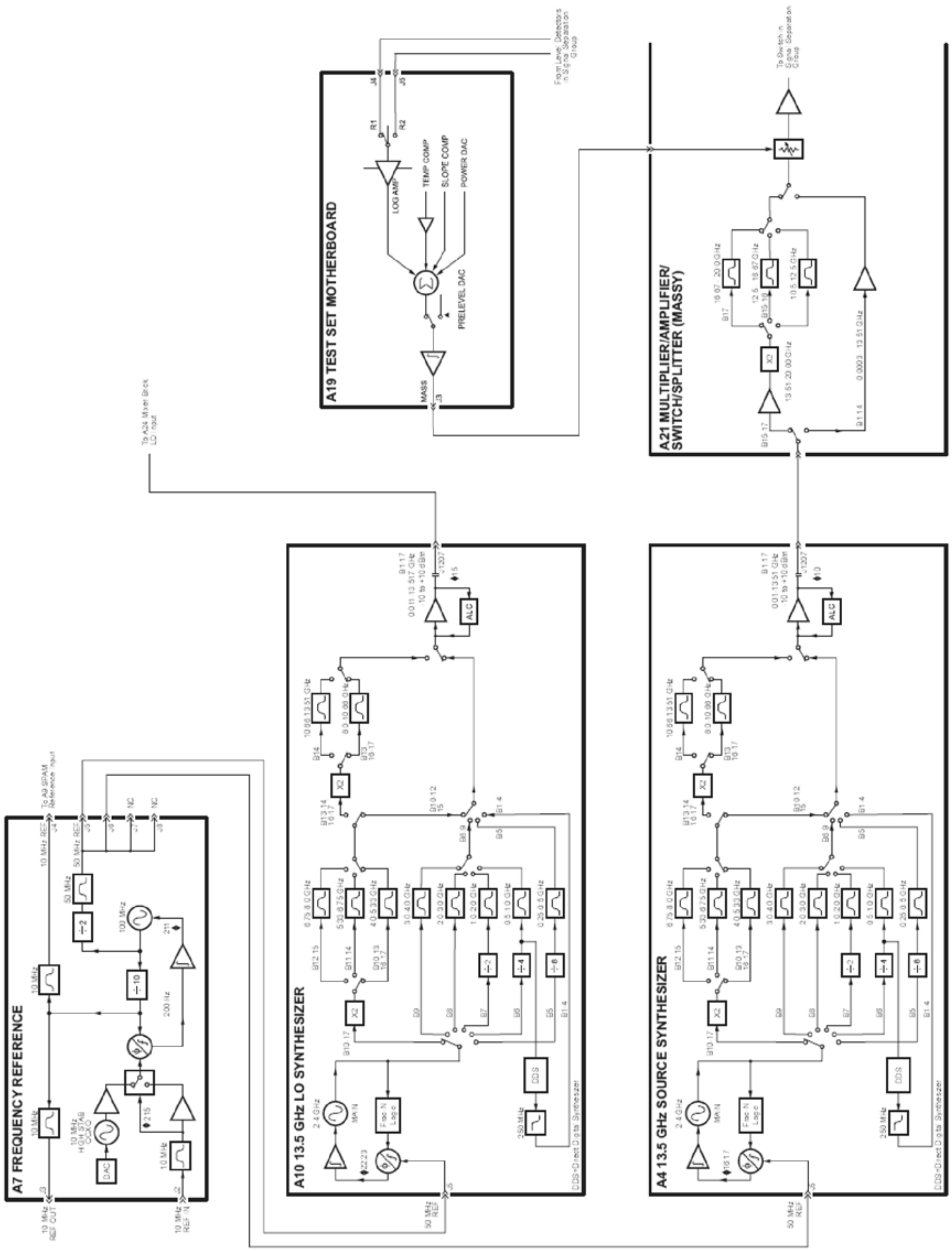


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Figure 5-4 4-Port Source Group

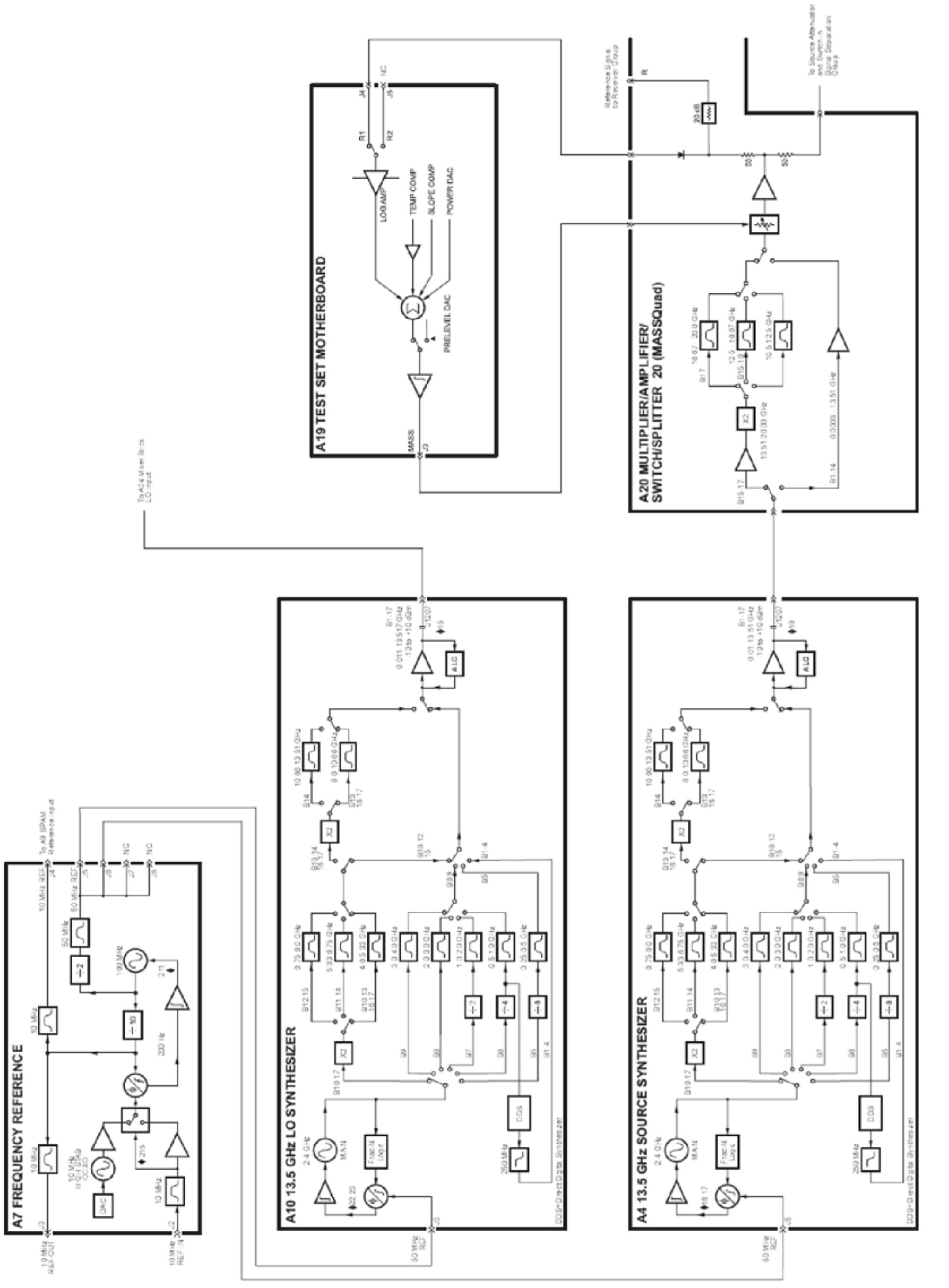

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Figure 5-5. Subsweep Frequencies

Band	Mixer Brick L.O. Harmonic Number	❶ A10 Synthesizer Frequency (GHz)	❷ A4 Synthesizer Frequency (GHz)	❸ A20 MASSQuad A21 MASSY Frequency (GHz)
1	1	0.00121 to 0.00133	0.0003 to 0.000425	0.0003 to 0.000425
2	1	0.00133 to 0.00211	0.000425 to 0.0012	0.000425 to 0.0012
3	1	0.00211 to 0.00841	0.0012 to 0.0075	0.0012 to 0.0075
4	1	0.00998 to 0.25744	0.0075 to 0.250	0.0075 to 0.250
5	1	0.25744 to 0.5074	0.250 to 0.500	0.250 to 0.500
6	1	0.5074 to 1.0074	0.500 to 1.000	0.500 to 1.000
7	1	1.0074 to 2.0074	1.000 to 2.000	1.000 to 2.000
8	1	2.0074 to 3.0074	2.000 to 3.000	2.000 to 3.000
9	1	3.0074 to 4.0074	3.000 to 4.000	3.000 to 4.000
10	1	4.0074 to 5.3394	4.000 to 5.332	4.000 to 5.332
11	1	5.3394 to 6.7594	5.332 to 6.752	5.332 to 6.752
12	1	6.7594 to 8.0074	6.752 to 8.000	6.752 to 8.000
13	1	8.0074 to 10.6714	8.000 to 10.664	8.000 to 10.664
14	1	10.6714 to 13.5174	10.664 to 13.510	10.664 to 13.510
15	3	4.5058 to 5.3358	6.755 to 8.000	13.510 to 16.000
16	3	5.3358 to 5.5591	8.000 to 8.335	16.000 to 16.670
17	3	5.5591 to 6.6691	8.335 to 10.000	16.670 to 20.000

A4 and A10 13.5 GHz Synthesizer Boards

The A4 and A10 13.5 GHz synthesizer boards use the 50 MHz reference signal from the A7 frequency reference board to tune a VCO circuit that sweeps from 2 GHz to 4 GHz.

Refer to Table 5-1 and Figure 5-3 for band numbers and frequencies discussed here.

In bands 1–9, the output of the swept VCO is passed directly or through a divide-by-2, 4, or 8 circuit to produce the output frequencies as listed in Table 5-1.

In band 6, the output of the swept VCO is passed through a divide-by-4 circuit and then sent to a Direct Digital Synthesizer to produce the output frequencies for bands 1–4 as listed in Table 5-1.

In bands 10–17, the swept VCO signal is passed through a doubler circuit where the signal for some bands are sent directly to the output of the synthesizer board while other bands are passed through another doubler circuit then to the output of the synthesizer board to produce the output frequencies listed in Table 5-1.

The output of the A10 13.5 GHz synthesizer board (the LO synthesizer) is 5.785 MHz higher than the output of the A4 13.5 GHz source synthesizer boards (the source synthesizers). This is because the output of the A10 13.5 GHz LO synthesizer board is routed to the A24 mixer brick where it is mixed with the test signals to produce a 5.785 MHz IF signal for each of five receivers (A–D and R). Refer to "A24 Mixer Brick" on page 5-19 for a more complete description.

A20 MASSQuad (4-Port Models)

In bands 1–14, the synthesizer inputs are amplified. In bands 15–17, the signals are doubled, filtered, and amplified. Together, these signals create the full output frequency range of 300 KHz to 20 GHz. The signals are then split into test and reference signals. A portion is also used for the ALC circuit of the A19 test set motherboard.

A21 MASSY (2-Port Models)

In bands 1–14, the synthesizer inputs are amplified. In bands 15–17, the signals are doubled, filtered, and amplified. Together, these signals create the full output frequency range of 300 KHz to 20 GHz. This is sent to the splitter where a portion of the signal is used for R1 and R2 channel reference signals and another portion for the ALC circuit of the A19 test set motherboard.

A7 Frequency Reference Board

This assembly provides stable reference frequencies to the rest of the instrument. A high stability 10 MHz oven-controlled crystal oscillator (OCXO) normally provides the frequency standard. However, if a 10 MHz external reference signal is detected at the 10 MHz EXT REF IN port on the rear panel, it is used as the frequency reference instead.

The 10 MHz reference signal is used to phase lock a 100 MHz VCO. The output of this VCO is then divided by ten to produce the 10 MHz EXT REF OUT rear panel signal and also a 10 MHz reference signal for the A9 signal processing ADC module (SPAM) board. The VCO output is also divided by two to produce 50 MHz reference signals for the A4 and A10 13.5 GHz synthesizer boards.

Rear-Panel Interconnects

10 MHz REF INPUT	A BNC connector that allows an external frequency reference signal to be used to phase lock the analyzer for increased frequency accuracy. The analyzer automatically enables the external frequency reference feature when a signal is connected to this input. When the signal is removed, the analyzer automatically switches back to its internal frequency reference.
10 MHz REF OUTPUT	A BNC connector that allows a 10 MHz reference signal, produced by the A7 frequency reference board, to be output for use in phase locking external test equipment.

A19 Test Set Motherboard

The A19 test set motherboard serves these functions:

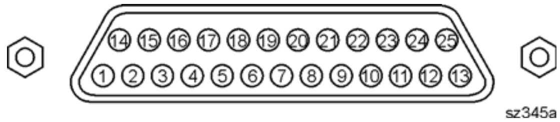
- to act as an interface between the A17 CPU board and the auxiliary rear panel interconnects.
- to provide ALC signals to the A20 MASSQuad or the A21 MASSY
- to route control signals to the signal separation group. Refer to "Signal Separation Group Operation" on page 5-15 for more information.

Rear Panel Interconnects

The A19 test set motherboard includes the following rear panel interconnects.

TEST SET I/O	A DB-25 female connector that is used to control external test sets. The external test set bus consists of 13 multiplexed address and data lines, three control lines, and an open-collector interrupt line. Pin assignments are listed in Table 5-1 on page 12. Up to 16 test sets may be "daisy-chained" on the bus at one time. The Test Set I/O is not compatible with 8753 network analyzer test sets.
HANDLER I/O	A rectangular 36-pin, female connector providing four independent parallel input/output ports, nine control signal lines, one ground, and a power supply line. This connector has Type 2 output pin assignments as listed in Table 5-2 on page 13. All signals are TTL-compatible. Data input/output ports consist of two 8-bit output ports (Port A and Port B) and two 4-bit bidirectional ports (Port C and Port D). Connector settings can be changed using SCPI and COM commands. The settings are not accessible from the front panel.
PWR I/O	A DB-9 female connector. Pin assignments are listed in Table 5-3 on page 14.

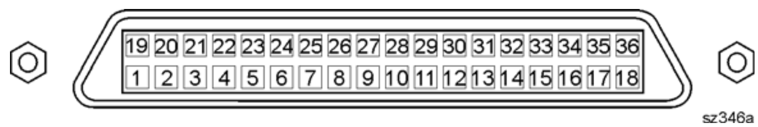
Table 5-1TEST SET I/O Connector Pin Assignments



DB-25 Female Connector

Pin Numbers	Name	Function
1	SEL0	TTL out, test set select bit 0, tied to 0 V
2	Sweep Holdoff In	TTL in, low level holds off sweep
3–6	AD12–AD8	TTL I/O, address and latched data
7	GND	0 V, ground reference
8	LAS	TTL out, active low address strobe (1 μs min)
9–11	AD4–AD2	TTL I/O, address and latched data
12	GND	0 V, ground reference
13	Interrupt In	TTL in, low level (10 μs min) aborts sweep
14	+22 V	+22 Vdc, 100 mA max.
15–16	SEL1–2	TTL out, test set select bits 1-2, tied to 0 V
17	AD11	TTL I/O, address and latched data
18	SEL3	TTL out, test set select bit 3, tied to 0 V
19–21	AD7–5	TTL I/O, address and latched data
22–23	AD0–1	TTL I/O, address and latched data
24	LDS	TTL out, active low data strobe (1 μs min)
25	RLW	TTL out, high = read, low = write

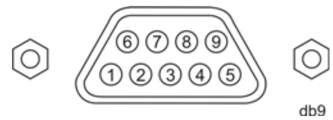
Table 5-2HANDLER I/O Connector Pin Assignments



Rectangular 36-Pin Female Connector

Pin Numbers	Name	Function
1	GND	0 V, ground reference
2	INPUT1	TTL in, negative pulse (1 μs min) latches OUTPUT1-2
3–4	OUTPUT1–2	TTL out, latched
5–12	Port A0–7 Out	TTL out, latched
13–20	Port B0–7 Out	TTL out, latched
21–24	Port C I/O	TTL I/O, latched
25–28	Port D I/O	TTL I/O, latched
29	Port C Status	TTL out, low = input mode, high = output mode
30	Port D Status	TTL out, low = input mode, high = output mode
31	Output Strobe Write Strobe	TTL out, active low data write strobe (1 μs min)
32	No connect	Not used
33	Pass Fail	TTL out, latched, indicates pass fail (programmable polarity)
34	+5 V	+5 Vdc, 100 mA max.
35	Sweep End	TTL out, active low (10 μs min) indicates sweep done
36	Pass/Fail Write Strobe	TTL out, active low pass/fail write strobe (1 μs min)

Table 5-3PWR I/O Connector Pin Assignments



DB-9 Female Connector

Pin	Name	Description
1	+15V	+15 V @ 400 mA
2	-15V	-15 V @ 400 mA
3	AnalogOut1	Analog Output Voltage Programmable ±10 V @ 100 mA out Nominally 0 ohms 2.44 mV typical resolution 1 MHz BW
4	AnalogOut2	Analog Output Voltage Programmable ±10 V @ 100 mA out Nominally 0 ohms 2.44 mV typical resolution 1 MHz BW
5	ACOM	System ground
6	GndSense	Ground sense for Analog In and Analog Out Connected with 51.1 ohms to ACOM
7	AnalogIn1	Analog input: ±10 V @ 1.22 mV typical resolution Rin > 1 M-ohm BW ≈ 1 MHz ADC conversion time < 1 us typical
8	AnalogIn2	Analog input: ±10 V @ 1.22 mV typical resolution Rin > 1 M-ohm BW ≈ 1 MHz ADC conversion time < 1 us typical
9	Power Button	Open collector input Active low replicates power button key press.

Signal Separation Group Operation

The signal separation group divides the source incident signals into a reference path and a test path. Refer to Figure 5-6 on page 5-17 and Figure 5-7 on page 5-18.

- The reference signals are transmitted to the receiver group as the R1 and R2 inputs.
- The test signals are transmitted through—and reflected from—the device under test (DUT) and then transmitted to the receiver group as the A and B inputs.
- Control lines to this group are routed from the A19 test set motherboard.

In this section, the following assemblies are described:

- Configurable Test Set — Front Panel Jumpers (Option 216 or 416)
- A25 and A28 Test Port Couplers
- A29–A30 60 dB Step Attenuators

Configurable Test Set

The configurable test set is included in the standard analyzer and allows you to measure devices with higher power and higher dynamic range limits than an analyzer without the configurable test set. There are six signal paths routed through front panels jumpers in the configurable test set.

As shown in Figure 5-6 on page 5-17 and Figure 5-7 on page 5-18, these jumpers are installed between the components listed below. Ports 3 and 4 apply only to 4-port models.

4-port models:

- the A25 test port 1 bridge coupler and the A24 mixer brick receiver A
- the A26 test port 2 bridge coupler and the A24 mixer brick receiver B
- the A27 test port 3 bridge coupler and the A24 mixer brick receiver C
- the A28 test port 4 bridge coupler and the A24 mixer brick receiver D
- the A20 MASSQuad and the A24 mixer brick receiver R
- the A20 MASSQuad and the A25 test port 1 bridge coupler
- the A20 MASSQuad and the A26 test port 2 bridge coupler
- the A20 MASSQuad and the A27 test port 3 bridge coupler
- the A20 MASSQuad and the A28 test port 4 bridge coupler

2-port models:

- the A25 test port 1 bridge coupler and the A24 mixer brick receiver A
- the A28 test port 2 bridge coupler and the A24 mixer brick receiver B
- the A21 MASSY and the A24 mixer brick receiver R1
- the A21 MASSY and the A24 mixer brick receiver R2
- the A29 60 dB step attenuator and the A25 test port 1 bridge coupler

- the A30 60 dB step attenuator and the A28 test port 2 bridge coupler

Normal Measurement Configuration

For those analyzers equipped with configurable test set and source attenuators, with the inclusion of an external amplifier and accessories, you can calibrate the analyzer and test devices at power levels up to +30 dBm. You can make measurements in the forward, reverse, or both directions and still achieve these high power levels.

High Dynamic Range Measurement Configuration

With a few jumper changes, you can configure the measurement configuration for higher dynamic range measurements. By swapping the front panel jumpers for one port, signal flow through the corresponding coupler is reversed, increasing the test signal sensitivity by 15 dB.

In the forward direction, for example, the signal flow through the test port 2 coupler is reversed by arranging the front panel jumpers such that RCVR B IN connects to CPLR THRU and CPLR ARM connects to SOURCE OUT.

While increasing forward (S_{21}) dynamic range, the reverse (S_{12}) dynamic range is degraded by the same amount.

A25 and A28 Test Port Couplers

The test port signals go into the through-line arm of the couplers, and from there to the test ports and the DUT.

The coupled arm of the couplers carries the signal reflected from or transmitted through the DUT, to the receiver for measurement (through front panel jumpers), as inputs A, B, C, and D for 4-port models or inputs A and B for 2-port models. The coupling coefficient of the directional couplers is nominally 15 dB over the full frequency range.

Figure 5-6 4-Port Signal Separation Group

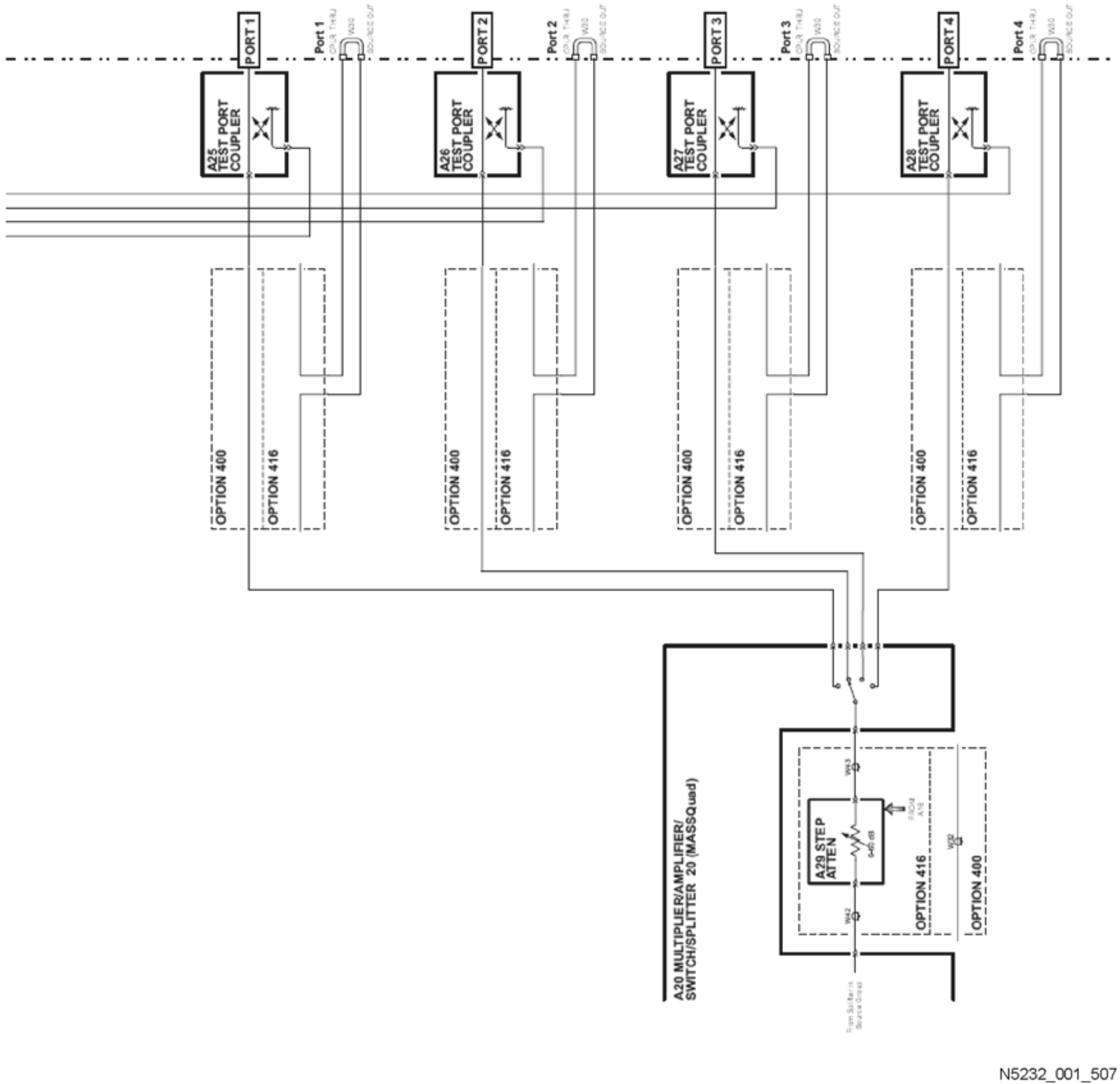
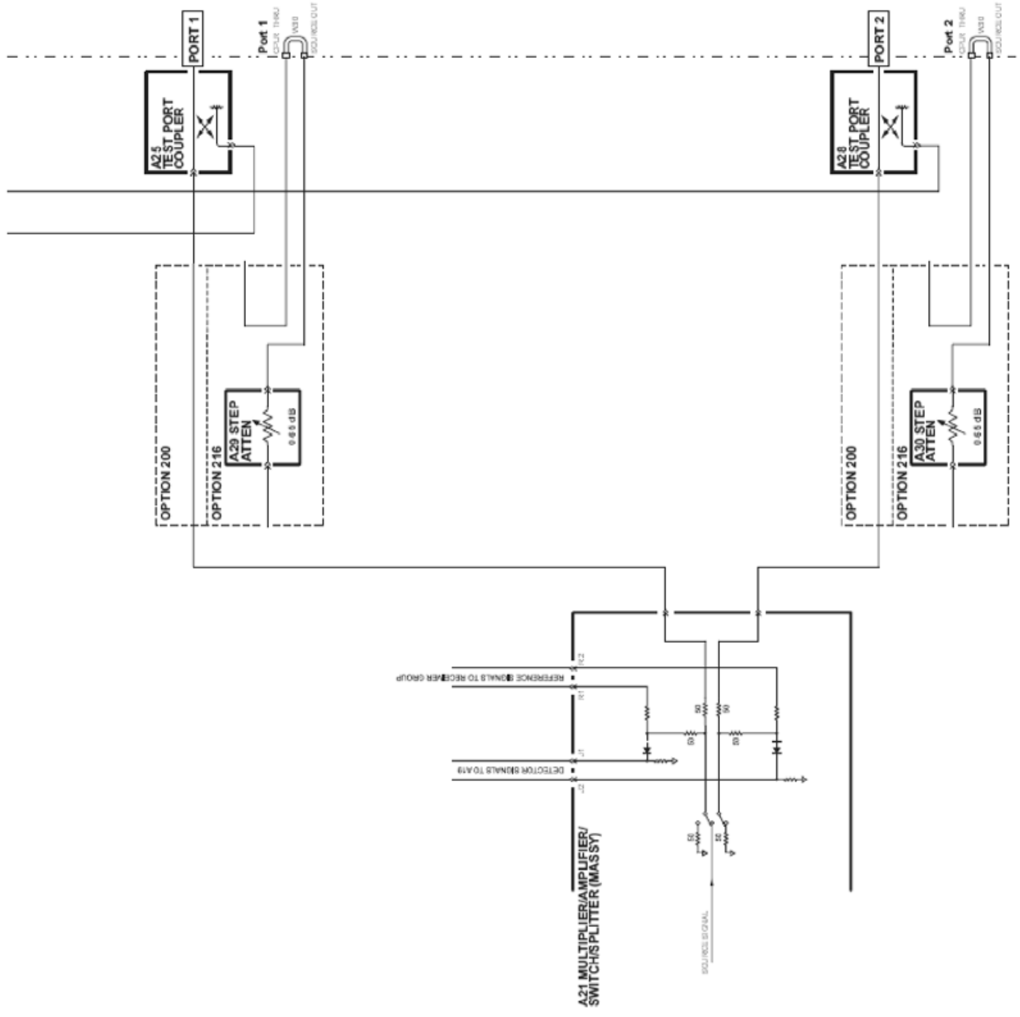


Figure 5-7 2-Port Signal Separation Group



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A29–A30 60 dB Step Attenuators

On 4-port models with Option 416, a step attenuator is placed between the A20 MASSQuad and the A25–A28 test port couplers.

On 2-port models with Option 216, a step attenuator is placed in the signal path of each test port between the A21 MASSY and the A25 and A28 test port couplers.

The 60 dB step attenuators provide coarse power control for the test port signals. They are electro-mechanical step attenuators that provide 0 to 60 dB of attenuation in 5-dB steps. They adjust the power level to the DUT without changing the level of the incident power in the reference path. These attenuators are controlled by the A17 CPU board.

Receiver Group Operation

The receiver group measures and processes the input signals into digital information for processing and eventual display. Figure 5-8 on page 5-21 and Figure 5-9 on page 5-22 are simplified block diagrams of the receiver functional group for 2-port and 4-port analyzers respectively.

In this section the following assemblies are described:

- A24 Mixer Brick
- A9 SPAM Board (Analog Description)

A24 Mixer Brick

The mixer brick contains five identical amplifiers, mixers, and filters.

For frequencies at or above 47 MHz, the test signals (receivers A, B, C, and D for 4-port models and A and B for 2-port models) and the reference signals (receivers R1, R2, R3, and R4 for 4-port models and R1 and R2 for 2-port models) are mixed with a synthesized source signal that is 5.785 MHz higher than the source incident signal to produce a 5.785 MHz IF signal. This synthesized source comes from the A10 13.5 GHz LO synthesizer board.

At frequencies between 7.5 MHz and 47 MHz, the IF is set to 0.826 MHz.

The analog IF signal is sent to the A9 SPAM board where it is processed.

A9 SPAM Board (Analog Description)

The A9 SPAM board contains digital and analog circuitry. For digital descriptions, refer to "A9 SPAM Board (Digital Description)" on page 5-26.

In this assembly, the IF signals (A, B, C, D, and R for 4-port models and A, B, R1, and R2 for 2-port models) from the A24 mixer brick go through a gain stage where small signals are amplified to ensure that they can be detected by the analog-to-digital converter (ADC).

All input signals are sampled simultaneously by the ADCs, where they are converted to digital form. The ADC conversions are triggered by timing signals from the digital signal processor (DSP) in response to commands from the central processing unit (CPU). The digitized data is processed into magnitude and phase data by the DSP and sent to the CPU random access memory (RAM) by way of the peripheral component interconnect (PCI) bus.

The processed and formatted data is finally routed to the display, and to the general-purpose interface bus (GPIB) for remote operation. Refer to "Digital Processing and Digital Control Group Operation" on page 5-23 for more information on signal processing.

Figure 5-8 4-Port Receiver Group

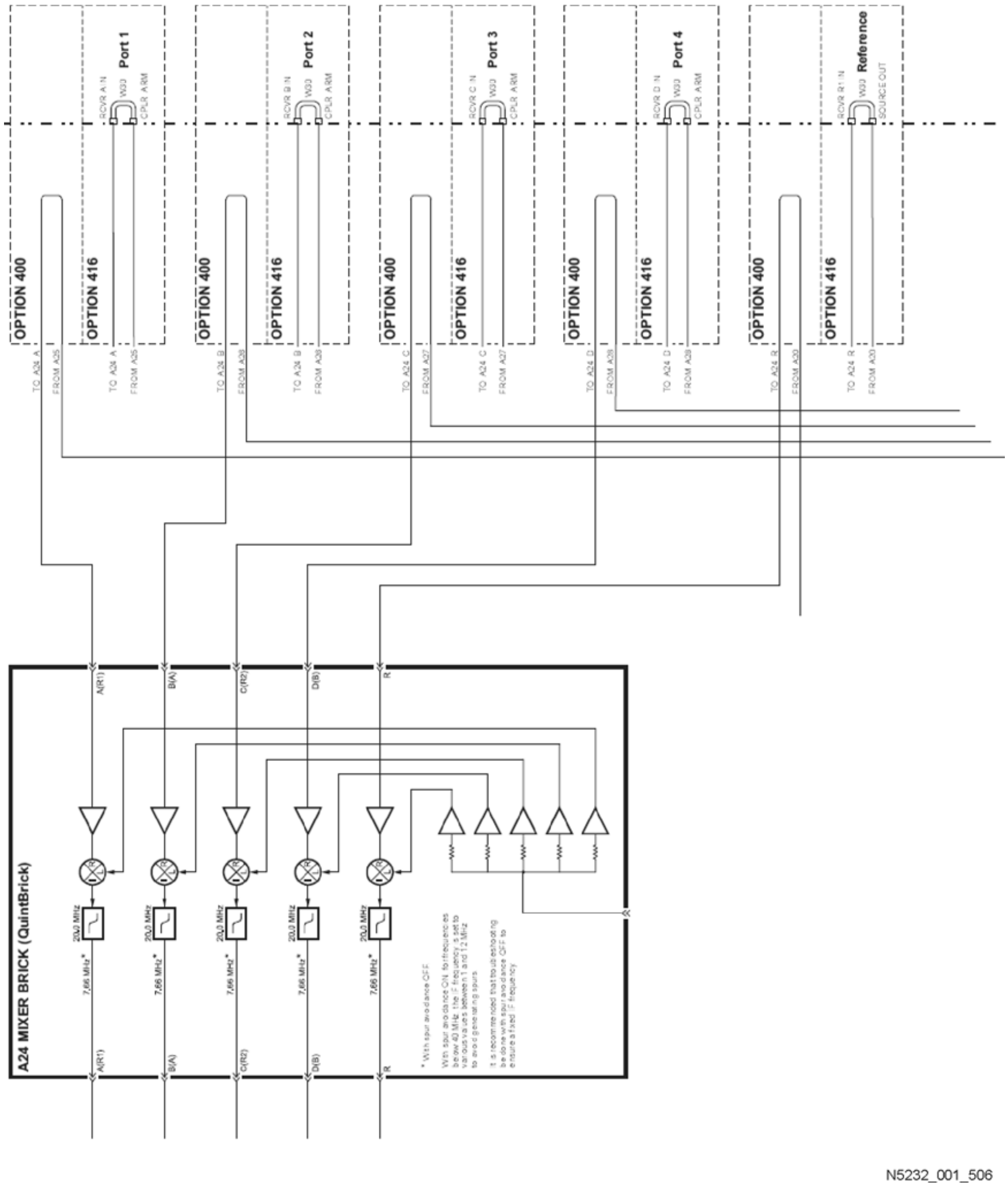
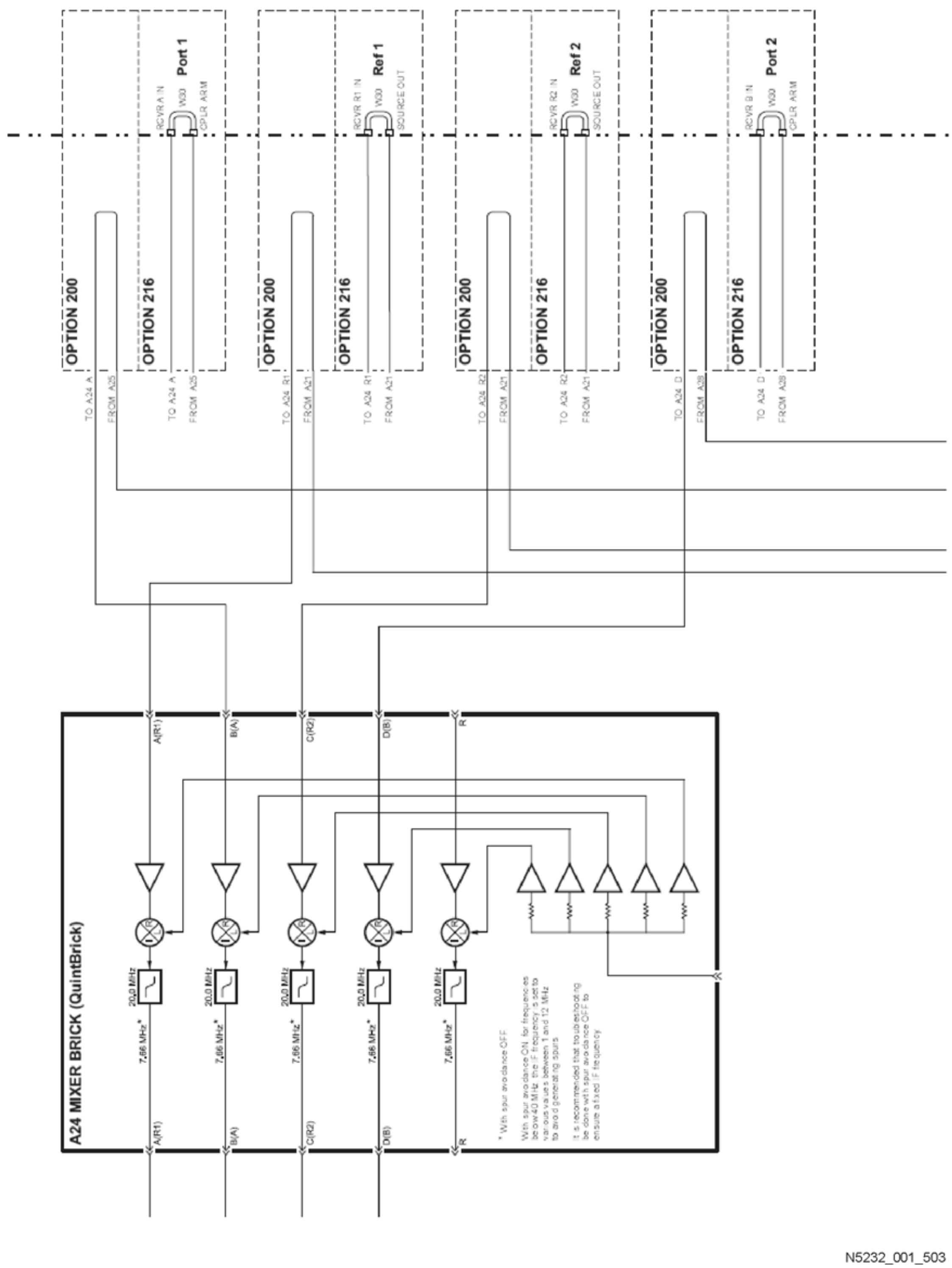


Figure 5-9 2-Port Receiver Group



Digital Processing and Digital Control Group Operation

The digital processor and control group provides digital control for the entire analyzer. It provides:

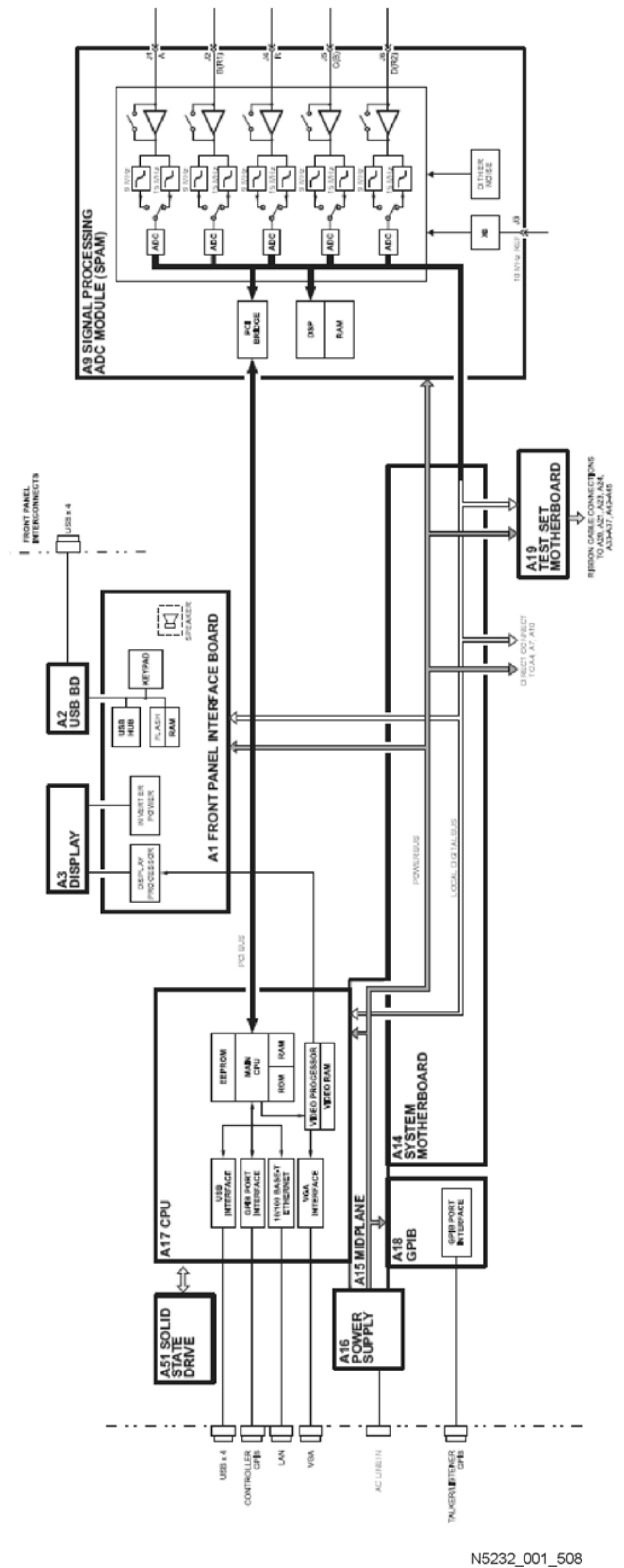
- front panel operation,
- output to the display,
- math processing functions, and
- communications between the analyzer and an external controller or peripherals.

A block diagram of the digital control functional group is shown in Figure 5-10 on page 5-24.

The digital control functional group consists of two subgroups:

- Front Panel Subgroup
  - A1 Front Panel Interface Board
  - A2 USB Board
  - A3 Display Assembly
  - Keypad Assembly
- Data Acquisition and Processing Subgroup
  - A9 SPAM Board (Digital Description)
  - A17 CPU Board
  - A51 Solid State Drive

Figure 5-10 Digital Processing and Digital Control Group



Front Panel Subgroup

The front panel subgroup contains the following assemblies:

- A1 Front Panel Interface Board
- A2 USB Board
- A3 Display Assembly
- Keypad Assembly

A1 Front Panel Interface Board

The A1 front panel interface board detects and decodes user inputs from the keypad assembly and front panel knob, and transmits them to the A17 CPU board by way of the A14 system motherboard. It also decodes video data from the video processor on the A17 CPU board and supplies this to the A3 display assembly. Power from the power bus on the A14 system motherboard is buffered and routed to the keypad assembly and the A3 display assembly. All data and power signals are routed through a single cable connector to the A14 system motherboard.

The A1 front panel interface board also includes a speaker that emits the audio signals received from the A17 CPU board.

A2 USB Board

This board provides four universal serial bus (USB) jacks that are industry standard 4-pin connectors allowing multiple USB devices to be connected to the analyzer's front panel.

A3 Display Assembly

The A3 display assembly contains an 10-inch LCD with associated drive circuitry and backlight inverter. Two cables between the A3 display assembly and the A1 front panel interface board provide all necessary power and data for normal operation. The two cables are:

1. A cable to the inverter that supplies buffered power.
2. A cable to the display circuitry that supplies decoded data from the video processor on the A17 CPU board and the necessary drive circuit power. The video data received from the A17 CPU board includes the following:

   - digital TTL horizontal sync
   - digital TTL vertical sync
   - digital TTL red video
   - digital TTL green video
   - digital TTL blue video
   - blanking
   - data clock

Keypad Assembly

The keypad assembly provides user interface to the analyzer. The front panel rotary pulse generator (RPG) knob is not electrically connected to the keypad, but rather provides user inputs directly to the front panel processor.

Data Acquisition and Processing Subgroup

The data acquisition and processing subgroup contain the following assemblies. See Figure 5-10 on page 5-24.

- A9 SPAM Board (Digital Description)
- A17 CPU Board (including rear-panel interconnects)
- A51 Solid State Drive

A9 SPAM Board (Digital Description)

The A9 SPAM board contains digital and analog circuitry. For analog descriptions, refer to "A9 SPAM Board (Analog Description)" on page 5-20.

The digital signal processor (DSP) receives digitized data from the digital circuitry of the A9 SPAM board. It computes discrete Fourier transforms to extract the complex phase and magnitude data from the analog IF signal. The resulting raw data is written into the main random access memory (RAM). The data taking sequence is triggered either externally from the rear panel or by firmware on the A17 CPU board.

A17 CPU Board

The A17 CPU board contains the circuitry to control the operation of the analyzer. Some of the components include the central processing unit (CPU), memory (EEPROM, ROM, RAM), bus lines to other board assemblies, and connections to the rear panel. Some of the main components are described next:

- CPU
- Main RAM
- Rear Panel Interconnects

CPU The central processing unit (CPU) is a microprocessor that maintains digital control over the entire instrument through the instrument bus. The CPU receives external control information from the keypad, any USB device, LAN or GPIB, and performs processing and formatting operations on the raw data in the main RAM. It controls the DSP, the video processor, and the interconnect port interfaces. In addition, when the analyzer is in the system controller mode, the CPU controls peripheral devices through the peripheral port interfaces.

Front panel settings are stored in SRAM, with a battery providing at least five years of backup storage when external power is off.

Main RAM The main random access memory (RAM) is shared memory for the CPU and the DSP. It stores the raw data received from the DSP while additional calculations are performed on it by the CPU. The CPU reads the resulting formatted data from the main RAM, converts it to a user-definable display format, and writes this to the video processor for display.

Rear Panel Interconnects The rear panel includes the following interfaces:

USB x4	Four universal serial bus (USB) jacks (industry standard 4-pin connectors).
GPIB (0) Controller	A 24-pin, female, type D-24 connector that meets IEEE-488 standards.
GPIB (1) Talker/Listener	A 24-pin, female, type D-24 connector that meets IEEE-488 standards.
LAN	A standard 8-pin, 10/100BaseT, Ethernet connection. It auto selects between the two data rates.
Display (VGA)	A 15-pin, female, D-sub connector that provides a video output of the analyzer display that can be viewed on an external VGA monitor.

A51 Solid State Drive

The solid state drive assembly (SSDA) is an integrated development environment (IDE) data storage device which is connected directly to, and physically mounted within the enclosure of, the A17 CPU board. The full operating system and firmware for the network analyzer is stored on the A51 solid state drive.

Power Supply Group Operation

The A16 power supply assembly is a switching power supply operating at 103 kHz switching frequency. The input power ranges for the power supply are 90 to 132 Vac or 195 to 250 Vac. The power supply automatically senses the input voltage and switches between these two ranges.

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.**

The dc output voltages of the A16 power supply assembly are:

- +15 V analog
- +9 V analog
- +3.3 V analog
- +5.2 V analog
- +15 V standby (always on)
- +32 V analog
- –15 V analog
- –5.2 V analog
- –7 V analog
- +5.1 V standby
- +12 V digital
- +3.35 V digital
- +5.1 V digital

The +15 V standby supply remains on continuously whenever the power supply is plugged in. This supply is used to provide power to front panel LEDs and CPU components when the analyzer is turned off.

6 Replaceable Parts

Information in This Chapter

This chapter:

- identifies the replaceable parts for the Keysight PNA series microwave network analyzer.
- includes several tables and illustrations to assist you in identifying the correct part for your analyzer.
- contains ordering information for new assemblies and rebuilt-exchange assemblies.

Chapter Six at-a-Glance

Ordering Information

To order a part listed in the replaceable parts lists:

- include the part number
- indicate the quantity required
- Contact Keysight Technologies for instructions on where to send the order. Refer to "Contacting Keysight" on page 2-7.

To order a part that is not listed in the replaceable parts lists:

- include the instrument model number and complete instrument serial number
- include the description and function of the part
- indicate the quantity required
- Contact Keysight Technologies for instructions on where to send the order. Refer to "Contacting Keysight" on page 2-7.

Assembly Replacement Sequence

The following steps describe how to replace an assembly in the network analyzer.

Step 1. Identify the faulty group. Begin with Chapter 4, “Troubleshooting.” Follow up with the appropriate troubleshooting chapter that identifies the faulty assembly.

Step 2. Order a replacement assembly. Refer to this chapter.

Step 3. Replace the faulty assembly and determine what adjustments are necessary. Refer to Chapter 7, “Repair and Replacement Procedures.”

Step 4. Perform the necessary adjustments. Refer to Chapter 3, “Tests and Adjustments.”

Step 5. Perform the necessary performance tests. Refer to Chapter 3 , “Tests and Adjustments.”

Step 6. Keysight personnel: see Figure 1-1 on page 1-5 to review where the calibration stickers should be placed on the PNA.

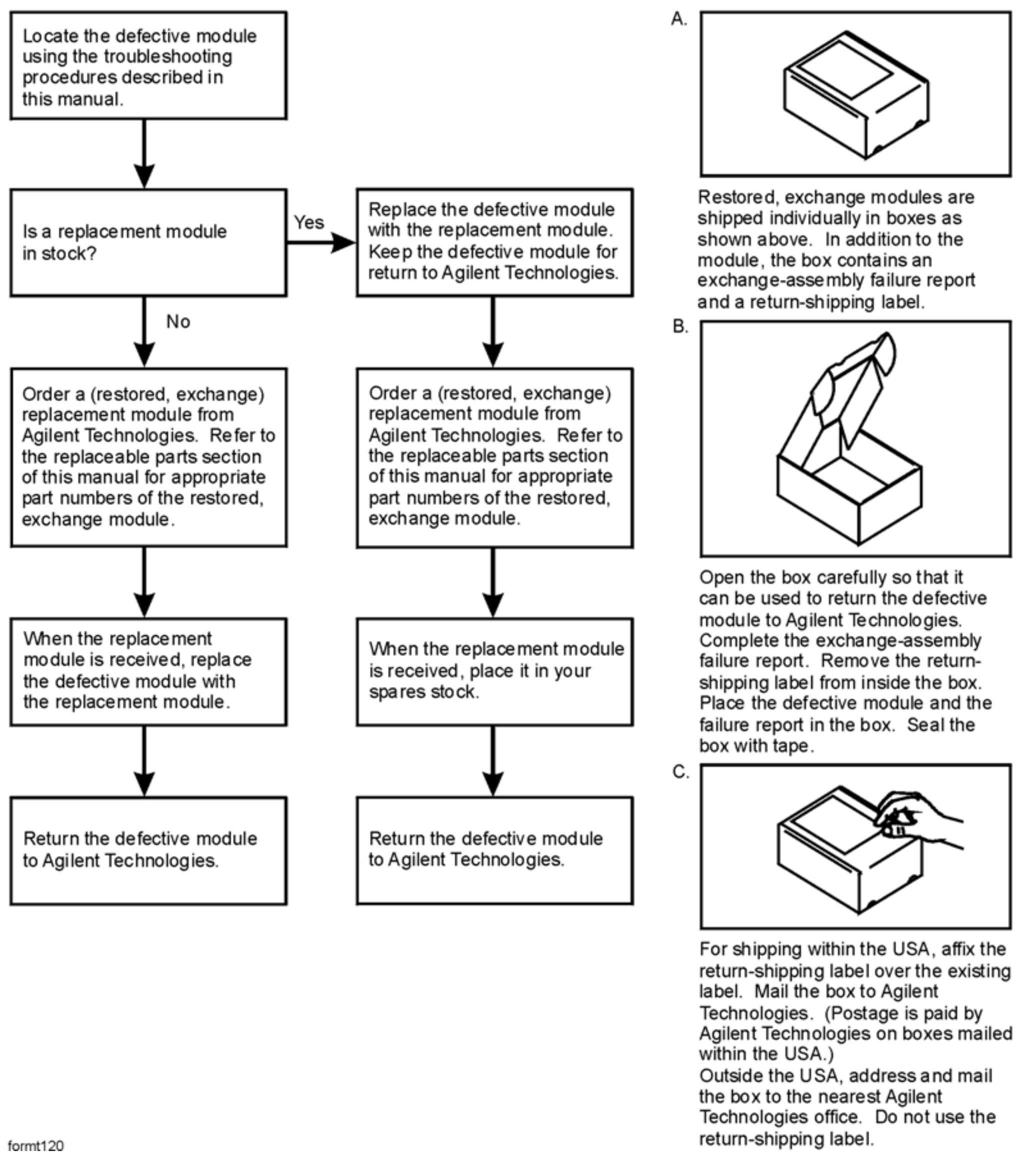
Rebuilt-Exchange Assemblies

Under the rebuilt-exchange assembly program:

- Certain factory-repaired and tested assemblies are available on a trade-in basis.
- Exchange assemblies are offered for lower cost than a new assembly, but meet all factory specifications required of a new assembly.
- The defective assembly must be returned for credit under the terms of the rebuilt-exchange assembly program.
- Spare assembly stock desired should be ordered using the new assembly part number.

Figure 6-1 Module Exchange Procedure

The module exchange program described here is a fast, efficient, economical method of keeping your instrument in service.



Replaceable Parts Listings

This section contains the replacement part numbers and their descriptions for your Keysight PNA series microwave network analyzer. You can find the locations of replaceable parts in this section:

listed

- by reference designator in Table 6-1, or
- listed by the type of part in Table 6-2.

Table 6-1Part Number Listing by Reference Designator

Reference Designator	Description	Location
A1	Front panel interface board	"Front Panel Assembly, Back Side, All Options" on page 6-12
A2	USB board	
A3	Display assembly	
A4	13.5 GHz source synthesizer board	"Top Assemblies, All Models" on page 6-16
A5	Not used	
A6	Not used	
A7	Frequency reference	
A8	Not used	
A9	Signal processing ADC module (SPAM) board	
A10	13.5 GHz LO synthesizer board	
A11	Not used	
A12	Not used	
A13	Not used	
A14	System motherboard	
A15	Midplane board	
A16	Power supply assembly	"Internal Hardware and Miscellaneous Parts, All Models" on page 6-46
A17	CPU board	
A18	GPIB board	
A19	Test set motherboard	Your option set determines which assemblies are in your PNA. Refer to "Bottom Assemblies and Cables by Option Set:" in Table 6-2 on page 6-8
A20	MASSQuad (4-Port models only)	
A21	MASSY (2-Port models only)	
A22	Not used	
A23	Not used	
A24	Mixer brick (QuintBrick)	
A25	Test port 1 bridge coupler	
A26	Test port 2 bridge coupler	

Table 6-1Part Number Listing by Reference Designator (Continued)

Reference Designator	Description	Location
A27	Test port 3 bridge coupler	Your option set determines which assemblies are in your PNA. Refer to "Bottom Assemblies and Cables by Option Set:" in Table 6-2 on page 6-8.
A28	Test port 4 bridge coupler	
A29	Source 60 dB step attenuator	
A30	Source 60 dB step attenuator (Option 216 only)	
A31 - A50	Not used	
A51	Solid state drive assembly (SSDA)	"Internal Hardware and Miscellaneous Parts, All Models" on page 6-46

Table 6-2 Part Number Listing by Type of Part

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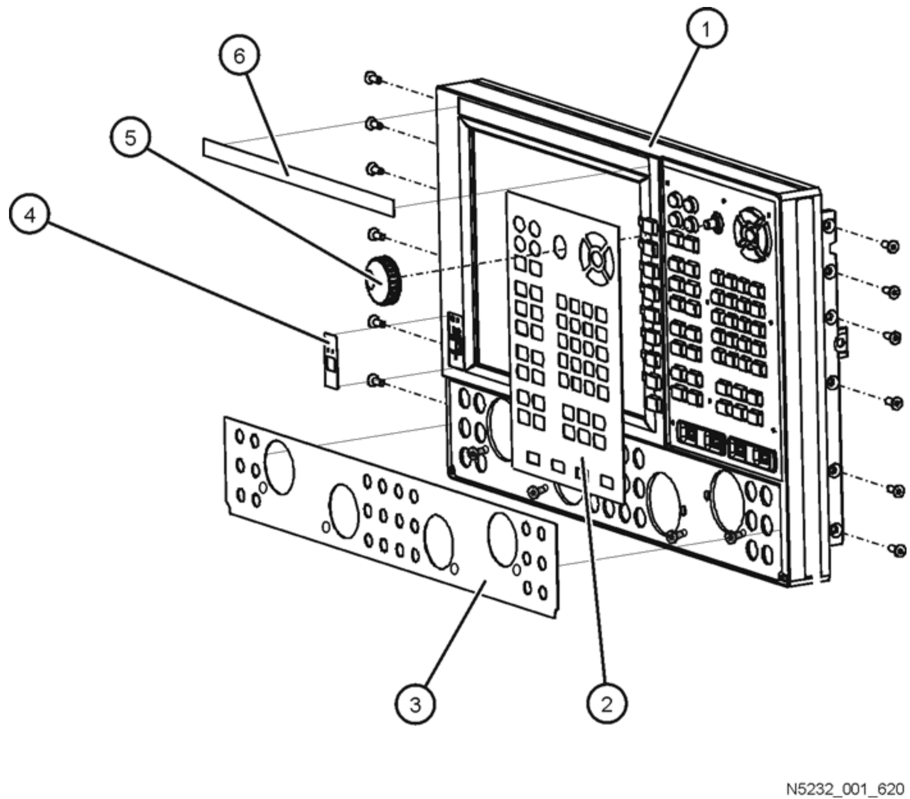
Front Panel Assembly, Front Side, All Options

NOTE The N5245-60024 (Was N5247-60004) 2-port front panel assembly and the N5232-60005 (Was N5232-60001) 4-port front panel assembly contain the items shown in the following table.

Reference Designator	Part Number	Qty	Description
①	N5247-20137	1	Front frame, 2-port
	N5232-20181		Front frame, 4-port
	8160-0660	1.2 m	RFI gasket material, 1.2 meters in length (Must be ordered separately from front frame assembly.)
②	N5242-80005	1	Keypad overlay
③	N5232-80001	1	Front panel overlay, 2-port (Option 200)
	N5232-80005		Front panel overlay, 2-port (Option 216)
	N5232-80002		Front panel overlay, 4-port (Options 400)
	N5232-80006		Front panel overlay, 4-port (Options 416)
④	N5242-80007	1	Power switch overlay
⑤	W1312-40017	1	Front (RPG) knob
⑥	N5231-80002	1	Nameplate, N5231A
	N5232-80004		Nameplate, N5232A
	N5239-80001		Nameplate, N5239A
--	0515-1946	--	Machine screw, M3.0 x 6, 90-deg flat head (to attach front fame to sub panel.) (2 used on 2-port models; 4 used on 4-port models.)
--	0515-2044	--	Machine screw, M4.0 x 10 flat head (to attach front frame to chassis.)

Figure 6-2 Front Panel Assembly, Front Side, All Options



Front Panel Assembly, Back Side, All Options

Reference Designator	Part Number	Qty	Description
A1	N5240-60065 Was N5240-60046	1	Front panel interface board
A2	N5240-60063 Was N5240-60047	1	USB board
not shown	N5242-60010	1	Ribbon cable, 60-wire, A14 system motherboard J9 to A1 front panel interface board J1
①	N5242-40001	1	Keypad assembly
②	0515-0430	12	Machine screw, M3.0 x 6 pan head (9 to attach front panel interface board to front frame and 3 to attach display cable to display hold down bracket.)
③	N5242-40009 Was N5242-40003	1	Touch screen rubber boot
④	2090-1045 Was 2090-0973	1	Touch screen, 10.4 inch
⑤	0515-0372	16	Machine screw, M3.0 x 8 pan head (6 to attach display to front frame, 6 to attach LCD display assy to bracket, and 4 to attach USB board to front frame.)
⑥	E6601-61028	1	Cable, A3 front panel interface board to inverter board
⑦	0515-1934	4	Machine screw, M2.5 x 6 pan head (To attach inverter board and USB controller board to display hold down bracket.)
⑧[a] critical footnote	0950-5396 (LED) 0950-4420 (Tube)	1	Inverter board
⑨	0960-3063 Was 0960-2804	1	Touch screen controller board
⑩	0515-1521	2	Machine screw, M3.0 x 5 flat head (To attach power switch assembly to front frame.)
⑪	N5240-60064 Was N5240-60050	1	Power switch board
⑫	N5240-40001	1	Power button keypad
⑬	W1312-60047 Was 8121-1452	1	Touch screen controller board cable harness
⑭	8121-1451	1	Power switch cable harness
⑮	1400-0510	2	Cable clamp (with adhesive backing)
⑯	0515-0667	1	Machine screw, M3.0 x 25 pan head (To attach display to front frame.)
⑰	2190-0017	1	Lock washer, helical #8 (To use with 0515-0667 screw.)
A3			Display assembly:
⑱[a] critical footnote	0515-2329 (LED) 0515-0664 (Tube)	4	Machine screw, M3.0 x 10 pan head (To attach LCD display to bracket.)
⑲[a] critical footnote	2090-1036 (LED) 2090-0883 (Tube)	1	LCD display

Reference Designator	Part Number	Qty	Description
A3			Display assembly (continued from previous page)
⑳[a] critical footnote	N5242-20121 (Tube)	4	Spacers (For display hold down bracket standoffs.) For use with LCD display 2090-0883 only.
㉑[a] critical footnote	N5242-00044 (LED) N5245-00027 (Tube) Was N5242-00034	1	LCD display rear plate
㉒	N5242-60043	1	LCD display cable
㉓[a] critical footnote	N5242-20168 (LED)	2	LCD display side bracket
㉔[a] critical footnote	8121-2132 (LED) 8121-1451 (Tube)	1	Cable assembly for LCD backlight

a. In March 2013, Keysight discontinued using a display with florescent tube backlighting, and began using a display with LED backlighting. Associated parts are indicated in this table with either “Tube” or “LED.” If you replace an old part number <designated “Tube”> with its new part number <designated “LED”>, you must also replace ALL of the other old part numbers <designated “Tube”> in the table with their new part numbers <designated “LED”>.

Figure 6-3. Front Panel Assembly, Back Side, All Options

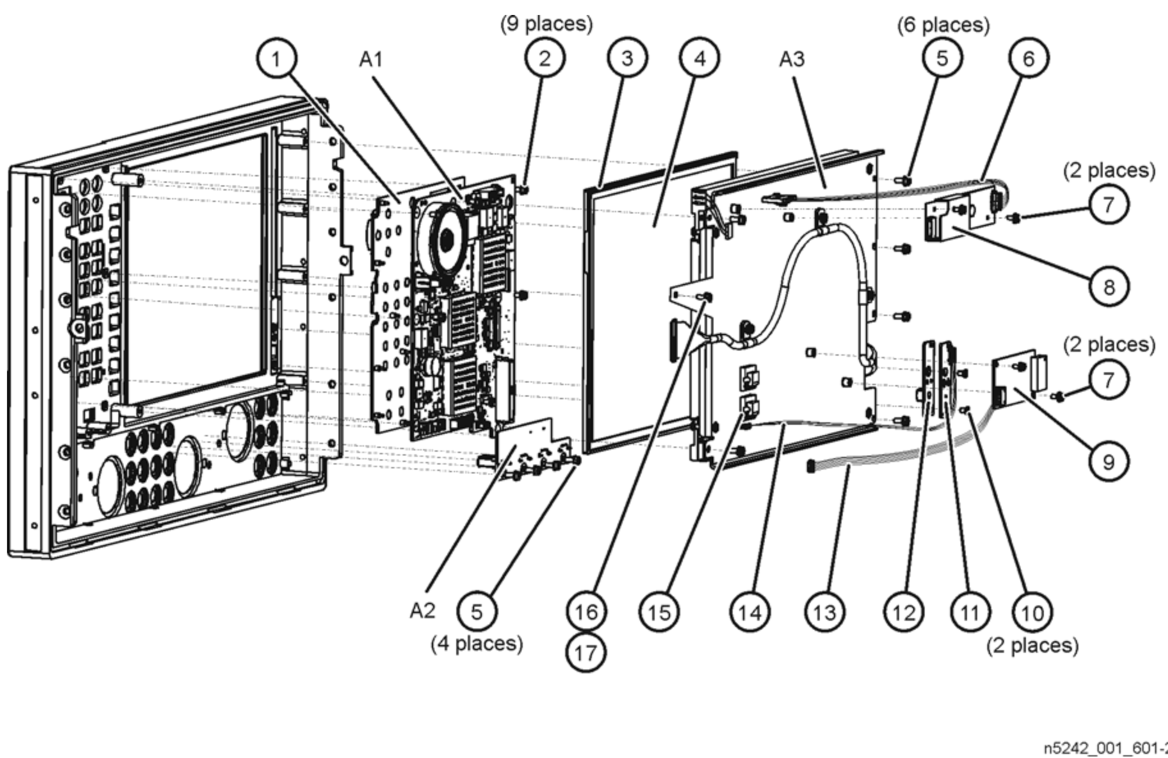


Figure 6-4 A3 Display Assembly with Old LCD Display 2090-0883

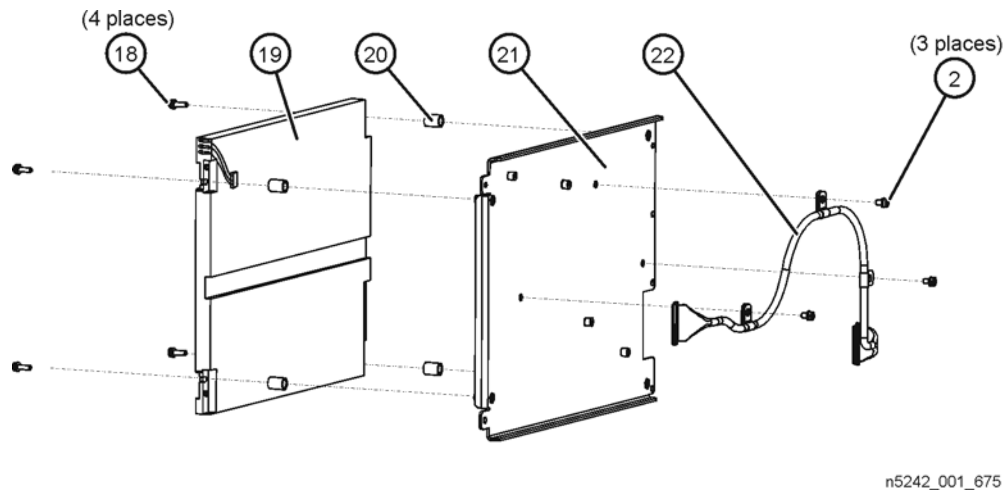
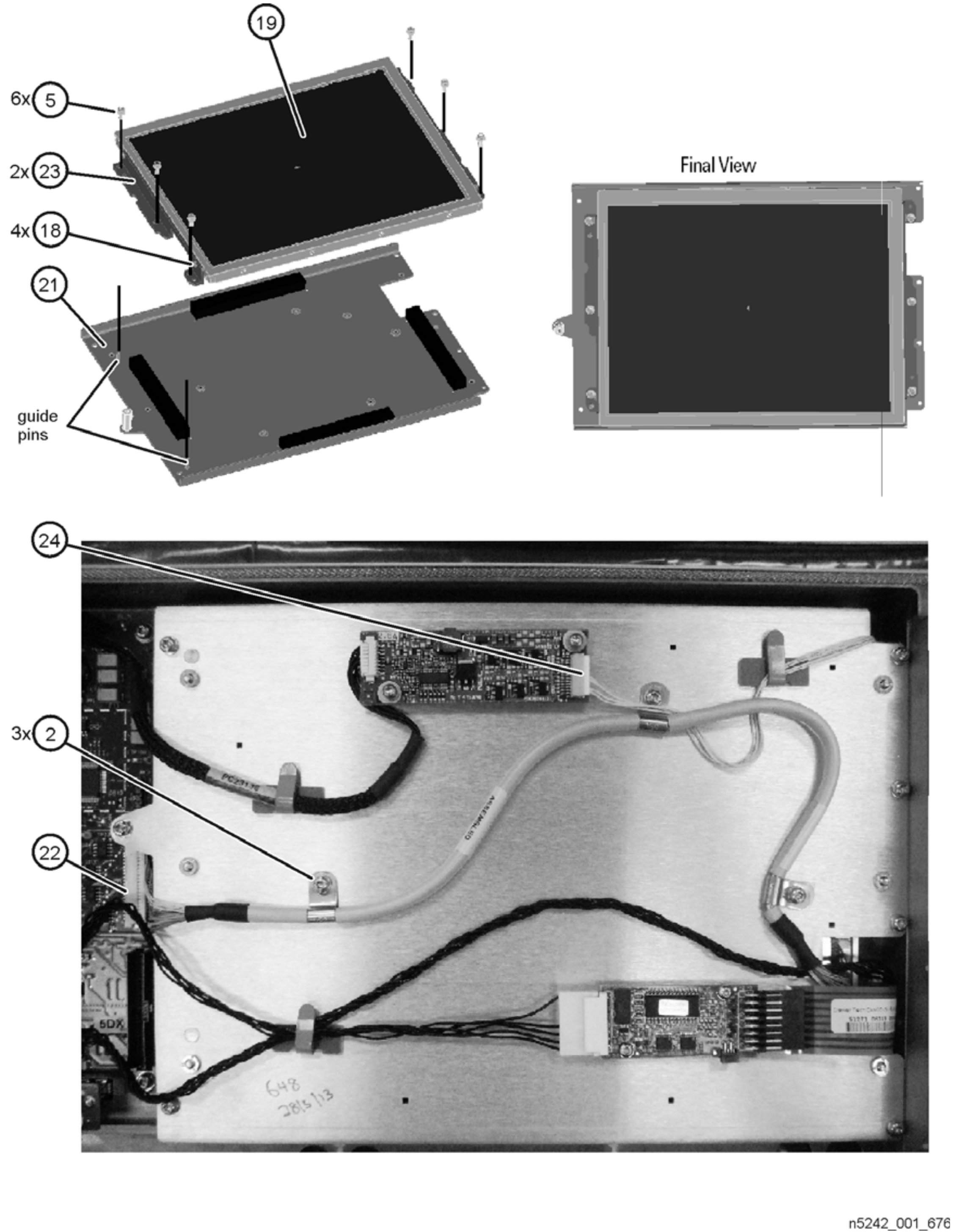


Figure 6-5 A3 Display Assembly with New LCD Display 2090-1036

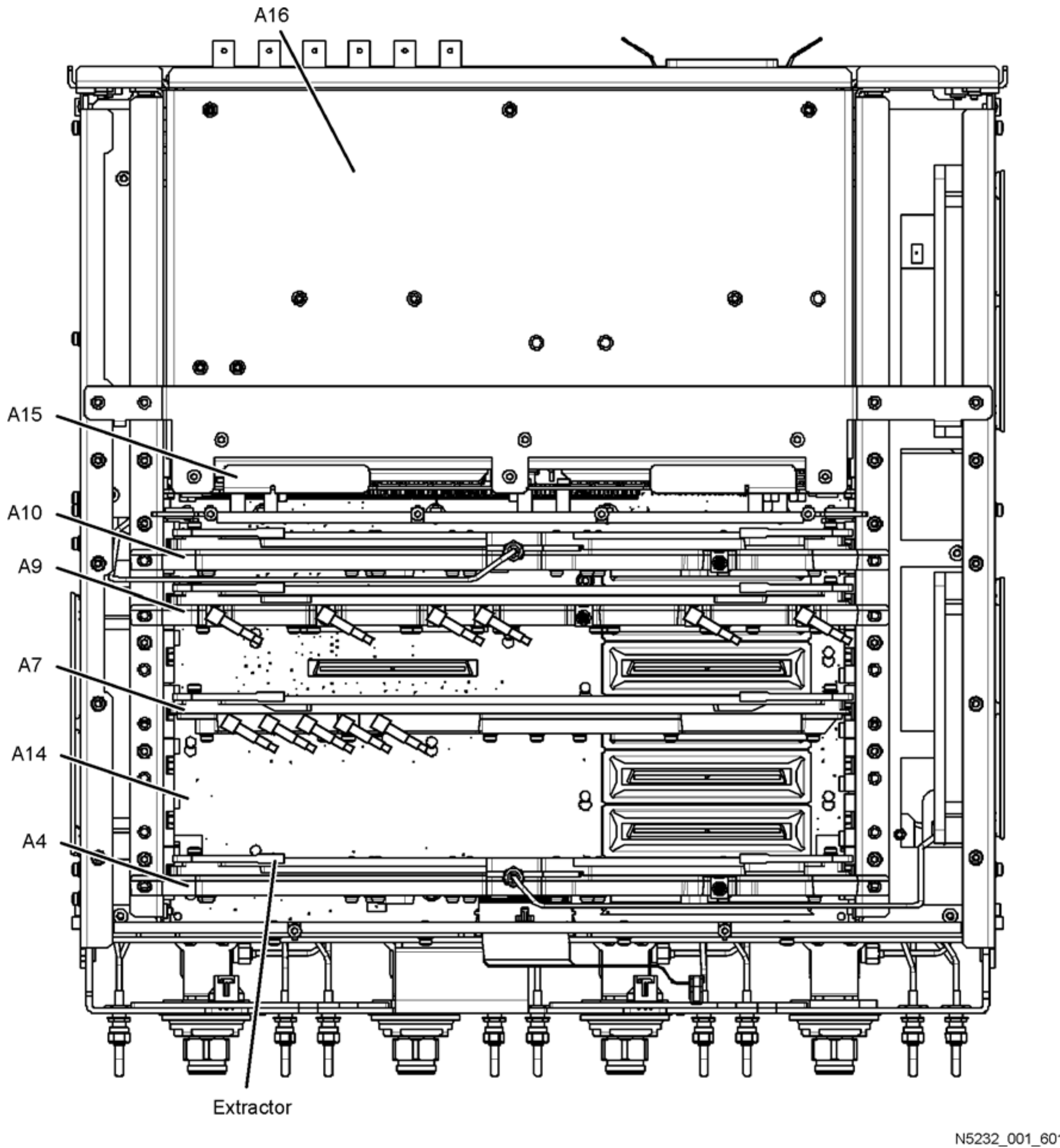


Top Assemblies, All Models

IMPORTANT When replacing an old assembly, install an assembly with either the same part number or the new part number.

Reference Designator	Part Number	Qty	Description
A4	N5240-60074 Was N5242-60150	1	13.5 GHz source synthesizer board
A7	N5240-60069	1	Frequency reference board
A9	N5240-60077 Was N5240-60056	1	Signal processing ADC module (SPAM) board
A10	N5240-60074 Was N5242-60150	1	13.5 GHz LO synthesizer board
A14	N5230-60133	1	System motherboard
A15	W1312-60095	1	Midplane board
A16	0950-4934	1	Power supply assembly

Figure 6-6 Top Assemblies, All Models

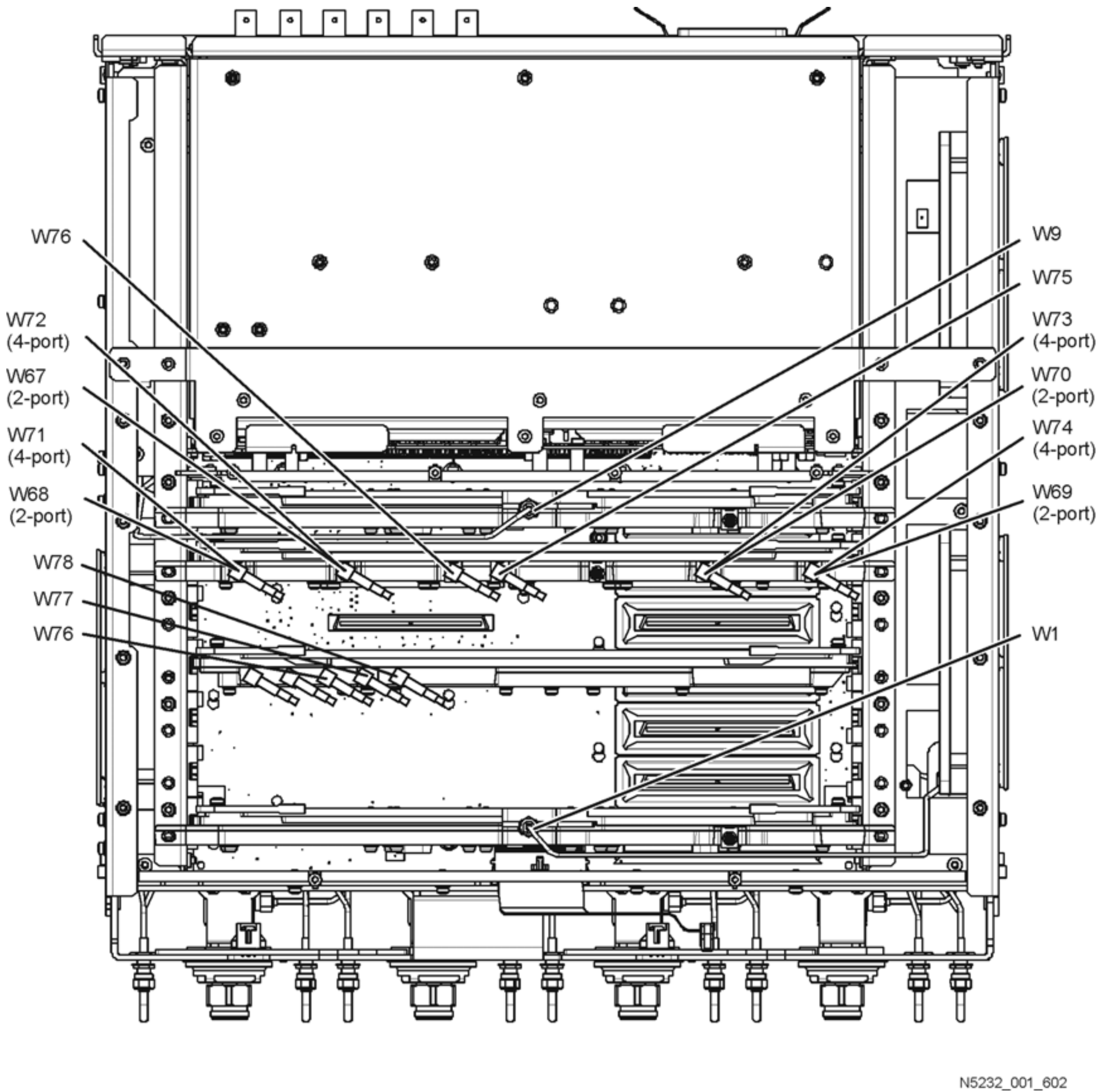


Top Cables, All Models

Reference Designator	Type[a]	Part Number	Qty	Description
W1	SR	N5235-20040	1	A4 13.5 GHz Source Synthesizer board to test set deck cable bracket
W9	SR	N5235-20041	1	A10 13.5 GHz LO Synthesizer board to test set deck cable bracket
W67	F	N5235-60012	1	A24 mixer brick R1 to A9 SPAM board J2 (For Option 200 and 216 analyzers.)
W68	F	N5235-60011	1	A24 mixer brick A to A9 SPAM board J1 (W67 reference designator is for Option 200 and 216 analyzers.)
W69	F	N5235-60013	1	A24 mixer brick R2 to A9 SPAM board J6 (For Option 200 and 216 analyzers.)
W70	F	N5235-60014	1	A24 mixer brick B to A9 SPAM board J5 (For Option 200 and 216 analyzers.)
W71	F	N5235-60011	1	A24 mixer brick A to A9 SPAM board J1 (W71 reference designator is for Option 400 and 416 analyzers.)
W72	F	N5235-60015	1	A24 mixer brick B to A9 SPAM board J2 (For Option 400 and 416 analyzers.)
W73	F	N5235-60016	1	A24 mixer brick C to A9 SPAM board J5 (For Option 400 and 416 analyzers.)
W74	F	N5235-60017	1	A24 mixer brick D to A9 SPAM board J6 (For Option 400 and 416 analyzers.)
W75	F	N5235-60018	1	A24 mixer brick R to A9 SPAM board J4 (For Option 400 and 416 analyzers.)
W76	F	N5242-60027	1	A7 frequency reference board J4 to A9 SPAM board J3
W77	F	N5242-60028	1	A7 frequency reference board J5 to A10 13.5 GHz LO Synthesizer board J5
W78	F	N5242-60029	1	A7 frequency reference board J6 to A4 13.5 GHz Source Synthesizer board J5

a. SR = semirigid coaxial cable; F = flexible coaxial cable.

Figure 6-7 Top Cables, All Models

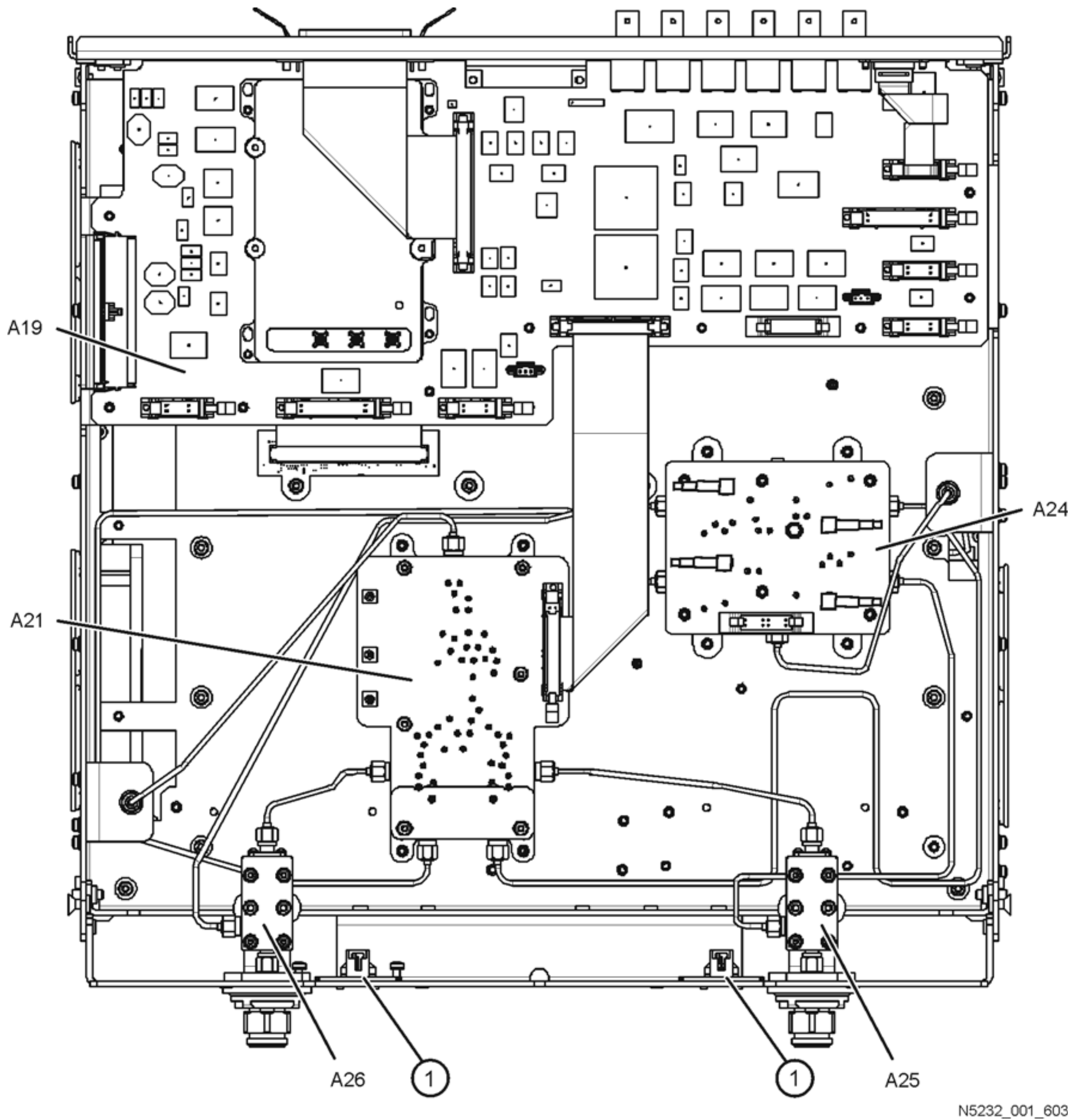


Bottom Assemblies, N523xA, Option 200

Reference Designator	Part Number	Qty	Description
A19	N5230-60134	1	Test set motherboard
A21	5087-7341	1	MASSY (Multiplier/amplifier/switch/splitter assembly)
A24 critical footnote	5087-7831[a] Was 5087-7761	1	Mixer brick (QuintBrick) - contains only four receivers Mixer brick (QuintBrick)
A25 A26	5087-7752	2	Test port 1 bridge coupler Test port 2 bridge coupler
①	N5240-60058	2	Front-panel LED board

a. The 2-port PNA A24 mixer brick (5087-7831) contains only four receivers. The 4-port PNA A24 mixer brick (5087-7823) contains five receivers. These items are NOT interchangeable.

Figure 6-8 Bottom Assemblies, N523xA, Option 200

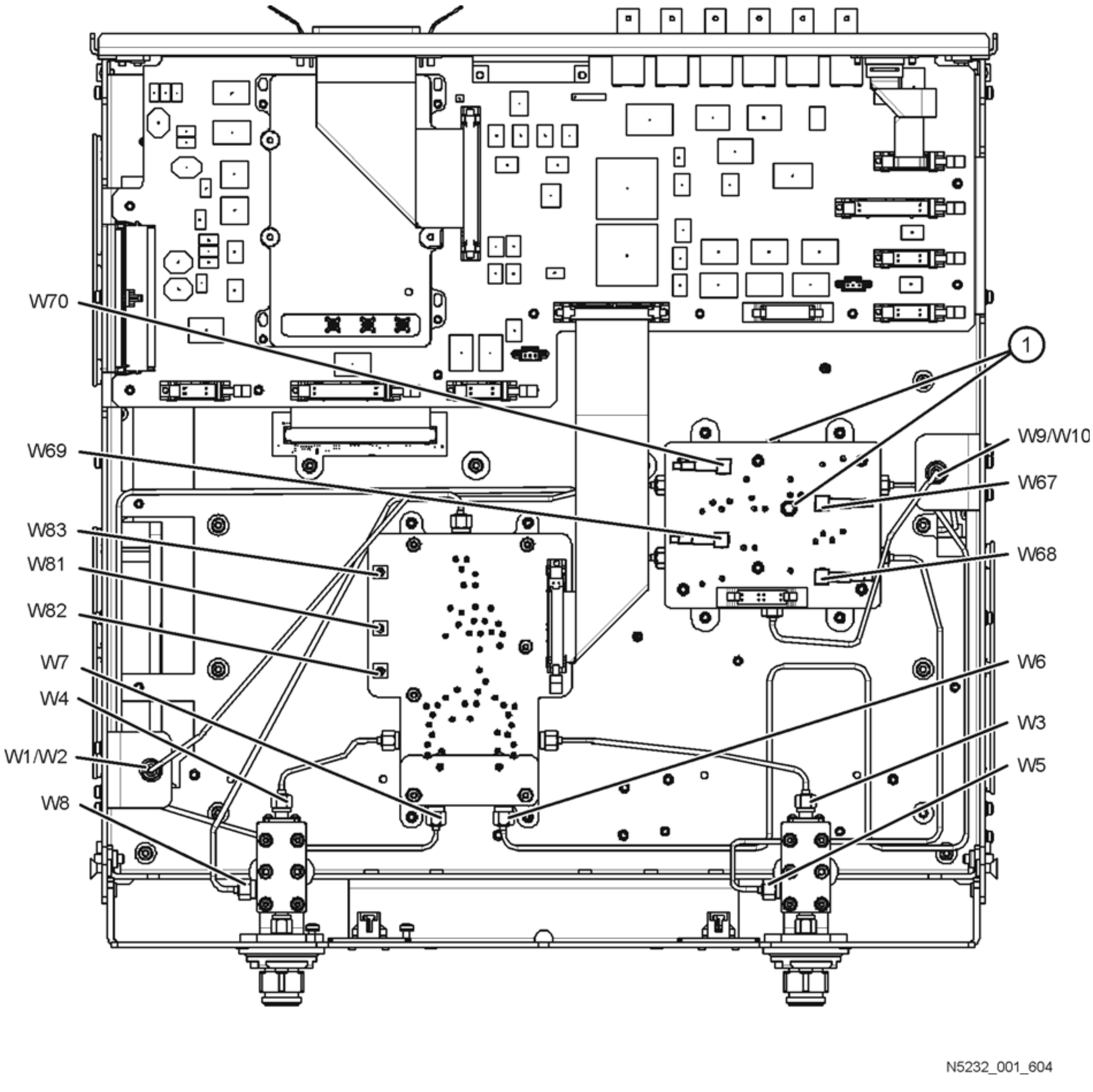


Bottom Cables, N523xA, Option 200

Reference Designator	Type[a]	Part Number	Qty	Description
W1	SR	Refer to "Top Cables, All Models" on page 6-18.		
W2	SR	N5232-20082	1	A21 MASSY to test set deck cable bracket
W3	SR	N5232-20013	1	A21 MASSY to A25 test port 1 bridge coupler (thru)
W4	SR	N5232-20011	1	A21 MASSY to A26 test port 2 bridge coupler (thru)
W5	SR	N5232-20016	1	A25 test port 1 bridge coupler (arm) to A24 mixer brick
W6	SR	N5232-20014	1	A21 MASSY to A24 mixer brick
W7	SR	N5232-20012	1	A21 MASSY to A24 mixer brick
W8	SR	N5232-20015	1	A26 test port 2 bridge coupler (arm) to A24 mixer brick
W9	SR	Refer to "Top Cables, All Models" on page 6-18.		
W10	SR	N5232-20081	1	A24 mixer brick to test set deck cable bracket
W67 - W70	SR	Refer to "Top Cables, All Models" on page 6-18.		
W81	F	N5235-60025	1	A19 test set motherboard J4 to A21 MASSY J4
W82	F	N5235-60026	1	A19 test set motherboard J5 to A21 MASSY J5
W83	F	N5235-60024	1	A19 test set motherboard J3 to A21 MASSY J3
①	--	1810-0118	2	Load, 50 ohm, SMA (installed on QuintBrick)

a. SR = semirigid coaxial cable; F = flexible coaxial cable.

Figure 6-9 Bottom Cables, N523xA, Option 200

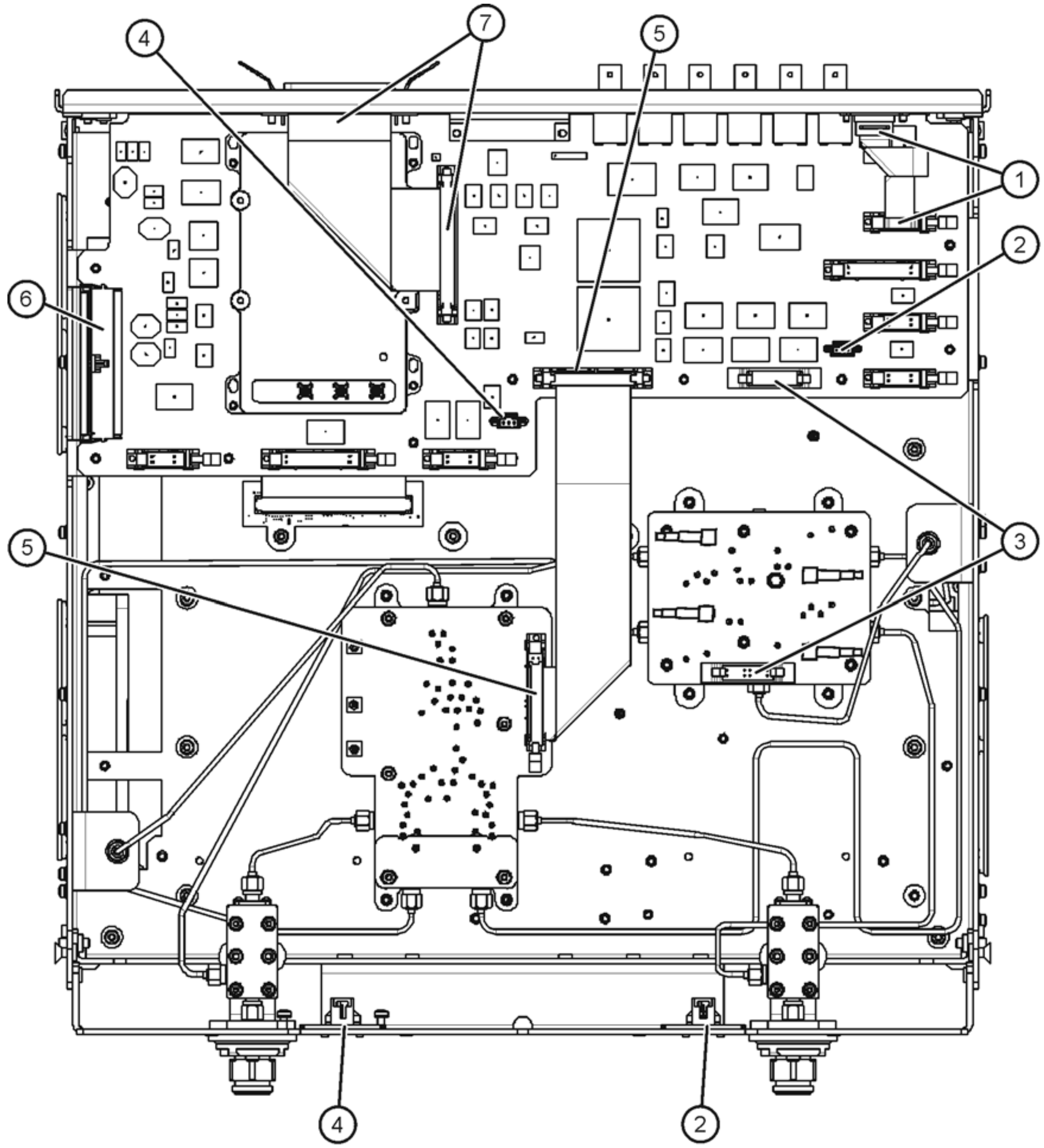


Bottom Ribbon Cables, N523xA, Option 200

Reference Designator	Type[a]	Part Number	Description
①	10R	N5242-60005	Rear-panel **PWR I/O** to A19 test set motherboard J301
②	2W	N5242-60009	A19 test set motherboard J12 to port 1 LED board J1
③	16R	N5242-60006	A19 test set motherboard J212 to A24 mixer brick J1
④	2W	N5242-60009	A19 test set motherboard J14 to port 2 LED board J1
⑤	26R	N5230-60012	A21 MASSY J1 to A19 test set motherboard J10
⑥	100R	N5235-60010	A14 system motherboard J1 to A19 test set motherboard J1
⑦	36R	8121-0834	Rear-panel **HANDLER I/O** to A19 test set motherboard J400

a. nR = n wires in a ribbon (flat) cable; nW = n wires in a wire harness.

Figure 6-10 Bottom Ribbon Cables, N523xA, Option 200

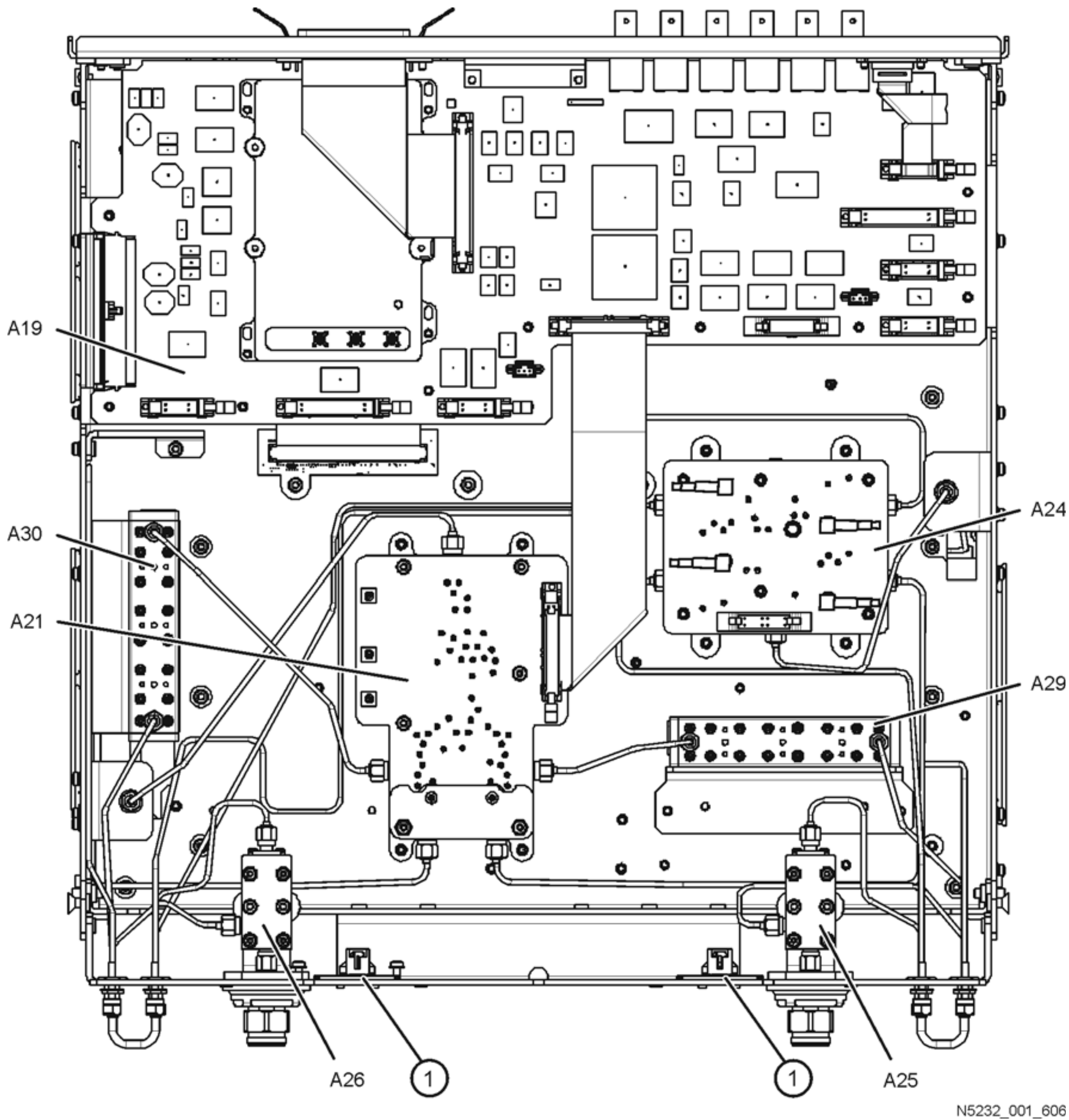


Bottom Assemblies, N523xA, Option 216

Reference Designator	Part Number	Qty	Description
A19	N5230-60134	1	Test set motherboard
A21	5087-7341	1	MASSY (Multiplier/amplifier/switch/splitter assembly)
A24 critical footnote	5087-7831[a] Was 5087-7761	1	Mixer brick (QuintBrick) - contains only four receivers Mixer brick (QuintBrick)
A25 A26	5087-7752	2	Test port 1 bridge coupler Test port 2 bridge coupler
A29 A30	33321-60082	2	Test port 1 source 60 dB step attenuator Test port 2 source 60 dB step attenuator
①	N5240-60058	2	Front-panel LED board

a. The 2-port PNA A24 mixer brick (5087-7831) contains only four receivers. The 4-port PNA A24 mixer brick (5087-7823) contains five receivers. These items are NOT interchangeable.

Figure 6-11 Bottom Assemblies, N523xA, Option 216

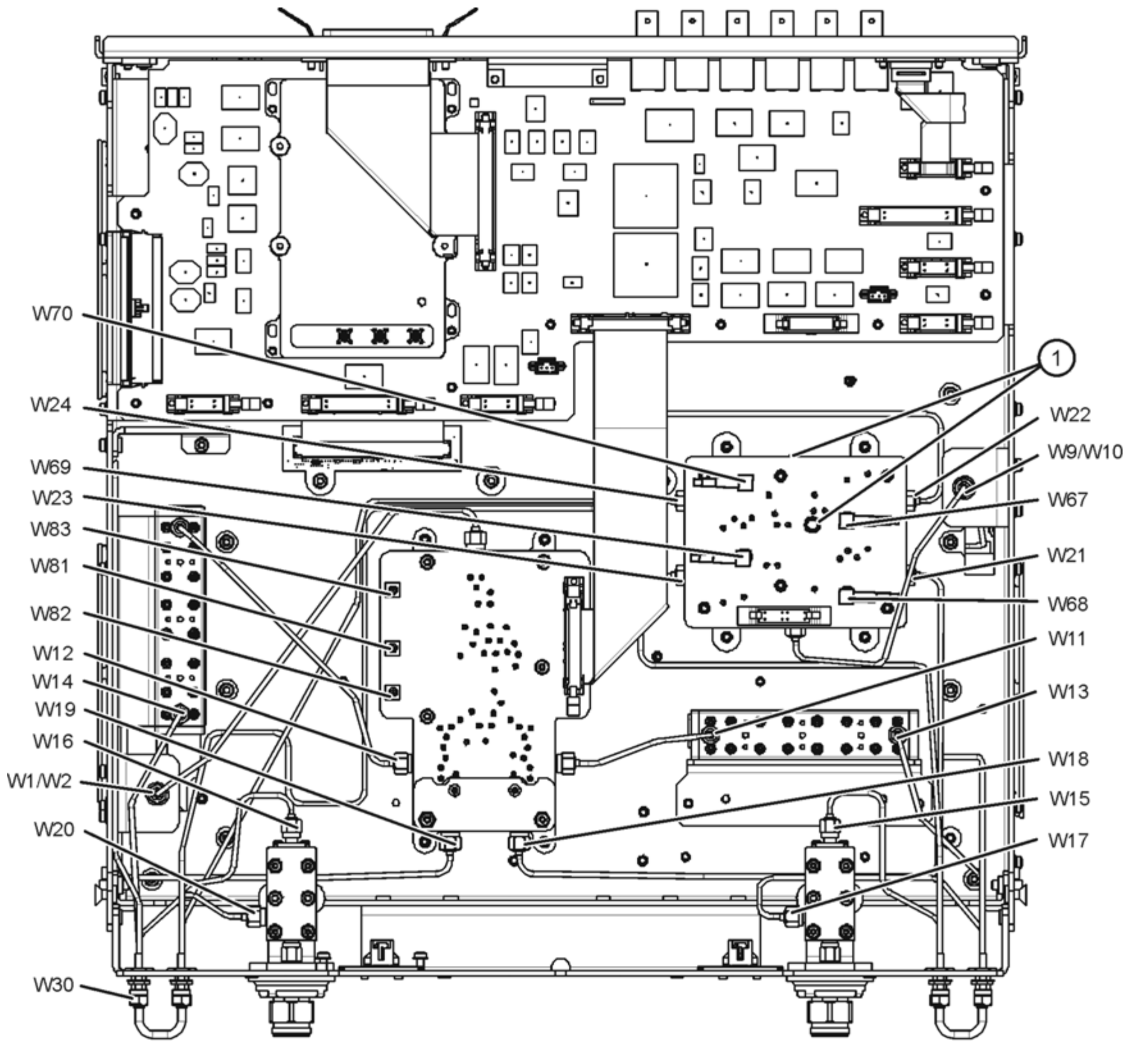


Bottom Cables, N523xA, Option 216

Reference Designator	Type[a]	Part Number	Qty	Description
W1	SR	Refer to "Top Cables, All Models" on page 6-18.		
W2	SR	N5232-20082	1	A21 MASSY to test set deck cable bracket
W9	SR	Refer to "Top Cables, All Models" on page 6-18.		
W10	SR	N5232-20081	1	A24 mixer brick to test set deck cable bracket
W11	SR	N5232-20026	1	A21 MASSY to A29 60 dB step attenuator
W12	SR	N5232-20019	1	A21 MASSY to A30 test port 2 source attenuator
W13	SR	N5232-20027	1	A29 60 dB step attenuator to PORT 1 SOURCE OUT
W14	SR	N5232-20020	1	A30 test port 2 source attenuator to PORT 2 SOURCE OUT
W15	SR	N5232-20028	1	A25 test port 1 bridge coupler (thru) to PORT 1 CPLR THRU
W16	SR	N5232-20021	1	A26 test port 2 bridge coupler (thru) to PORT 2 CPLR THRU
W17	SR	N5232-20029	1	A25 test port 1 bridge coupler (arm) to PORT 1 CPLR ARM
W18	SR	N5232-20032	1	A21 MASSY to REF 1 SOURCE OUT
W19	SR	N5232-20025	1	A21 MASSY to REF 2 SOURCE OUT
W20	SR	N5232-20022	1	A26 test port 2 bridge coupler (arm) to PORT 2 CPLR ARM
W21	SR	N5232-20030	1	A24 mixer brick to PORT 1 RCVR A IN
W22	SR	N5232-20031	1	A24 mixer brick to REF 1 RCVR R1 IN
W23	SR	N5232-20024	1	A24 mixer brick to REF 2 RCVR R2 IN
W24	SR	N5232-20023	1	A24 mixer brick to PORT 2 RCVR B IN
W30	SR	N5222-20091	6	Front panel jumper
W67 - W70	SR	Refer to "Top Cables, All Models" on page 6-18.		
W81	F	N5235-60025	1	A19 test set motherboard J4 to A21 MASSY J4
W82	F	N5235-60026	1	A19 test set motherboard J5 to A21 MASSY J5
W83	F	N5235-60024	1	A19 test set motherboard J3 to A21 MASSY J3
①	--	1810-0118	2	Load, 50 ohm, SMA (installed on QuintBrick)

a. SR = semirigid coaxial cable; F = flexible coaxial cable.

Figure 6-12 Bottom Cables, N523xA, Option 216

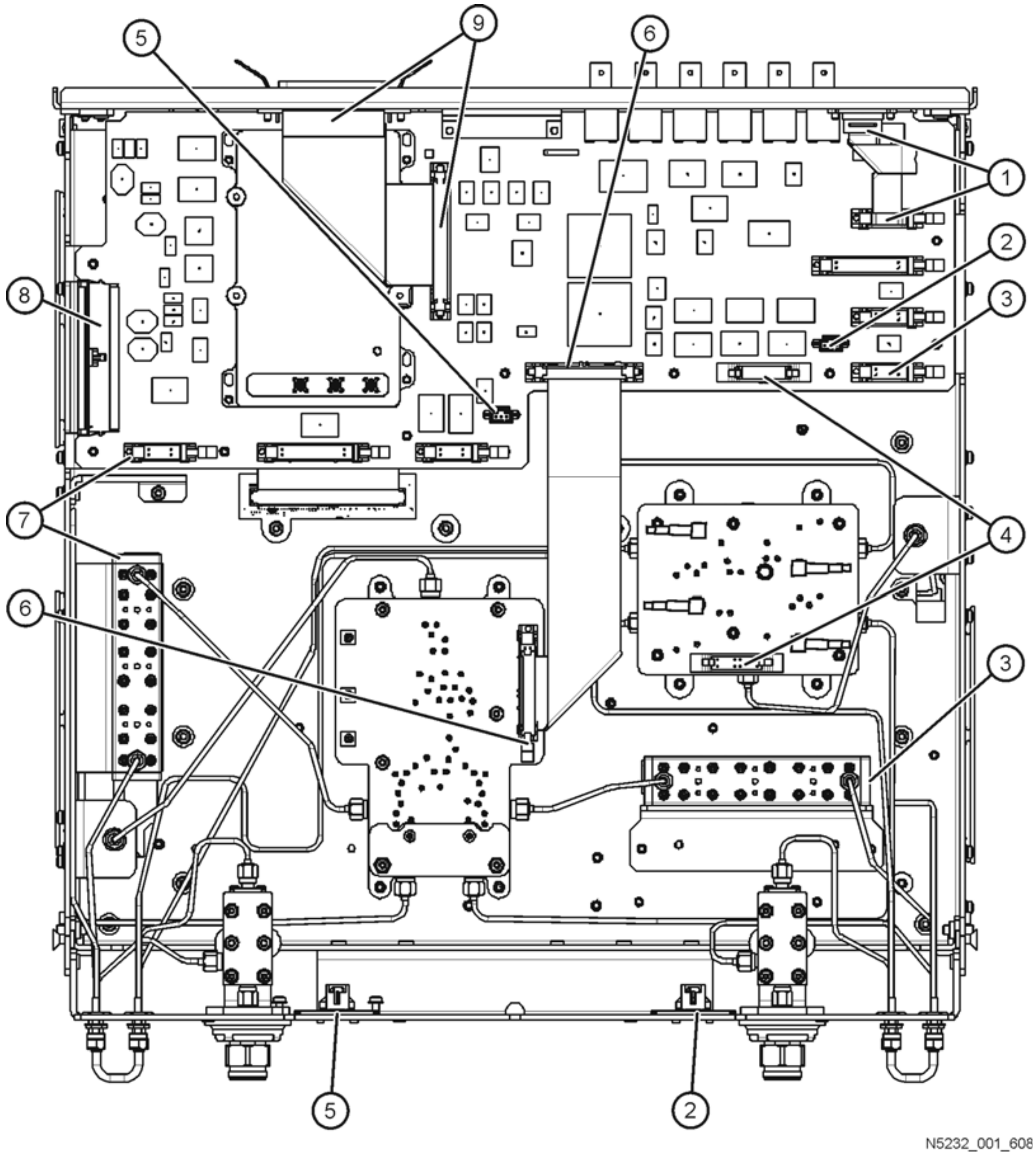


Bottom Ribbon Cables, N523xA, Option 216

Reference Designator	Type[a]	Part Number	Description
①	10R	N5242-60005	Rear-panel **PWR I/O** to A19 test set motherboard J301
②	2W	N5242-60009	A19 test set motherboard J12 to port 1 LED board J1
③	10R	8121-0982 Was N5242-60007	A19 test set motherboard J8 to A29 60 dB step attenuator
④	16R	N5242-60006	A19 test set motherboard J212 to A24 mixer brick J1
⑤	2W	N5242-60009	A19 test set motherboard J14 to port 2 LED board J1
⑥	26R	N5230-60012	A19 test set motherboard J10 to A21 MASSY J1
⑦	10R	8121-0982 Was N5242-60007	A19 test set motherboard J6 to A30 test port 2 source attenuator
⑧	100R	N5235-60010	A14 system motherboard J1 to A19 test set motherboard J1
⑨	36R	8121-0834	Rear-panel **HANDLER I/O** to A19 test set motherboard J400

a. nR = n wires in a ribbon (flat) cable; nW = n wires in a wire harness.

Figure 6-13 Bottom Ribbon Cables, N523xA, Option 216

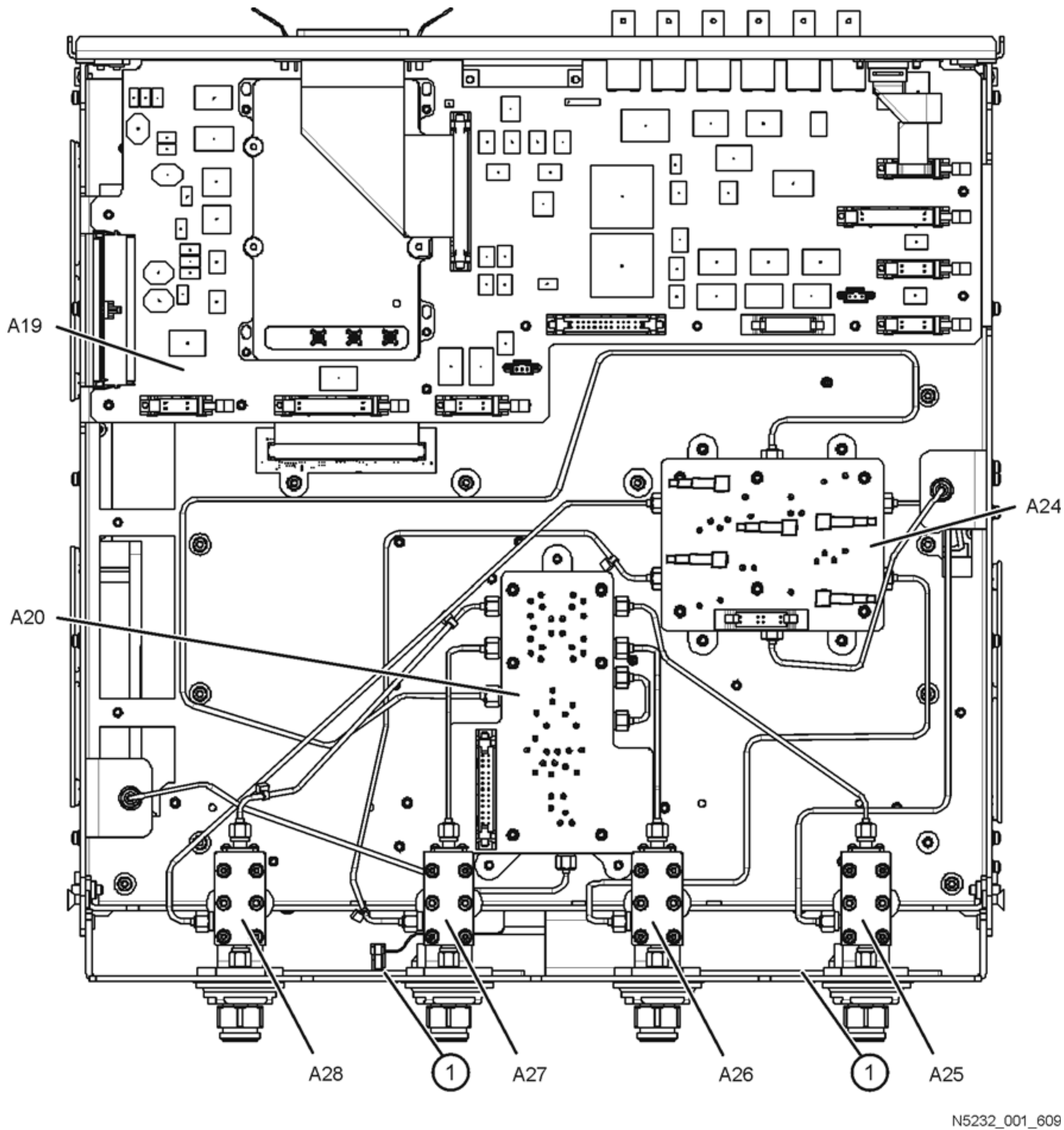


Bottom Assemblies, N5231A and N5232A, Option 400

Reference Designator	Part Number	Qty	Description
A19	N5230-60134	1	Test set motherboard
A20	5087-7762	1	MASSQuad (Multiplier/amplifier/switch/splitter assembly)
A24 critical footnote	5087-7823[a] Was 5087-7761	1	Mixer brick (QuintBrick)
A25 A26 A27 A28	5087-7752	4	Test port 1 bridge coupler Test port 2 bridge coupler Test port 3 bridge coupler Test port 4 bridge coupler
①	N5230-60137	2	Front-panel LED board

a. The 2-port PNA A24 mixer brick (5087-7831) contains only four receivers. The 4-port PNA A24 mixer brick (5087-7823) contains five receivers. These items are NOT interchangeable.

Figure 6-14 Bottom Assemblies, N5231A and N5232A, Option 400

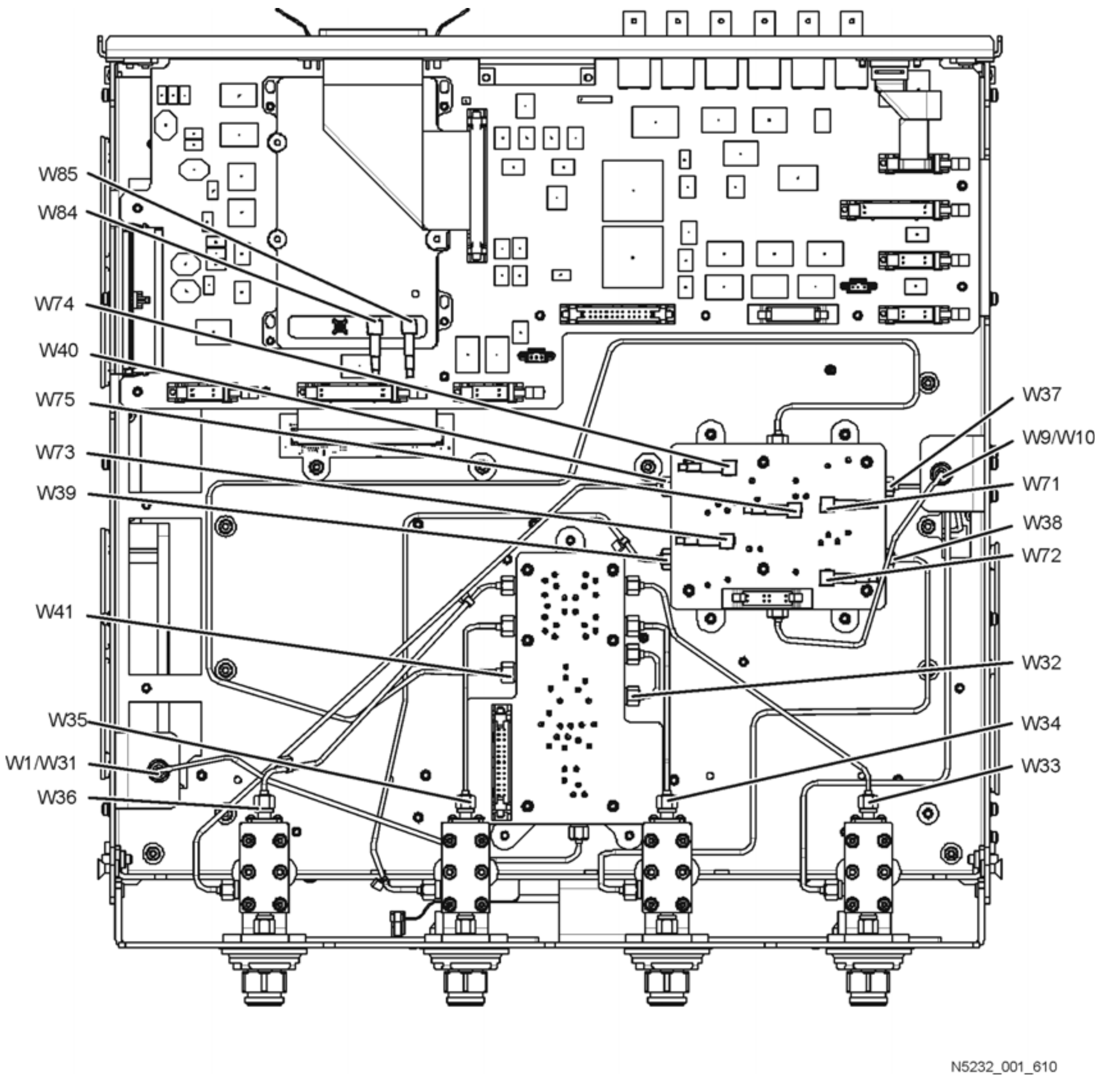


Bottom Cables, N5231A and N5232A, Option 400

Reference Designator	Type[a]	Part Number	Qty	Description
W1	SR	Refer to “Top Cables, All Models” on page 6-18.		
W9	SR	Refer to “Top Cables, All Models” on page 6-18.		
W10	SR	N5232-20081	1	A24 mixer brick LO In to test set deck cable bracket
W31	SR	N5232-20049	1	A20 MASSQuad to test set deck cable bracket
W32	SR	N5232-20064	1	A20 MASSQuad jumper cable
W33	SR	N5232-20046	1	A20 MASSQuad A to A25 test port 1 bridge coupler (thru)
W34	SR	N5232-20044	1	A20 MASSQuad B to A26 test port 2 bridge coupler (thru)
W35	SR	N5232-20042	1	A20 MASSQuad C to A27 test port 3 bridge coupler (thru)
W36	SR	N5232-20040	1	A20 MASSQuad D to A28 test port 4 bridge coupler (thru)
W37	SR	N5232-20045	1	A25 test port 1 bridge coupler (arm) to A24 mixer brick
W38	SR	N5232-20043	1	A26 test port 2 bridge coupler (arm) to A24 mixer brick
W39	SR	N5232-20041	1	A27 test port 3 bridge coupler (arm) to A24 mixer brick
W40	SR	N5232-20039	1	A28 test port 4 bridge coupler (arm) to A24 mixer brick
W41	SR	N5232-20047	1	A20 MASSQuad to mixer brick
W71-75	SR	Refer to “Top Cables, All Models” on page 6-18.		
W84	F	N5235-60023	1	A19 test set motherboard J4 to A20 MASSQuad J26
W85	F	N5235-60022	1	A19 test set motherboard J3 to A20 MASSQuad J23

a. SR = semirigid coaxial cable; F = flexible coaxial cable.

Figure 6-15 Bottom Cables, N5231A and N5232A, Option 400

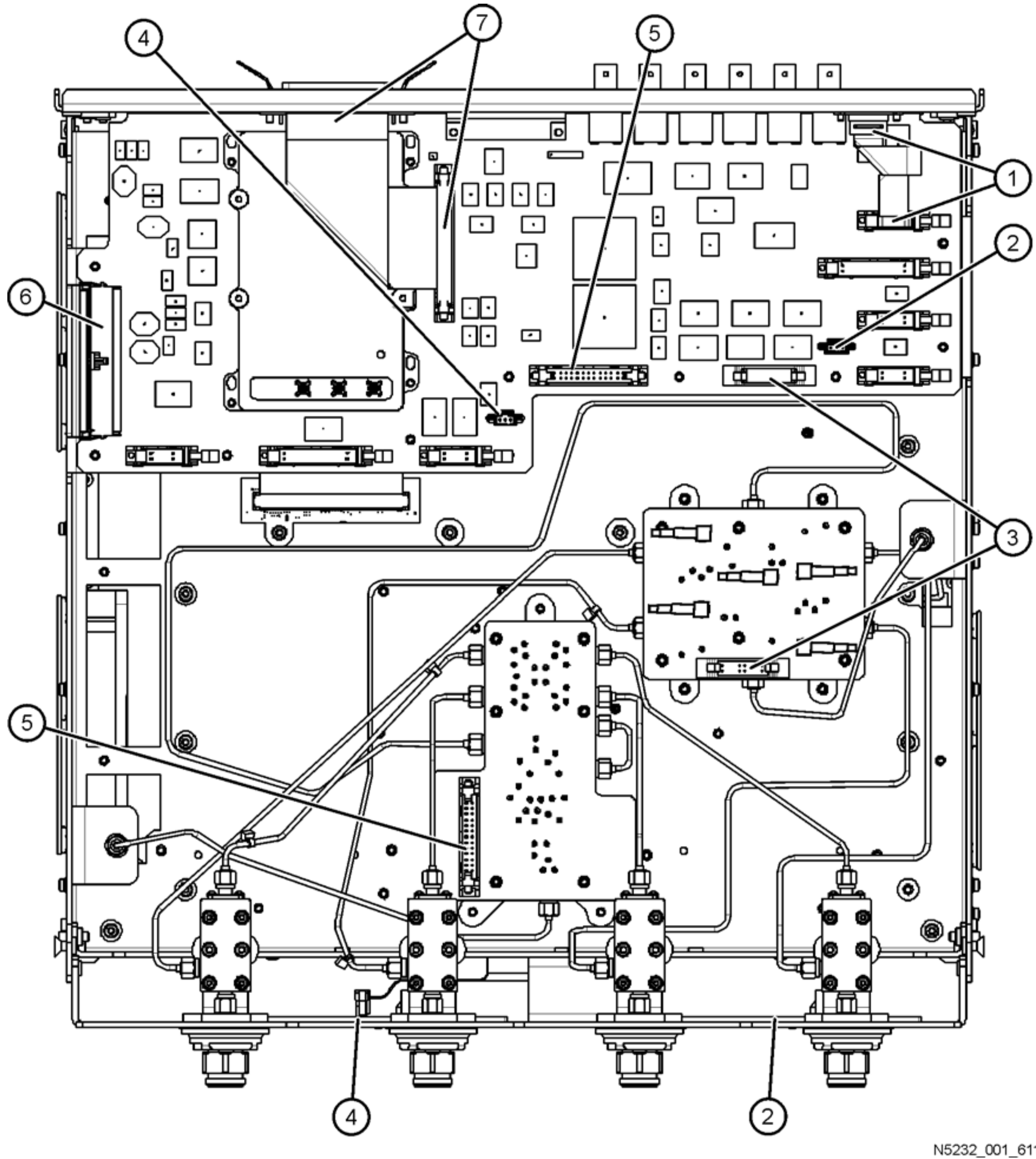


Bottom Ribbon Cables, N5231A and N5232A, Option 400

Reference Designator	Type[a]	Part Number	Description
①	10R	N5242-60005	Rear-panel **PWR I/O** to A19 test set motherboard J301
②	3W	N5225-60001	A19 test set motherboard J12 to ports 1/2 LED board J1
③	16R	N5242-60006	A19 test set motherboard J212 to A24 mixer brick J1
④	3W	N5225-60001	A19 test set motherboard J14 to ports 3/4 LED board J1
⑤	26R	N5230-60027	A19 test set motherboard J10 to A20 MASSQuad J4
⑥	100R	N5235-60010	A14 system motherboard J1 to A19 test set motherboard J1
⑦	36R	8121-0834	Rear-panel **HANDLER I/O** to A19 test set motherboard J400

a. nR = n wires in a ribbon (flat) cable; nW = n wires in a wire harness.

Figure 6-16 Bottom Ribbon Cables, N5231A and N5232A, Option 400

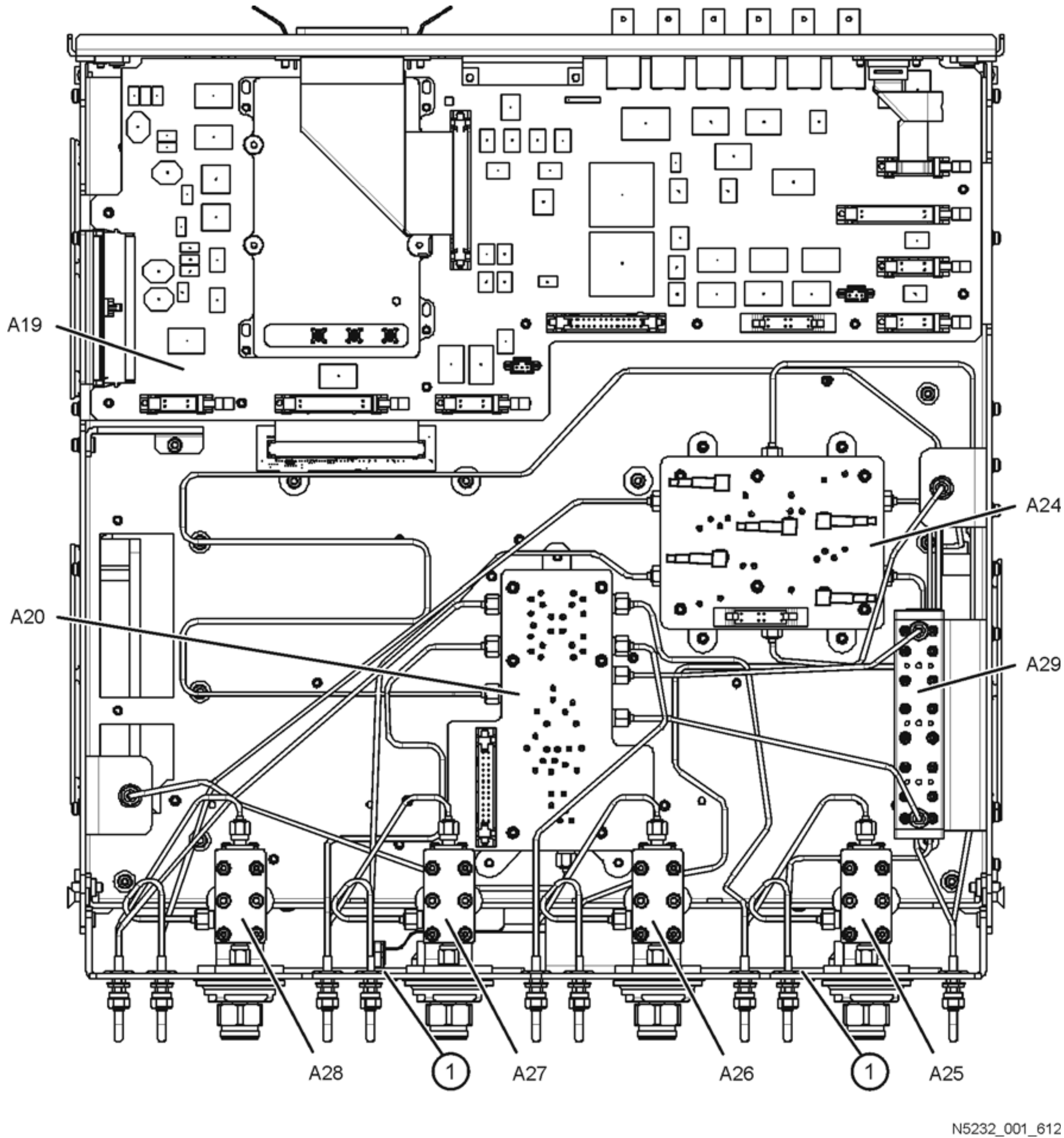


Bottom Assemblies, N5231A and N5232A, Option 416

Reference Designator	Part Number	Qty	Description
A19	N5230-60134	1	Test set motherboard
A20	5087-7762	1	MASSQuad (Multiplier/amplifier/switch/splitter assembly)
A24 critical footnote	5087-7823[a] Was 5087-7761	1	Mixer brick (QuintBrick)
A25 A26 A27 A28	5087-7752	4	Test port 1 bridge coupler Test port 2 bridge coupler Test port 3 bridge coupler Test port 4 bridge coupler
A29	33321-60082	1	Source 60 dB step attenuator
①	N5230-60137	2	Front-panel LED board

a. The 2-port PNA A24 mixer brick (5087-7831) contains only four receivers. The 4-port PNA A24 mixer brick (5087-7823) contains five receivers. These items are NOT interchangeable.

Figure 6-17 Bottom Assemblies, N5231A and N5232A, Option 416

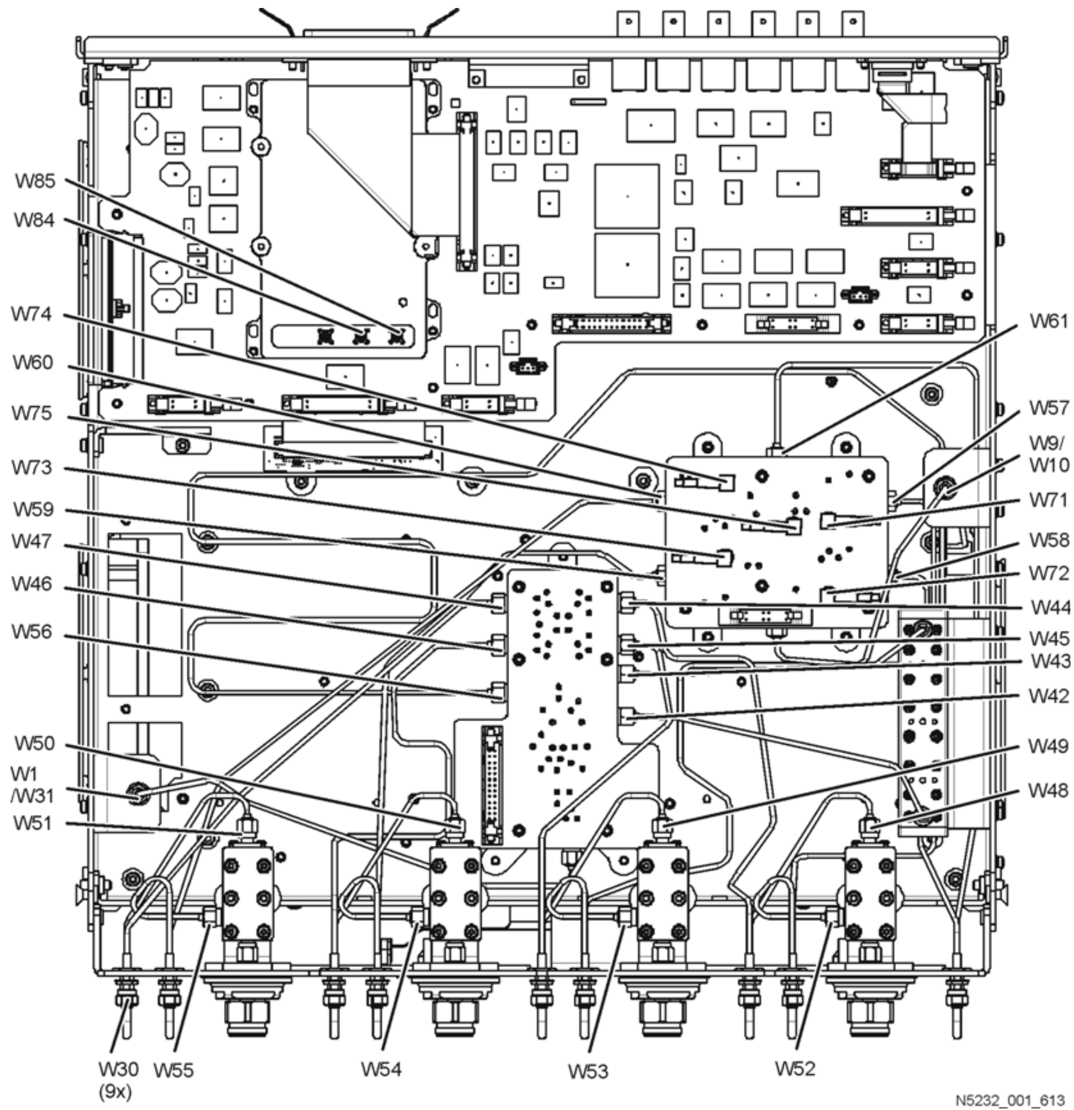


Bottom Cables, N5231A and N5232A, Option 416

Reference Designator	Type[a]	Part Number	Qty	Description
W1	SR	Refer to "Top Cables, All Models" on page 6-18.		
W9	SR	Refer to "Top Cables, All Models" on page 6-18.		
W10	SR	N5232-20081	1	A24 mixer brick LO In to test set deck cable bracket
W30	SR	N5222-20091	9	Front panel jumper
W31	SR	N5232-20049	1	A20 MASSQuad to test set deck cable bracket
W42	SR	N5232-20057	1	A20 MASSQuad (main out) to A29 60 dB step attenuator
W43	SR	N5232-20056	1	A20 MASSQuad (main switch input) to A29 60 dB step attenuator
W44	SR	N5232-20050	1	A20 MASSQuad (A) to PORT 1 SOURCE OUT
W45	SR	N5232-20058	1	A20 MASSQuad (B) to Port 2 SOURCE OUT
W46	SR	N5232-20060	1	A20 MASSQuad to Port 3 SOURCE OUT
W47	SR	N5232-20062	1	A20 MASSQuad (D) to Port 4 SOURCE OUT
W48	SR	N5232-20051	1	PORT 1 CPLR THRU to A25 test port 1 bridge coupler (thru)
W49	SR	N5232-20051	1	PORT 2 CPLR THRU to A26 test port 2 bridge coupler (thru)
W50	SR	N5232-20051	1	PORT 3 CPLR THRU to A27 test port 3 bridge coupler (thru)
W51	SR	N5232-20051	1	PORT 4 CPLR THRU to A28 test port 4 bridge coupler (thru)
W52	SR	N5232-20052	1	A25 test port 1 bridge coupler (arm) to PORT 1 CPLR ARM
W53	SR	N5232-20052	1	A26 test port 2 bridge coupler (arm) to PORT 2 CPLR ARM
W54	SR	N5232-20052	1	A27 test port 3 bridge coupler (arm) to PORT 3 CPLR ARM
W55	SR	N5232-20052	1	A28 test port 4 bridge coupler (arm) to PORT 4 CPLR ARM
W56	SR	N5232-20054	1	A20 MASSQuad (Ref) to Reference SOURCE OUT
W57	SR	N5232-20053	1	Port 1 RCVR A IN to A24 mixer brick
W58	SR	N5232-20059	1	Port 2 RCVR B IN to A24 mixer brick
W59	SR	N5232-20061	1	Port 3 RCVR C IN to A24 mixer brick
W60	SR	N5232-20063	1	Port 4 RCVR D IN to A24 mixer brick
W61	SR	N5232-20055	1	Reference RCVR R1 IN to A24 mixer brick
W71-75	SR	Refer to "Top Cables, All Models" on page 6-18.		
W84	F	N5235-60023	1	A19 test set motherboard J4 to A20 MASSQuad J26
W85	F	N5235-60022	1	A19 test set motherboard J3 to A20 MASSQuad J23

a. SR = semirigid coaxial cable; F = flexible coaxial cable.

Figure 6-18 Bottom Cables, N5231A and N5232A, Option 416

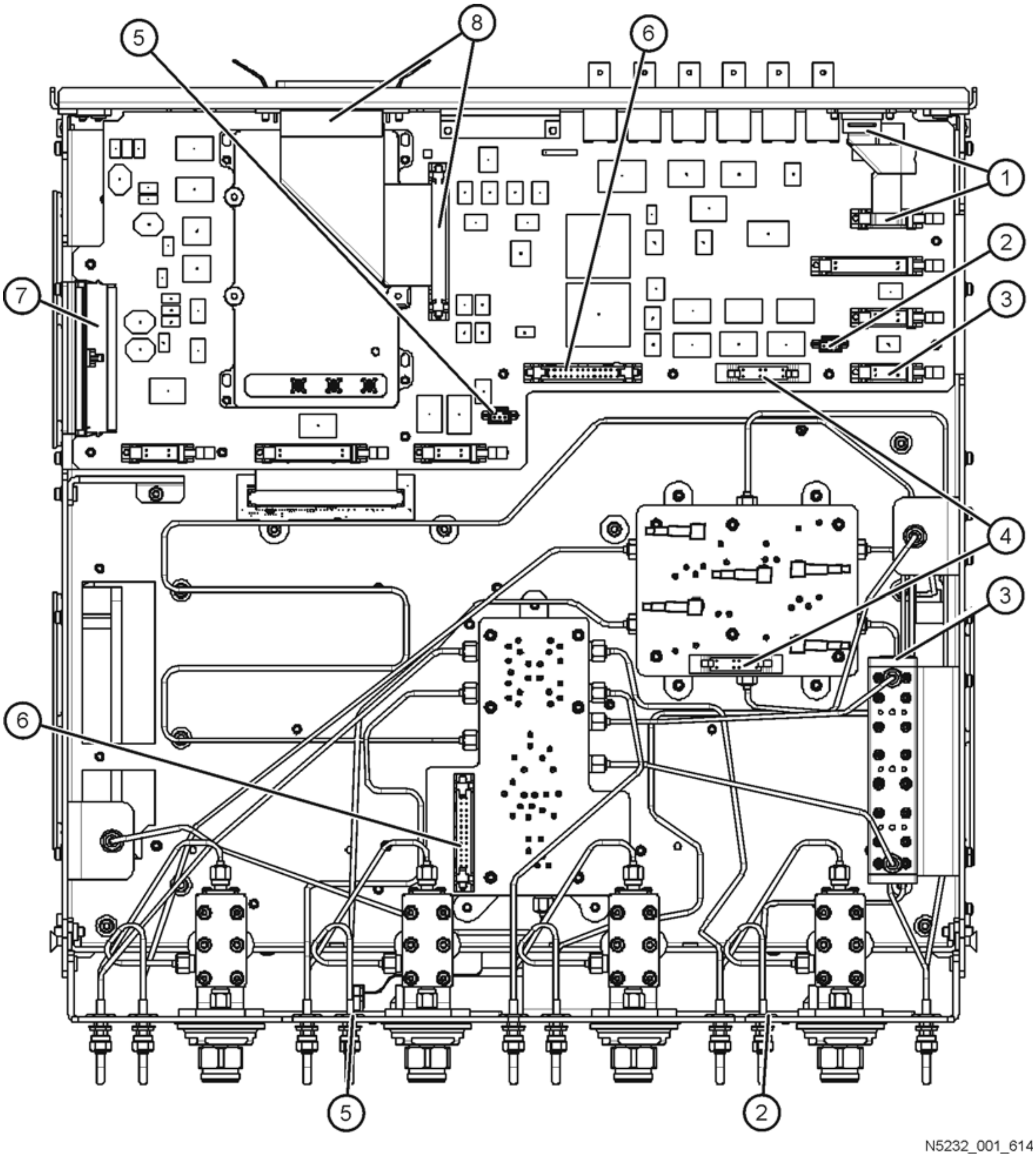


Bottom Ribbon Cables, N5231A and N5232A, Option 416

Reference Designator	Type[a]	Part Number	Description
①	10R	N5242-60005	Rear-panel **PWR I/O** to A19 test set motherboard J301
②	3W	N5225-60001	A19 test set motherboard J12 to ports 1/2 LED board J1
③	10R	8121-0982 Was N5242-60007	A19 test set motherboard J8 to A29 60 dB step attenuator
④	16R	N5242-60006	A19 test set motherboard J212 to A24 mixer brick J1
⑤	3W	N5225-60001	A19 test set motherboard J14 to ports 3/4 LED board J1
⑥	26R	N5230-60027	A19 test set motherboard J10 to A20 MASSQuad J4
⑦	100R	N5235-60010	A14 system motherboard J1 to A19 test set motherboard J1
⑧	36R	8121-0834	Rear-panel **HANDLER I/O** to A19 test set motherboard J400

a. nR = n wires in a ribbon (flat) cable; nW = n wires in a wire harness.

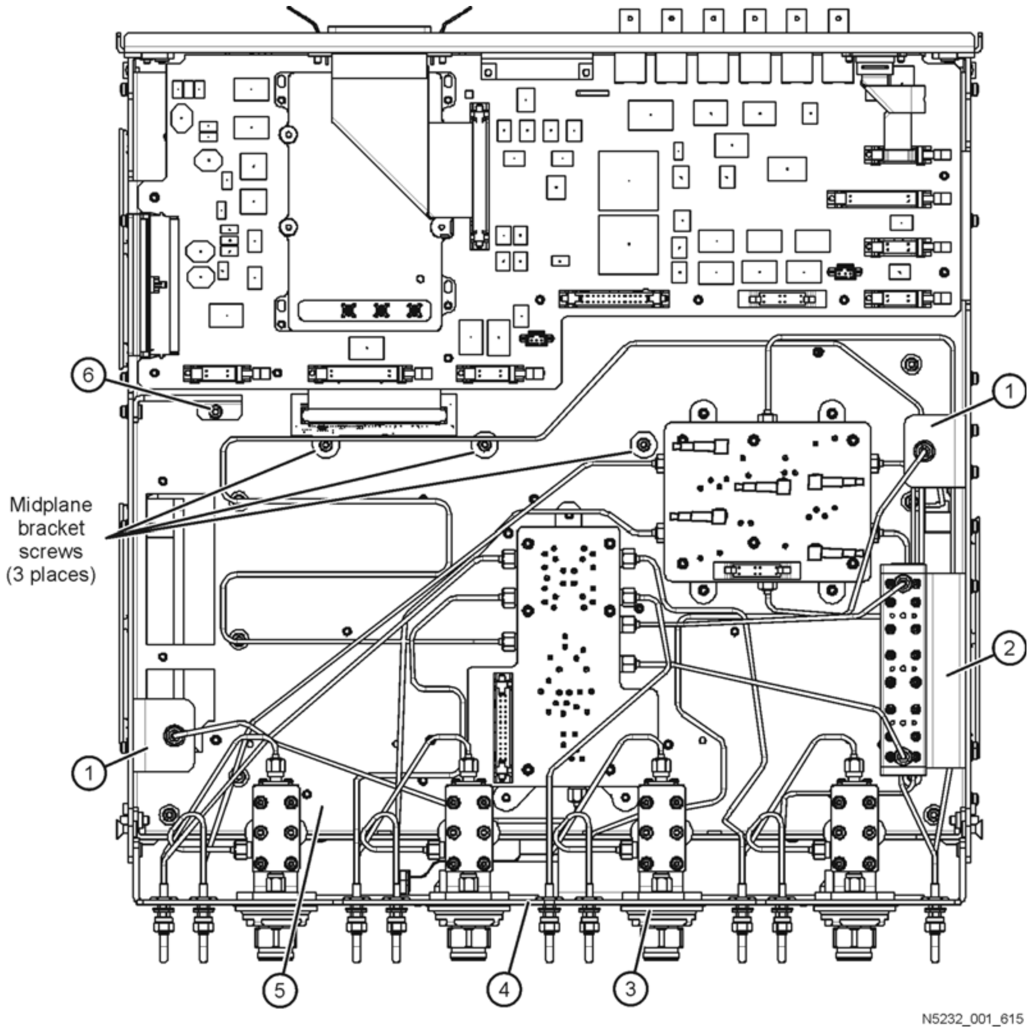
Figure 6-19 Bottom Cables, N5231A and N5232A, Option 416



Bottom Hardware and Miscellaneous Parts

Reference Designator	Part Number	Qty	Description
①	N5235-00014	2	Bracket, angle
②	N5235-00012	1	Bracket, A29 60 dB step attenuator (Option 216 and Option 416)
③	5022-1087	2	Test port coupler nut (2-port)
		4	Test port coupler nut (4-port)
④	N5232-00001	1	Test set deck front plate (2-port)
	N5232-00002	1	Test set deck front plate (4-port)
⑤	N5235-00002	1	Test set deck
⑥	N5235-00017	1	Test set support bracket
--	N5235-00013	1	Bracket, A30 source attenuator (Option 216)
--	0515-1227	--	Machine screw, M3.0 x 6 flat head (to attach front plate to deck)
--	0515-1521	--	Machine screw M3.0 x 5 flat head (to attach LED boards to front plate)
--	0515-0372	--	Machine screw M3.0 x 8 pan head (to attach: midplane bracket to chassis (see callout in Figure 6-20); angle bracket to deck side; TSMB to deck; attenuator bracket to deck; MassQuad to deck; front plate to deck)
--	0515-0374	--	Machine screw, M3.0 x 10, pan head (to attach test set support bracket from test set wall to test set base)
--	0515-0430	--	Machine screw M3.0 x 6 pan head (to attach: QuintBrick to deck)

Figure 6-20 Bottom Hardware and Miscellaneous Parts, All Options

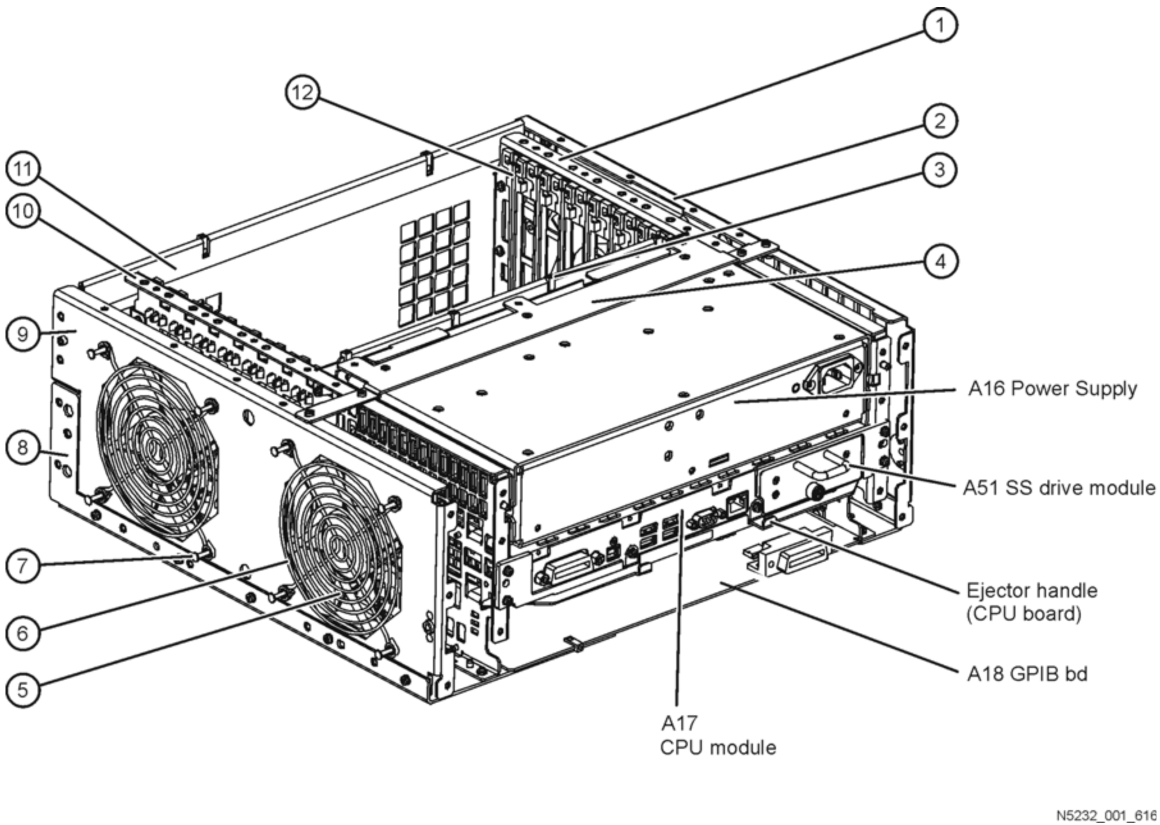


Internal Hardware and Miscellaneous Parts, All Models

Reference Designator	Part Number	Qty	Description
①	N5235-00005	1	Inner bracket, left side (holds seven card guides)
②	N5235-00006	1	Fan bracket (for one fan)
③	W1312-00048	1	Midplane bracket, (attached to left side and right side inner brackets)
④	W1312-00062	1	Bracket (for power supply assembly)
⑤	3160-4199	3	Fan
⑥	3160-0281	3	Fan guard
⑦	0361-1272	12	Rivets, to attach fan guard to fan bracket
⑧	N5235-00001	1	Chassis base
⑨	N5235-00003	1	Fan bracket (for two fans)
⑩	N5235-00004	1	Inner bracket, right side (holds seven card guides)
⑪	N5247-00013	1	Front bracket, (attached to chassis base)
⑫	N5242-40002	14	Card guides
A16	0950-4934	1	Power supply assembly
A17	W1312-60297	1	CPU Replacement Kit, 2.0 GHz (includes 8 GB RAM)
A18	N5240-60059	1	GPIB board
A51[a]	N5235-60060	1	Solid state drive assembly (SSDA) for Windows XP Operating System
	N8983A[b]	1	Solid state drive assembly (SSDA) for Windows 7 Operating System
--	E4440-00021	1	EMI fan shield (adhesive)
--	0400-0353	6	Grommets, to attach midplane board to midplane bracket
--	1400-0249	--	Cable tie
--	1400-1334	--	Cable clamp
--	0515-0372	--	Machine screw, M3.0 x 8, pan head (to attach: front bracket to chassis base; midplane bracket to inner brackets; inner brackets to chassis base; front, midplane, and inner brackets to underside of chassis base; front bracket to inner brackets; fan assemblies to chassis base; CPU module to inner brackets and ejectors; power supply bracket to inner brackets and fan assemblies; system motherboard to chassis base)
--	0515-1946	--	Machine screw M3.0 x 6, flat head (to attach power supply bracket to power supply assy)
--	0515-0380	--	Machine screw, M4.0 x 10, pan head (to attach 13.5 GHz LO Synthesizer board, 13.5 GHz Source Synthesizer board, Reference board, and SPAM board to inner brackets)
--	0515-0375	--	Machine screw M3.0 x 16, pan head (to secure midplane board to midplane bracket)

a. The A51 solid state disk drive for the 2.0 GHz CPU board plugs into the A17 CPU board assembly from the rear panel. Refer to “Removing and Replacing the A17 CPU Board” on page 7-21 for an illustration.
b. For more information on the N8983A SSDA, refer to the *Windows 7 Operating System Upgrade Kit Installation Note*, available online at http://literature.cdn.keysight.com/litweb/pdf/N8983-90001.pdf.

Figure 6-21 Internal Hardware and Miscellaneous Parts, All Models

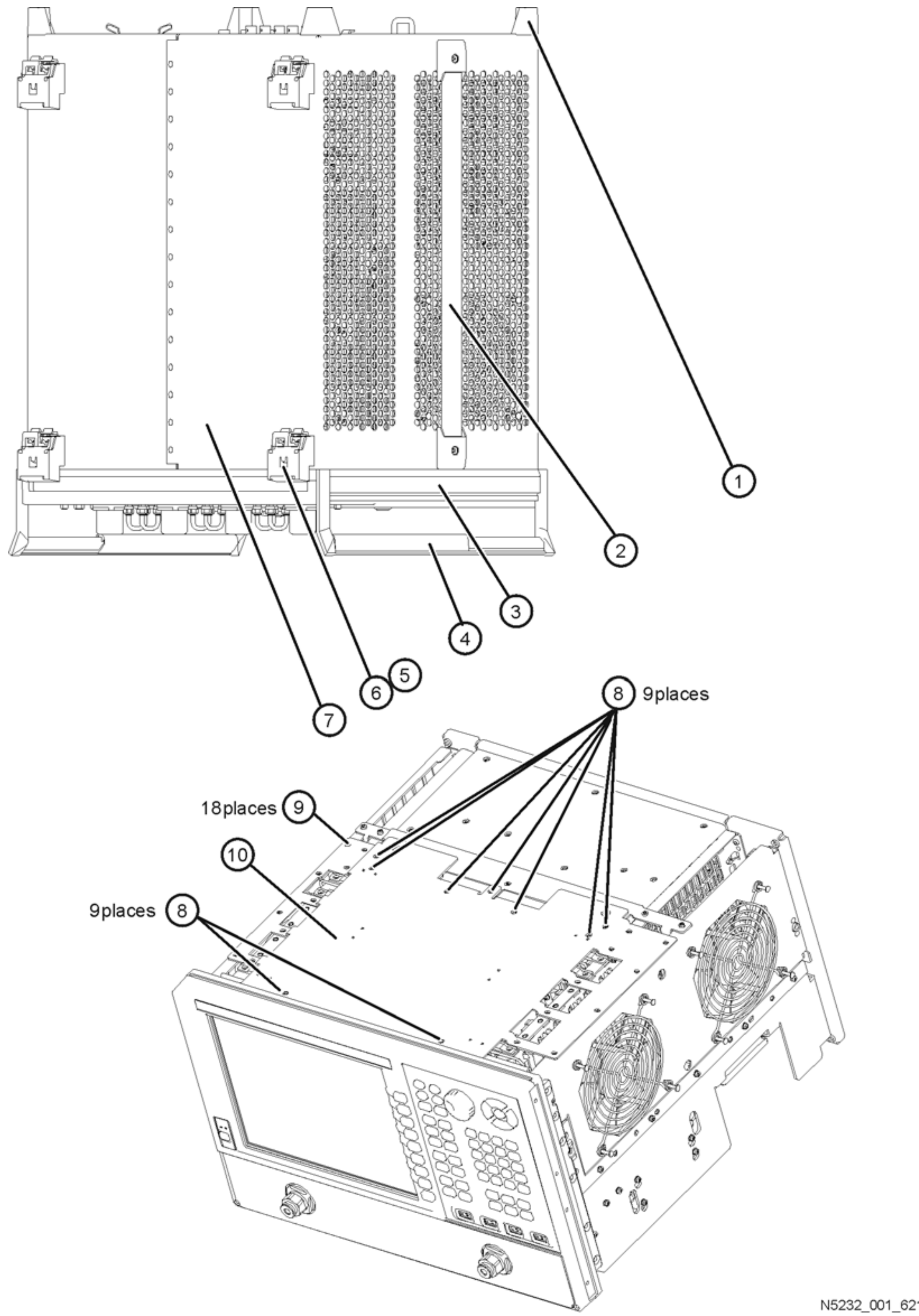


External Hardware and Miscellaneous Parts, All Models

Reference Designator	Part Number	Qty	Description
①	5041-9611	4	Rear feet
②	N5232-60003	2	Strap handle assembly (includes screws)
③[a]	5041-9691	2	Front handle side trim
④	5023-1399	2	Front handle, ruggedized
⑤	5041-9167	4	Bottom feet
⑥	5021-2840	4	Key lock, to secure bottom foot
⑦	N5235-00009	1	Outer cover
⑧	0515-1946	--	Machine screw, M3.0 x 6 flat head (to attach inner cover to brackets)
⑨	0515-0372	--	Machine screw, M3.0 x 8, pan head (to attach inner cover to brackets)
⑩	N5235-00008	1	Inner cover
--	N5245-40001	1	Impact cover, front
--	N5245-40002	1	Impact cover, rear
--	N5242-00029	2	Front panel jumper guard, Option 216 only
--	N5232-00004	1	Front panel jumper guard, Option 416 only
	N5232-00003	4	
--	0515-1619	--	Machine screw M4.0 x 25, pan head (to attach rear feet)
--	0515-0710	--	Machine screw M5.0 x 18, flat head
--	0515-2044	--	Machine screw, M4.0 x 10 flat head (to attach: front handles to front frame; front frame to chassis)

a. Refer to "Rack Mount Kits and Handle Kits" on page 6-53 for part numbers of complete rack mount kits.

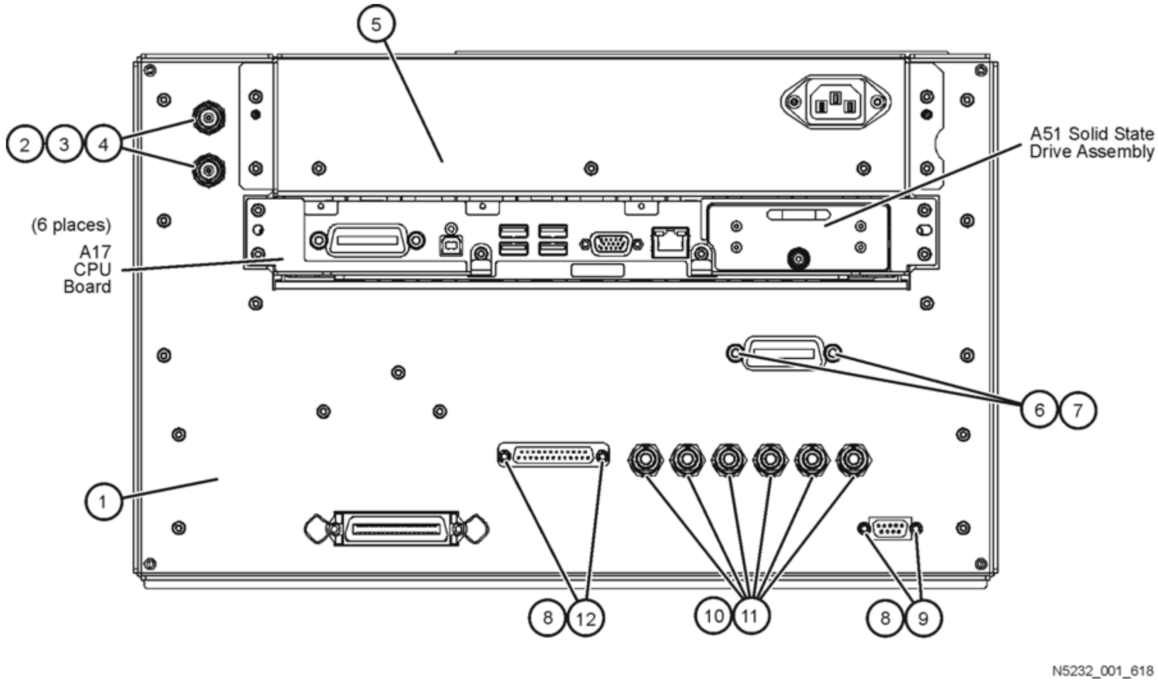
Figure 6-22 External Hardware and Miscellaneous Parts, All Models



Rear Panel Assembly, All Models

Item Number	Part Number	Description
①	N5235-00007	Rear panel
②	8120-5063	BNC cable assembly; rear panel 10MHz Ref In BNC to A7 frequency reference board J2
		BNC cable assembly; rear panel 10MHz Ref Out BNC to A7 frequency reference board J3
③	2950-0035	Hex nut (for BNC connector)
④	2190-0102	Lock washer (for BNC connector)
⑤	N5245-00028	Rear panel power supply bracket
⑥	2190-0958	Washer, to secure rear panel GPIB board connector for GPIB cable
⑦	0380-0644	Jackscrew, to secure rear panel GPIB board connector for GPIB cable
⑧	2190-0584	Washer, to secure two rear panel connectors for ribbon cables
⑨	0380-4670	Jackscrew, to secure rear panel connector for Power I/O cable
⑩	2190-0068	Washer (for BNC connector)
⑪	2950-0054	Nut (for BNC connector)
⑫	1251-7812	Jackscrew, to secure Testset I/O rear panel connector for ribbon cable
A17	CPU board. Refer to "Internal Hardware and Miscellaneous Parts, All Models" on page 6-46 for the part number.	
A51	Solid state drive assembly (SSDA) for A17 CPU board. Refer to "Internal Hardware and Miscellaneous Parts, All Models" on page 6-46 for the part number.	
--	0515-0372	Machine screw, M3.0 x 8, pan head (to secure: rear panel; rear panel power supply bracket; CPU board; handler i/o cable to rear panel;)

Figure 6-23 Rear Panel Assembly, All Models



Miscellaneous Part Numbers

Table 6-3Part Numbers for Miscellaneous Parts and Accessories

Description	Model or Part Number
Service Tools	
1/4 inch and 5/16 inch open-end wrench, thin profile	8710-0510
5/16 inch (8 mm), open-end wrench	8710-2174
1/2 inch to 9/16 inch (8 mm), open-end wrench	8710-1770
20 mm open-end torque wrench; 0.9 N-m (8 in-lb)	8710-1764
Spanner wrench	08513-20014
Documentation	
Installation and Quick Start Guide (for all PNA series analyzers) (Cannot be ordered. Part number is for reference only. Must be printed from the Keysight Web site. Refer to “Printing Copies of Documentation from the Web” in the title section of this document.)	E8356-90001
Service Guide. (Not available in printed form. Part number is for reference only. Must be printed from the Keysight Web site. Refer to Refer to “Printing Copies of Documentation from the Web” in the title section of this document.)	N5232-90001
Protective Caps for Connectors	
Protective cap for GPIB connector and GPIB Talker/Listener connector	1252-5007
Protective cap for Test Set I/O connector	1252-1935
Protective cap for Handler I/O connector	1253-5320
Protective cap for Display (VGA) connector and PWR I/O connector	1252-0220
Protective cap for Test port (Port 1, Port 2, etc.) connectors	1401-0214
GPIB Cables/GPIB Adapter	
GPIB cable, 0.5 meter (1.6 feet)	10833D
GPIB cable, 1 meter (3.3 feet)	10833A
GPIB cable, 2 meter (6.6 feet)	10833B
GPIB cable, 4 meter (13.2 feet)	10833C
GPIB cable to GPIB cable adapter	10834A
Battery	
Battery, lithium, 3V, 0.22A-HR (located on the A17 CPU board)	1420-0356
USB Accessories	
Mouse	1150-7799
Keyboard (U.S. style)	1150-7896
USB to GPIB adapter	82357B

Table 6-3Part Numbers for Miscellaneous Parts and Accessories (Continued)

Description	Model or Part Number
ESD Supplies	
Adjustable antistatic wrist strap	9300-1367
Antistatic wrist strap grounding cord *(5 foot length)*	9300-0980
Static control table mat and earth ground wire	9300-0797
ESD heel strap	9300-1308
EMI/RFI Shielding Accessories	
7 mm ferrite bead for serial cable	9170-1793
9 mm ferrite bead for parallel port	9170-1702
Upgrade Kits and Accessories	
To see a list of the upgrade kits and accessories available for the network analyzers, refer to the *Keysight PNA Family Microwave Network Analyzers Configuration Guide*, available online at http://literature.cdn.keysight.com/litweb/pdf/5990-7745EN.pdf.	
Rack Mount Kits and Handle Kits	
Rack mount kit for analyzers without handles (Option 1CM)	N5231AU-1CM or N5232AU-1CM or N5239AU-1CM
Option 1CM includes the following separately orderable items:	
Rack mount kit (rack mount flanges and hardware)	*1CM042A* *Was 5063-9217*
Rack mount rail set	*E3663AC*
Rack mount kit for analyzers with handles (Option 1CP)	N5231AU-1CP or N5232AU-1CP or N5239AU-1CP
Option 1CP includes the following separately orderable items:	
Rack mount kit (rack mount flanges and hardware)	*5063-9237*
Rack mount rail set	*E3663AC*
Front handle kit (two classic[a] handles and hardware)	*5063-9230*
Touch-up Paint	
Dove gray (*for use on frame around front panel and painted portion of handles*)	6010-1146
French gray (*for use on cover)*	6010-1147
Parchment white (*for use on rack mount flanges, rack support flanges, and front panels*)	6010-1148

a. For rack mount use, you must replace factory installed ruggedized handles (thick aluminum, no trim) with classic handles (thin aluminum with plastic trim), included with Option 1CP.

7 Repair and Replacement Procedures

Information in This Chapter

This chapter contains procedures for removing and replacing the major assemblies of your Keysight Technologies PNA series microwave network analyzer.

Chapter Seven at-a-Glance

Personal Safety Warnings

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

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

WARNING **Procedures described in this document may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.**

WARNING **The power cord is connected to internal capacitors that may remain live for 10 seconds after disconnecting the plug from its power supply assembly. Wait at least 10 seconds, after disconnecting the plug, before removing the covers.**

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

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

Electrostatic Discharge (ESD) Protection

CAUTION Many of the assemblies in this instrument are very susceptible to damage from electrostatic discharge (ESD). Perform the following procedures only at a static-safe workstation and wear a grounded wrist strap.

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

To reduce the chance of electrostatic discharge, follow all of the recommendations outlined in "Electrostatic Discharge Protection" on page 1-6, for all of the procedures in this chapter.

Assembly Replacement Sequence

The following steps show the sequence that you should follow to replace an assembly in the network analyzer.

Step 1. Identify the faulty group. Begin with Chapter 4, “Troubleshooting.”

Step 2. Order a replacement assembly. Refer to Chapter 6, “Replaceable Parts.”

Step 3. Replace the faulty assembly and determine what adjustments are necessary. Refer to “Post-Repair Procedures” in this chapter.

Step 4. Perform the necessary adjustments. Refer to Chapter 3, “Tests and Adjustments.”

Step 5. Perform the necessary performance tests. Refer to Chapter 3, “Tests and Adjustments.”

Removal and Replacement Procedures

Table 7-1List of Procedures

Reference Designator	Assembly Description	Location
N/A	Covers, outer and inner	page 7-8
N/A	Front panel assembly	page 7-10
A1 A2 A3	Front panel interface board USB board Display assembly	page 7-12
A4 A7 A9 A10	13.5 GHz source synthesizer board Frequency reference board SPAM board 13.5 GHz LO synthesizer board	page 7-16
A14	System motherboard	page 7-17
A15	Midplane board	page 7-19
A16	Power supply assembly	page 7-20
A17	CPU board	page 7-21
A18	GPIB board	page 7-22
A19	Test set motherboard	page 7-23
A20	MASSQuad (4-port models only)	page 7-24
A21	MASSY (2-port models only)	page 7-25
A24	Mixer brick (QuintBrick)	page 7-26
A25 A26 A27 A28	Test port 1 bridge coupler Test port 2 bridge coupler Test port 3 bridge coupler Test port 4 bridge coupler	page 7-27
A29 A30	60 dB source step attenuator 60 dB source step attenuator (Option 216 only)	page 7-28
A51	Solid state drive assembly (SSDA)	page 7-29
N/A	Rear panel	page 7-30

Table 7-1 List of Procedures (Continued)

Reference Designator	Assembly Description	Location
N/A	Front Panel LED boards	page 7-31
N/A	Fans	page 7-33
N/A	Battery	page 7-35

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Removing the Covers

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- ESD grounding wrist strap

Removing the Outer Cover

CAUTION This procedure is best performed with the analyzer resting on its front handles in the vertical position, as shown in Figure 7-1. on page 7-9. *Do not place the analyzer on its front panel without the handles.* This will damage the front panel assemblies.

Refer to Figure 7-1. for this procedure.

1. Disconnect the power cord.
2. With a T-20 TORX driver, remove the strap handles (item ①) by loosening the screws (item ②) on both ends until the handle is free of the analyzer.
3. With a T-20 TORX driver, remove the four rear panel feet (item ③) by removing the center screws with a T-20 TORX driver.
4. Remove the foot locks (secured in the bottom feet), then slide the four bottom feet (item ④) off the cover.
5. Slide the outer cover toward the rear of the analyzer and remove it.

Removing the Inner Cover

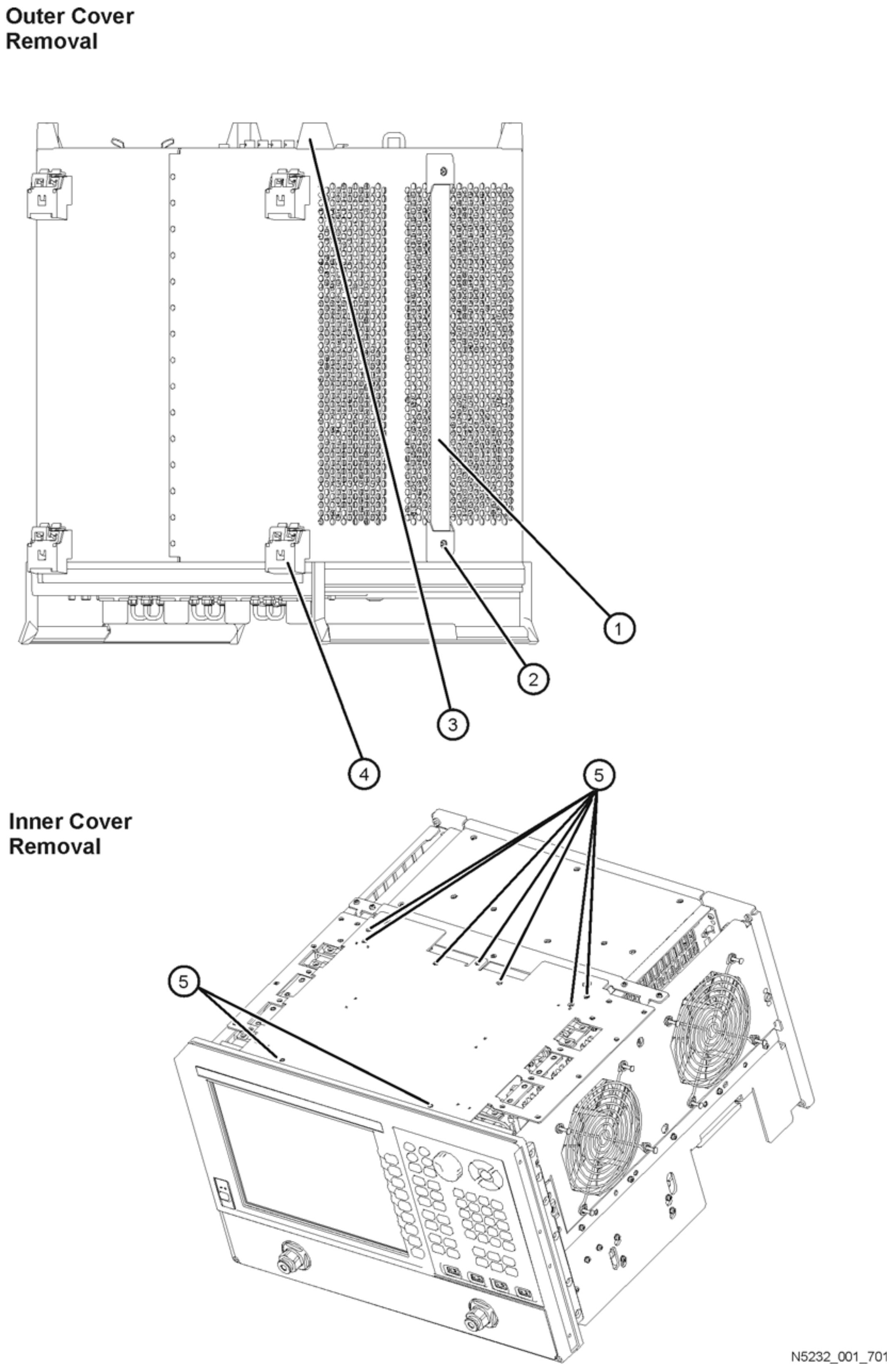
Refer to Figure 7-1. for this procedure.

1. With a T-10 TORX driver, remove the eighteen 8mm pan head screws, and the nine 6mm flat head screws (item ⑤).
2. Lift off the cover.

Replacement Procedure

1. On the top side of the PNA, carefully position the grey flex cables so they can't be pinched between the covers and the rails.
2. On the bottom side of the PNA, carefully fold or push down the ribbon cables and wires so they can't be pinched between the hardware and the outer cover. Ribbon cables and wires must never be positioned on top of hardware.
3. Reverse the order of the removal procedures above.

Figure 7-1. Outer and Inner Cover Removal



Removing and Replacing the Front Panel Assembly

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 5/16 inch open-end torque wrench (torque to 10 in-lb or 1.13 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 7-2 for this procedure.

1. Disconnect the power cord.
2. Remove the outer cover. Refer to "Removing the Covers" on page 7-8.
3. With a 5/16 inch torque wrench, remove all the semirigid jumpers (item ①) from the front panel (if present).
4. Remove screws (item ②) from the lower front panel. There are two screws for 2-port models and four screws for 4-port models.
5. With a T-20 TORX driver, remove the 12 screws (item ③) from the sides of the frame.

CAUTION Before removing the front panel from the analyzer, lift and support the front of the analyzer frame.

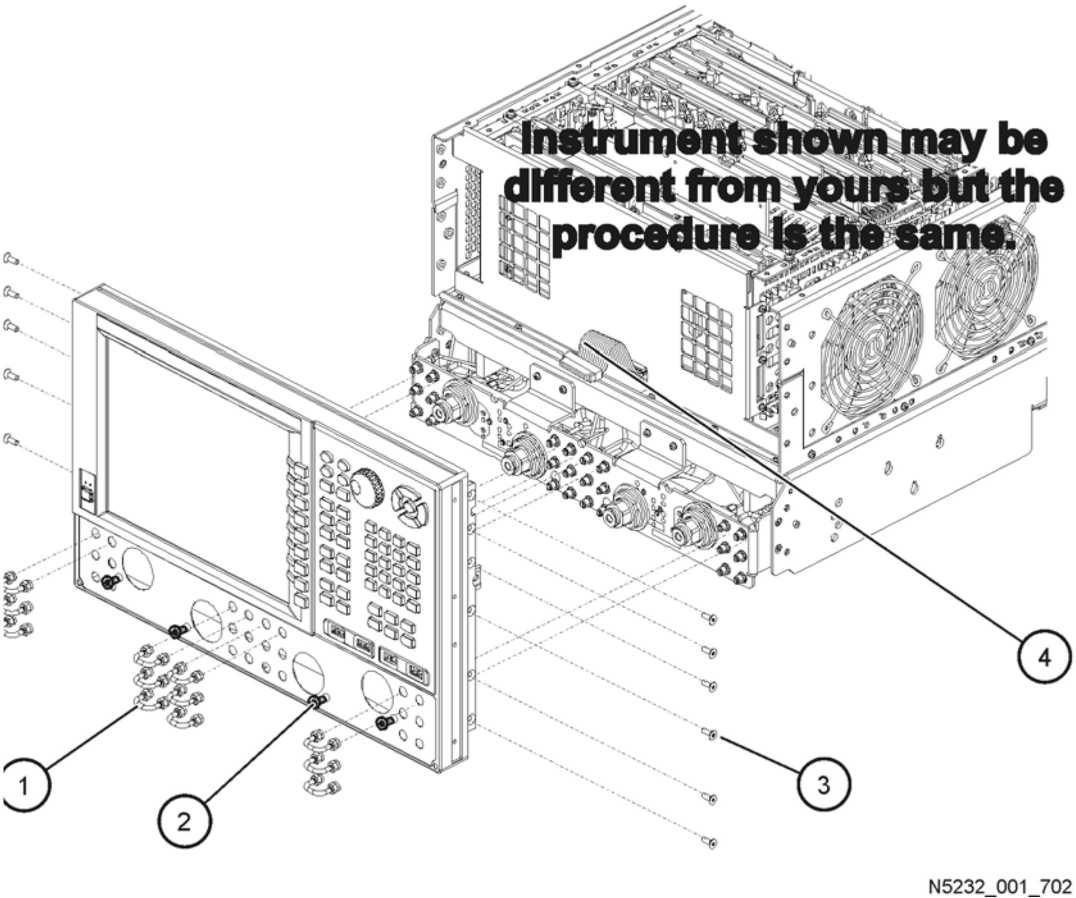
6. Slide the front panel over the front-panel connectors.
7. Disconnect the ribbon cable (item ④) from the A1 front panel interface board.

Replacement Procedure

IMPORTANT When reconnecting the front-panel jumpers, torque the connectors to 10 in-lb.

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Figure 7-2 Front Panel Assembly Removal



Removing and Replacing the A1–A3 and Other Front Panel Subassemblies

Tools Required

- T-8 TORX driver (torque to 6 in-lb or 0.68 N.m)
- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 5/16 inch open-end torque wrench (torque to 10 in-lb or 1.13 N.m)
- ESD grounding wrist strap

Refer to Figure 7-3, Figure 7-4, and Figure 7-5 for the following procedures.

NOTE Any cables that are removed should be labeled for reinstallation later.

Pre-removal Procedure

1. Disconnect the power cord.
2. Remove the front panel assembly. Refer to "Removing and Replacing the Front Panel Assembly" on page 7-10.

Removing the A2 USB Board

1. Remove the four retaining screws (item ①) from the USB board and unplug it from the A1 front panel interface board.

Removing the A1 Front Panel Interface Board and Keypad Assembly

1. Remove the round knob (RPG) from the front panel by gently pulling the knob forward.
2. Remove the A2 USB board as outlined above.
3. Disconnect the following cables from the A1 front panel interface board: display cable (item ②), inverter board cable (item ③), touchscreen controller board cable (item ④), and power switch cable (item ⑤).
4. Remove the seven screws (item ⑥) from the A3 display assembly and remove it from the front panel assembly.
5. Remove the eight screws (item ⑦) from the A1 front panel interface board and remove it from the front panel assembly.
6. The keypad assembly can now be removed from the A1 front panel interface board by gently pulling each of the rubber tabs through the PC board.

Removing the Inverter Board

1. Disconnect the inverter board cable (item ③) and the LCD cable (item ⑧) from the inverter board.
2. Remove two screws (item ⑨) and remove the inverter board.

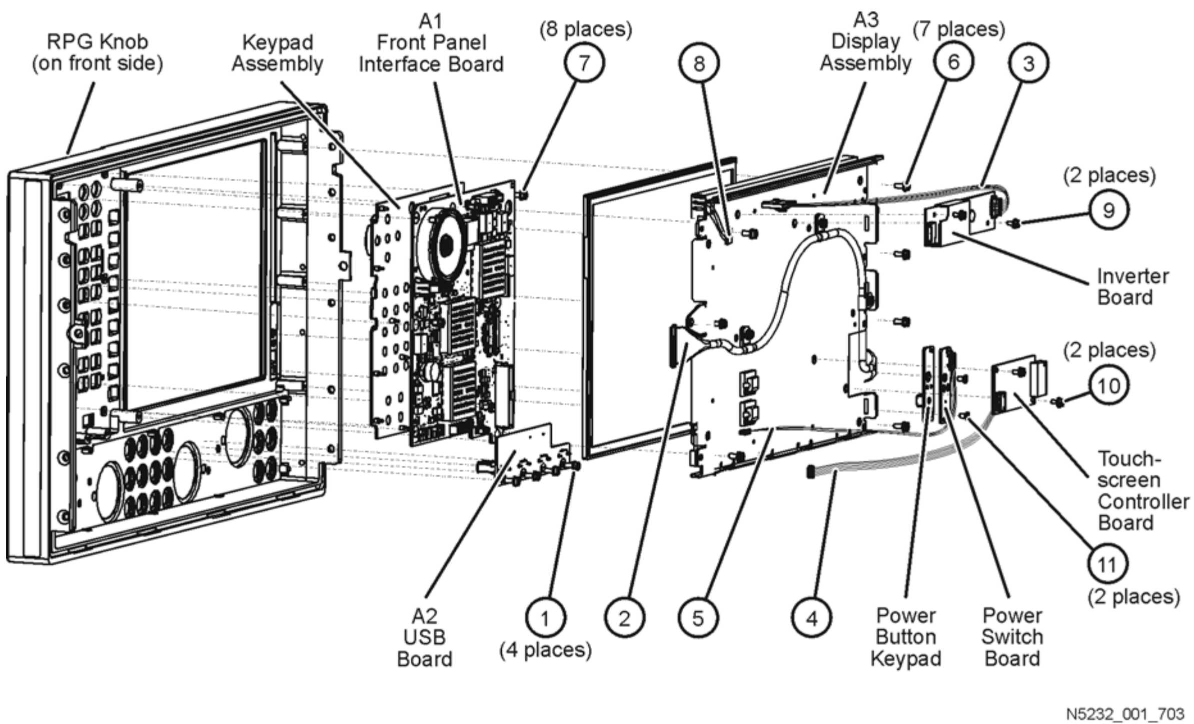
Removing the Touchscreen Controller Board

1. Disconnect the touchscreen controller board cable (item ④) from the touchscreen controller board and front panel interface board.
2. Disconnect the flat flex cable from the touchscreen.
3. Remove two screws (item ⑩) and remove the touchscreen controller board.

Removing the Power Switch Board and Power Button Keypad

1. Disconnect the power switch cable (item ⑤) from the power switch board.
2. Remove two screws (item ⑪) and remove the power switch board.
3. The power button keypad can now be removed from the power switch board by gently pulling each of the rubber tabs through the PC board.

Figure 7-3 Front Panel Subassemblies Removal

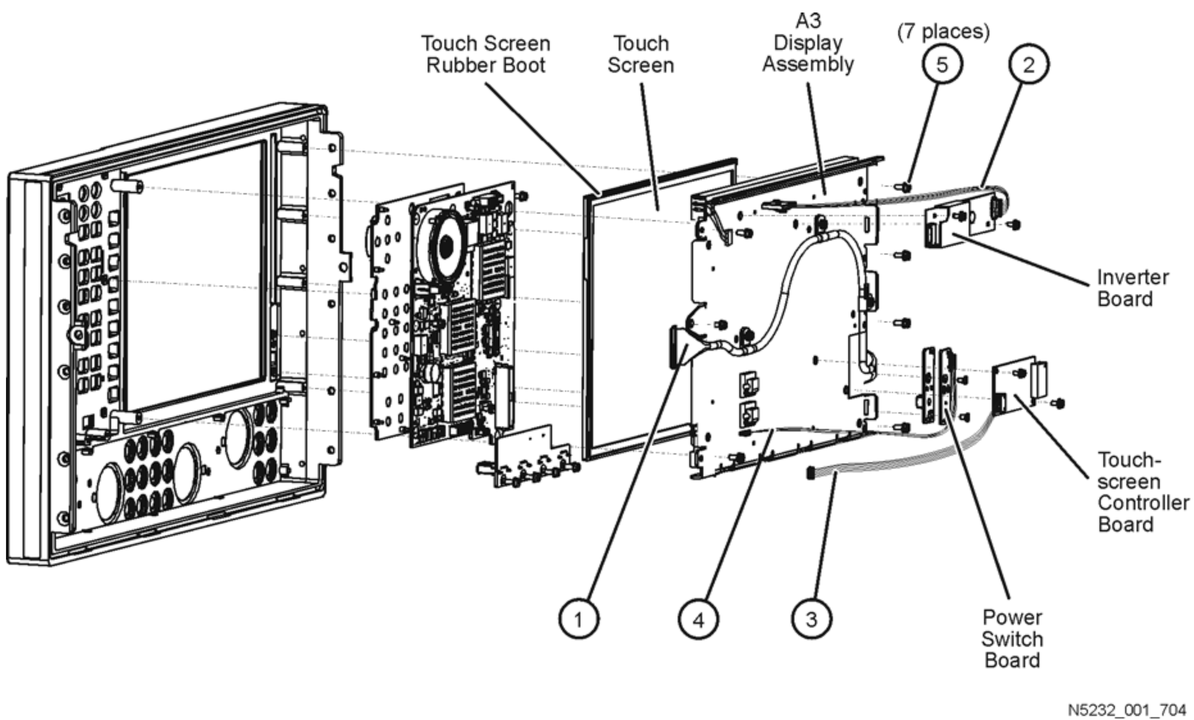


Removing the A3 Display Assembly and the Touchscreen

1. Disconnect the following cables from the A1 front panel interface board: display cable (item ①), inverter board cable (item ②), touchscreen controller board cable (item ③), and power switch cable (item ④).
2. Remove seven screws (item ⑤) from the A3 display assembly and remove the A3 display assembly from the front panel assembly.
3. The touch screen can now be removed from the front panel assembly. Note the orientation of the touch screen in the front panel assembly for installation of the new touch screen.

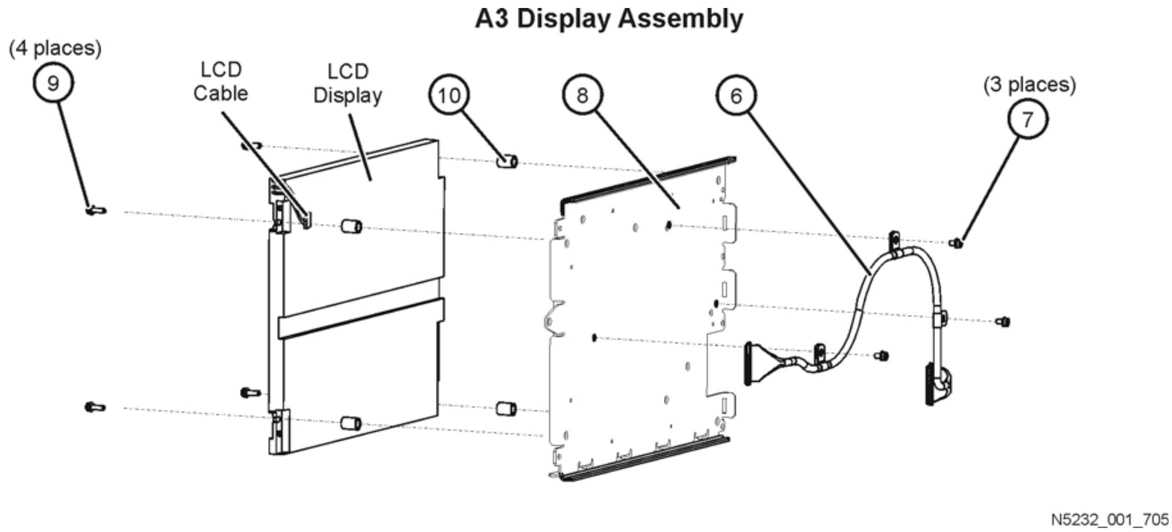
   To replace the touch screen, note the orientation of the rubber boot on the old touch screen and then remove it and install it on the new one in the same orientation.

Figure 7-4 A3 Display Assembly and Touch Screen Removal-1



4. The display cable (item ⑥) can be removed by removing the three screws (item ⑦) that attach it to the LCD display hold down bracket (item ⑧).
5. The LCD display can be removed by disconnecting the LCD cable from the inverter board and then removing the four screws (item ⑨) that attach it to the LCD display hold down bracket (item ⑧). Note the location of the four spacers (item ⑩) before separating the LCD display from the hold down bracket.

Figure 7-5 A3 Display Assembly and Touch Screen Removal-2



Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A4, A7, A9, and A10 Boards

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 5/16 inch open-end torque wrench (torque to 10 in-lb or 1.13 N.m)
- 9 mm socket or open-end wrench (torque to 21 in-lb or 2.38 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-6 on page 6-17 for this procedure.

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. If present, remove two screws, one at each end of the board, from the board to be removed. These screws secure the board to the analyzer's left and right inner bracket.
4. Disconnect cables (if any) connected to the top of the board to be removed.
5. Lift the two ejectors, one at each end of the board, and lift the board.
6. Before removing the board, disconnect cables (if any) connected to the bottom of the board.

Replacement Procedure

1. Reverse the order of the removal procedure.

   The board ejectors should be in the upright position when installing the board. Align these ejectors with the slots in the chassis inner panels as the board is lowered into position and then push them down flat.

2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

NOTE The fractional-N synthesizer boards will not perform correctly and will cause the PNA to display errors until the Synthesizer Bandwidth Adjustment and the EE Default Adjustment are completed, as per Table 7-2 on page 7-37.

Removing and Replacing the A14 System Motherboard

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 9/32 inch nutsetter (torque to 9 in-lb or 1.02 N.m)
- 3/16 inch nutsetter (torque to 6 in-lb or 0.68 N.m)
- 5/8 inch nutsetter (torque to 21 in-lb or 2.38 N.m)
- ESD grounding wrist strap

Removal Procedure

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. Remove the front panel assembly. Refer to "Removing and Replacing the Front Panel Assembly" on page 7-10.
4. Remove the A16 power supply. Refer to "Removing and Replacing the A16 Power Supply Assembly" on page 7-20.
5. Remove the A17 CPU board. Refer to "Removing and Replacing the A17 CPU Board" on page 7-21.
6. Disconnect the rear panel cables.
7. Remove the threaded hardware from the rear panel.
8. Remove the rear panel.
9. Remove the A18 GPIB board. Refer to "Removing and Replacing the A18 GPIB Board" on page 7-22.
10. Remove the A15 midplane board. Refer to "Removing and Replacing the A15 Midplane Board" on page 7-19.
11. Remove the A4, A7, A9, and A10 boards. Refer to "Removing and Replacing the A4, A7, A9, and A10 Boards" on page 7-16.
12. Remove the right side and left side fan brackets. Disconnect the right fan wire and the left fan wire from the A14 System Motherboard, and then remove the fan brackets. Refer to "Removing and Replacing the Fans" on page 7-33.
13. Turn the analyzer over so that the bottom side is up and remove the A19 Test Set Motherboard. Refer to "Removing and Replacing the A19 Test Set Motherboard" on page 7-23. Disconnect the ribbon cable from the A14 System Motherboard.
14. Remove the three screws (refer to Figure 6-20 on page 6-45) that secure the bottom of the midplane bracket to the chassis.
15. Remove the screws that secure the left side inner bracket to the chassis.
16. Turn the analyzer back over so that the top side is up. Refer to Figure 7-6 on page 7-18. Remove the two screws (item ②) from each side that secure the midplane bracket to the chassis inner panels. Lift the

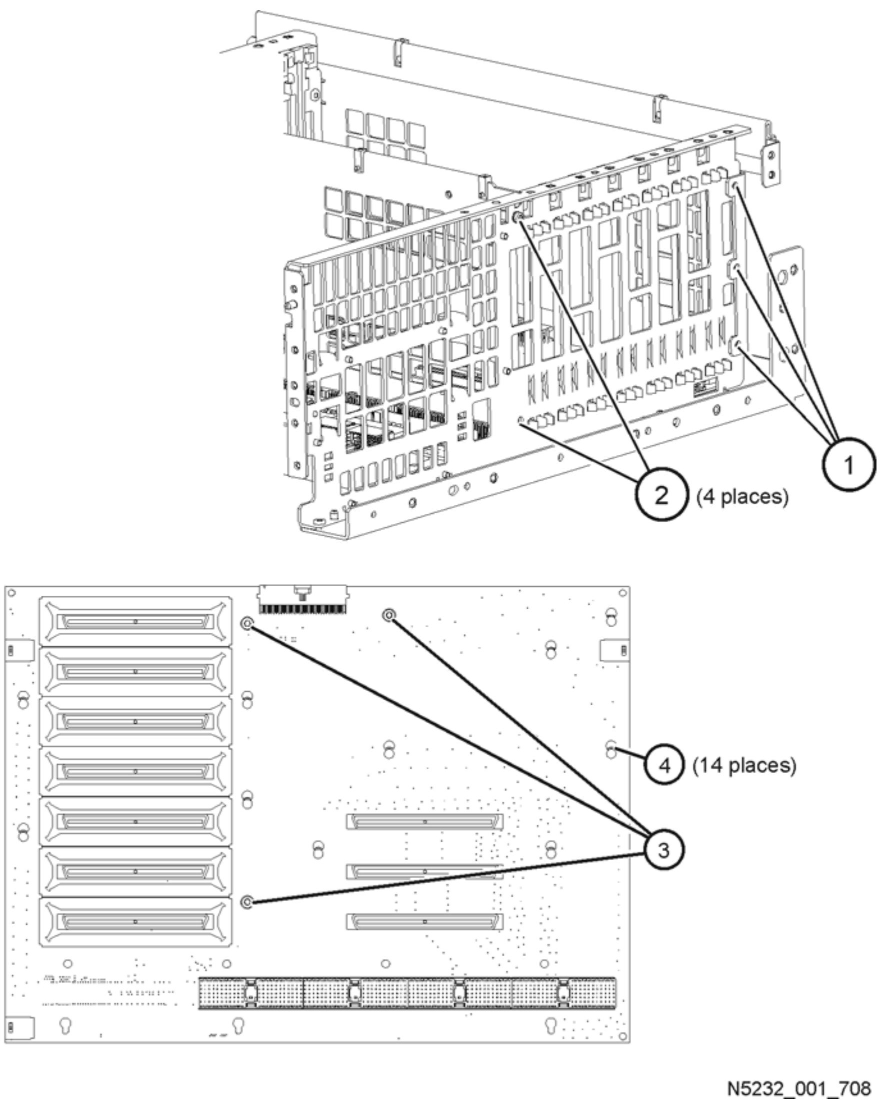
midplane bracket out of the analyzer.

17. Remove the three screws (item ①) that secure the front bracket to the left side inner bracket.
18. Remove the three screws (item ③) that secure the A14 system motherboard to the chassis.
19. Slide the A14 system motherboard toward the rear of the analyzer to release it from the keyhole standoffs (item ④) on the chassis.
20. Lift the A14 system motherboard out of the analyzer.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Figure 7-6 A14 System Motherboard Removal



Removing and Replacing the A15 Midplane Board

Tools Required

- T-10 TORX driver (torque to 9 in-lb)
- T-20 TORX driver (torque to 21 in-lb)
- 5/16 inch open-end torque wrench (torque to 10 in-lb)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-21 on page 6-47 for this procedure.

NOTE	Any cables that are removed should be labeled for reinstallation later.

CAUTION	Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. Remove the A16 power supply assembly. Refer to "Removing and Replacing the A16 Power Supply Assembly" on page 7-20.
4. Remove the A17 CPU board. Refer to "Removing and Replacing the A17 CPU Board" on page 7-21.
5. Remove the screws that attach the A15 midplane board to the midplane bracket. Three screws are near the top edge of the board and another three screws are near the middle of the board.
6. Lift the board ejectors to the upright position to disengage the A15 midplane board from the A14 system motherboard.
7. Note the positions of the six rubber grommets on the bottom three A15 midplane board alignment pins. Remove these rubber grommets and retain them for reinstallation on the new A15 midplane board.
8. Lift the A15 midplane board out of the analyzer.

Replacement Procedure

1. Reverse the order of the removal procedure.

   Be careful to align the guide pins on the A15 midplane board connectors with the slots on the A14 system motherboard connectors.

   The board ejectors should be in the upright position when installing the A15 midplane board. Align these ejectors with the slots in the chassis inner panels as the board is lowered into position and then push them down flat.

   Remember to install the six rubber grommets on the bottom three alignment pins.

2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A16 Power Supply Assembly

Tools Required

- T-10 TORX driver (set to 9 in-lb)
- T-20 TORX driver (set to 21 in-lb)
- ESD grounding wrist strap

Removal Procedure

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. Remove the seven screws from the bracket for the power supply assembly, then remove the bracket. Refer to Figure 6-21 on page 6-47.
4. Remove the seven screws from the rear panel power supply bracket, then remove the bracket. Refer to Figure 6-23 on page 6-51.
5. Slide out and remove the A16 power supply assembly.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A17 CPU Board

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-21 on page 6-47 for this procedure.

1. Disconnect the power cord.
2. It is *not* necessary to remove the instrument cover(s) to remove the A17 CPU board.
3. Remove six screws from the A17 CPU board - four from the CPU board rear panel and two from the ejector handles.
4. Grasp the two ejector handles and rotate them outward toward the sides of the analyzer. This will disengage the A17 CPU board from the A15 midplane board.
5. Slide the A17 CPU board out the rear of the analyzer.
6. If the A17 CPU board is being replaced, you must first remove the A51 solid state drive assembly for reinstallation in the new A17 CPU board. Refer to "Removing and Replacing the A51 Solid State Drive (SSD)" on page 7-29.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A18 GPIB Board

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-21 on page 6-47 for this procedure.

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. Remove the A16 power supply assembly. Refer to "Removing and Replacing the A16 Power Supply Assembly" on page 7-20.
4. Remove the A17 CPU board. Refer to "Removing and Replacing the A17 CPU Board" on page 7-21.
5. Remove the rear panel. Refer to "Removing and Replacing the Rear Panel" on page 7-30.
6. Slide the A18 GPIB board out the rear of the analyzer.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A19 Test Set Motherboard

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 5/8 inch nutsetter (torque to 21 in-lb)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-17 on page 6-39 for this procedure.

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer cover. Refer to "Removing the Covers" on page 7-8.
3. Position the analyzer bottom side up.
4. Disconnect ALL ribbon cables and ALL wire harnesses from the A19 test set motherboard.
5. Remove connector hardware from the rear panel BNC connectors.
6. Remove the screws securing the A19 test set motherboard to the test set deck.
7. Slide the A19 test set motherboard toward the front of the instrument until the rear panel BNC connectors are free of the rear panel, then lift the motherboard and remove it from the analyzer.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A20 MASSQuad

Tools Required

- T-10 TORX driver (set to 9 in-lb)
- T-20 TORX driver (set to 21 in-lb)
- 5/16 inch open-end torque wrench (set to 10 in-lb)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-17 on page 6-39 for this procedure.

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer cover. Refer to "Removing the Covers" on page 7-8. Position the analyzer bottom side up.
3. With a 5/16 inch torque wrench, disconnect the semirigid cables and 50 ohm loads (if present) from the A20 MASSQuad.
4. Disconnect the flexible cables, and the ribbon cable from the A20 MASSQuad.
5. With a T-10 TORX driver, remove the four mounting screws that secure the A20 MASSQuad to the test set deck.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove the assembly. Do not over-bend them.

6. Remove the A20 MASSQuad from the analyzer. Observe the **CAUTION** above.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A21 MASSY

Tools Required

- T-10 TORX driver (set to 9 in-lb)
- T-20 TORX driver (set to 21 in-lb)
- 5/16 inch open-end torque wrench (set to 10 in-lb)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-8 on page 6-21 for this procedure.

NOTE	Any cables that are removed should be labeled for reinstallation later.

CAUTION	Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove the assembly. Do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer cover. Refer to "Removing the Covers" on page 7-8. Position the analyzer bottom side up.
3. With a 5/16 inch torque wrench, disconnect the semirigid cables from the A21 MASSY.
4. Disconnect the flexible cables, and the ribbon cable from the A21 MASSY.
5. With a T-10 TORX driver, remove the four mounting screws that secure the A21 MASSY to the test set deck.
6. Remove the A21 MASSY from the analyzer. Observe the **CAUTION** above.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A24 Mixer Brick (QuintBrick)

Tools Required

- T-10 TORX driver (set to 9 in-lb)
- T-20 TORX driver (set to 21 in-lb)
- 5/16 inch open-end torque wrench (set to 10 in-lb)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-17 on page 6-39 for this procedure.

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer cover. Refer to "Removing the Covers" on page 7-8. Position the analyzer bottom side up.
3. With a 5/16 inch torque wrench, disconnect the semirigid cables from the A24 mixer brick.
4. Disconnect the flexible cables and the ribbon cable from the A24 mixer brick.
5. With a T-10 TORX driver, remove the mounting screws from the A24 mixer brick.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove the assembly. Do not over-bend them.

6. Remove the A24 mixer brick from the analyzer. Observe the **CAUTION** above.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A25–A28 Test Port Bridge Couplers

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 5/16 inch open-end torque wrench (torque to 10 in-lb or 1.13 N.m)
- 1 inch open-end torque wrench (torque to 72 in-lb or 8.15 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-17 on page 6-39 for this procedure.

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the front panel assembly. Refer to "Removing and Replacing the Front Panel Assembly" on page 7-10.
3. Position the analyzer bottom side up.
4. Disconnect two semirigid cables from each coupler to be removed. It may be necessary to loosen the other end of the cables to allow them to be moved. Do not overbend them.
5. Remove the coupler nut that secures the coupler to the test set front plate.
6. Move the disconnected semirigid cables out of the way and remove the coupler(s) from the analyzer. It may be necessary to remove other cables to remove the coupler(s). If so, make note of the connection locations for reinstallation later.

Replacement Procedure

1. Reverse the order of the removal procedure.

   Torque all connectors to 10 in-lbs. Torque coupler nuts to 72 in-lbs.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A29 and A30 60 dB Source Step Attenuators

Tools Required

- T-10 TORX driver (set to 9 in-lb)
- T-20 TORX driver (set to 21 in-lb)
- 5/16-inch open-end torque wrench (set to 10 in-lb)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-11 on page 6-27 if you have a 2-port PNA, or to Figure 6-17 on page 6-39 if you have a 4-port PNA for this procedure.

NOTE	Any cables that are removed should be labeled for reinstallation later.

CAUTION	Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the outer cover. Refer to "Removing the Covers" on page 7-8. Position the analyzer bottom side up.
3. Identify the attenuator to be removed. To replace the attenuator, the bracket holding the attenuator must be removed.
4. Disconnect the ribbon cable from the appropriate attenuator.
5. Using a 5/16-inch wrench, disconnect the RF cable from each end of the step attenuator.
6. With a T-10 TORX driver, remove the screws that secure the attenuator bracket to the side or floor of the test set deck.
7. Remove the bracket from the analyzer with the attenuator attached. Observe the **CAUTION** above.
8. With a T-10 TORX driver, remove the mounting screws that attach the attenuator to the bracket.

Replacement Procedure

1. Reverse the order of the removal procedure using the existing attenuator ribbon cable.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the A51 Solid State Drive (SSD)

Certain unique files exist on the SSD that are necessary for proper operation of your analyzer. These files must be copied to another location to allow them to be installed onto the new SSD after it has been installed.

If you are replacing the SSD, the following procedure must be performed first.

Copy Unique Files from the Solid State Drive

If installing an SSD for Windows XP: if the user has loaded unique calibration kit information, navigate to C:\Program Files\Keysight\Network Analyzer and copy USER_CALKITFILE to a USB flash memory drive. Also copy any personal user files that you wish to preserve.

If installing an SSD for Windows 7: for more information on the N8983A SSD, refer to the *Windows 7 Operating System Upgrade Kit Installation Note*, available online at http://literature.cdn.keysight.com/litweb/pdf/N8983-90001.pdf.

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m; for solid state drive replacement)
- ESD grounding wrist strap

SSD Removal Procedure

Refer to Figure 6-23 on page 6-51 for this procedure.

1. Disconnect the analyzer power cord.
2. Position the analyzer for access to the rear panel.
3. Loosen the SSD thumb screw.
4. Pull the SSD out from the CPU board, using the handle.

Reinstalling the SSD

1. Reverse the order of the removal procedure.

Install Backup Files onto the New Solid State Drive

The files that were previously saved onto a USB flash memory drive must now be installed onto the new SSD. The network analyzer must be powered up and operating.

Removing and Replacing the Rear Panel

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- 5/8 inch nutsetter (torque to 21 in-lb or 2.38 N.m)
- 9/32 inch nutsetter (torque to 9 in-lb or 1.02 N.m)
- 3/16 inch nutsetter (torque to 6 in-lb or 0.68 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-23 on page 6-51 for this procedure.

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. Remove the A16 power supply assembly. Refer to "Removing and Replacing the A16 Power Supply Assembly" on page 7-20.
4. Remove the A17 CPU board. Refer to "Removing and Replacing the A17 CPU Board" on page 7-21.
5. Remove the connector hardware from each of the multi-pin connectors. The hardware is not the same on each connector so note which hardware goes with which connector.
6. Remove the screws that attach the rear panel to the chassis.
7. Slide the rear panel over the cable connectors and off of the analyzer.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Removing and Replacing the Front Panel LED Boards

Tools Required

- T-10 TORX driver (torque to 9 in-lb)
- T-20 TORX driver (torque to 21 in-lb)
- 5/16 inch open-end torque wrench (torque to 10 in-lb)
- 1 inch open-end torque wrench (torque to 72 in-lb or 8.15 N.m)
- ESD grounding wrist strap

Removal Procedure

Refer to Figure 6-8 on page 6-21 for this procedure.

NOTE Any cables that are removed should be labeled for reinstallation later.

CAUTION Be careful not to damage the center pins of the semirigid cables. Some flexing of the cables is necessary to remove assemblies but do not over-bend them.

1. Disconnect the power cord.
2. Remove the test port couplers. Refer to "Removing and Replacing the A25–A28 Test Port Bridge Couplers" on page 7-27.
3. Remove the two screws that secure the LED board to the test set front plate, and remove the LED board from the analyzer.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

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Removing and Replacing the Fans

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- Pozidriv screw driver
- 5/16 inch open-end torque wrench (torque to 10 in-lb or 1.13 N.m)
- ESD grounding wrist strap

Removal Procedure

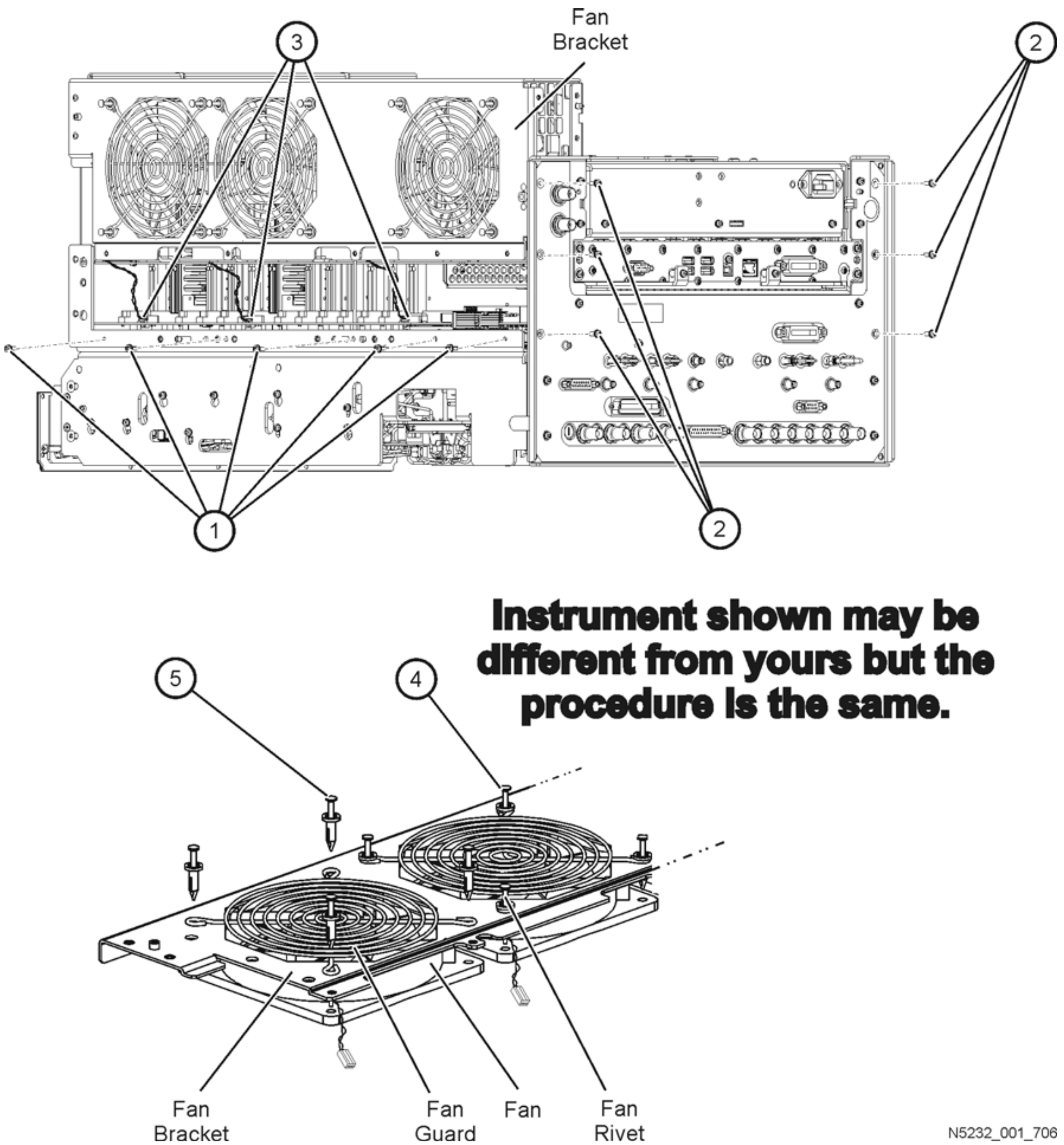
Refer to Figure 7-7 for this procedure.

1. Disconnect the power cord.
2. Remove the outer and inner covers. Refer to "Removing the Covers" on page 7-8.
3. Remove the front panel assembly. Refer to "Removing and Replacing the Front Panel Assembly" on page 7-10.
4. Remove screws (item ①) (five on the right side and seven on the left side) that attach the fan brackets to the chassis.
5. Remove three screws (item ②) on both sides that attach the rear panel to the fan bracket.
6. Raise the fan bracket out of both sides in the analyzer just enough to access the fan cables. Disconnect the fan cables from the A14 system motherboard connectors (item ③).
7. Remove the fan brackets and fans from the analyzer.
8. To remove a fan or fan guard from the fan bracket:
    a. Before removing a fan or fan guard, note the orientation of each fan and fan guard for reinstallation.
    b. Pull up the center pin of each of the fan rivets as shown by (item ④) in the illustration.
    c. Pull out the rivet completely (as shown by (item ⑤) in the illustration) to release the fan and fan guard.

Replacement Procedure

1. Reverse the order of the removal procedure.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Figure 7-7 Fan Removal



Removing and Replacing the Lithium Battery

Tools Required

- T-10 TORX driver (torque to 9 in-lb or 1.02 N.m)
- T-20 TORX driver (torque to 21 in-lb or 2.38 N.m)
- ESD grounding wrist strap

Removal Procedure

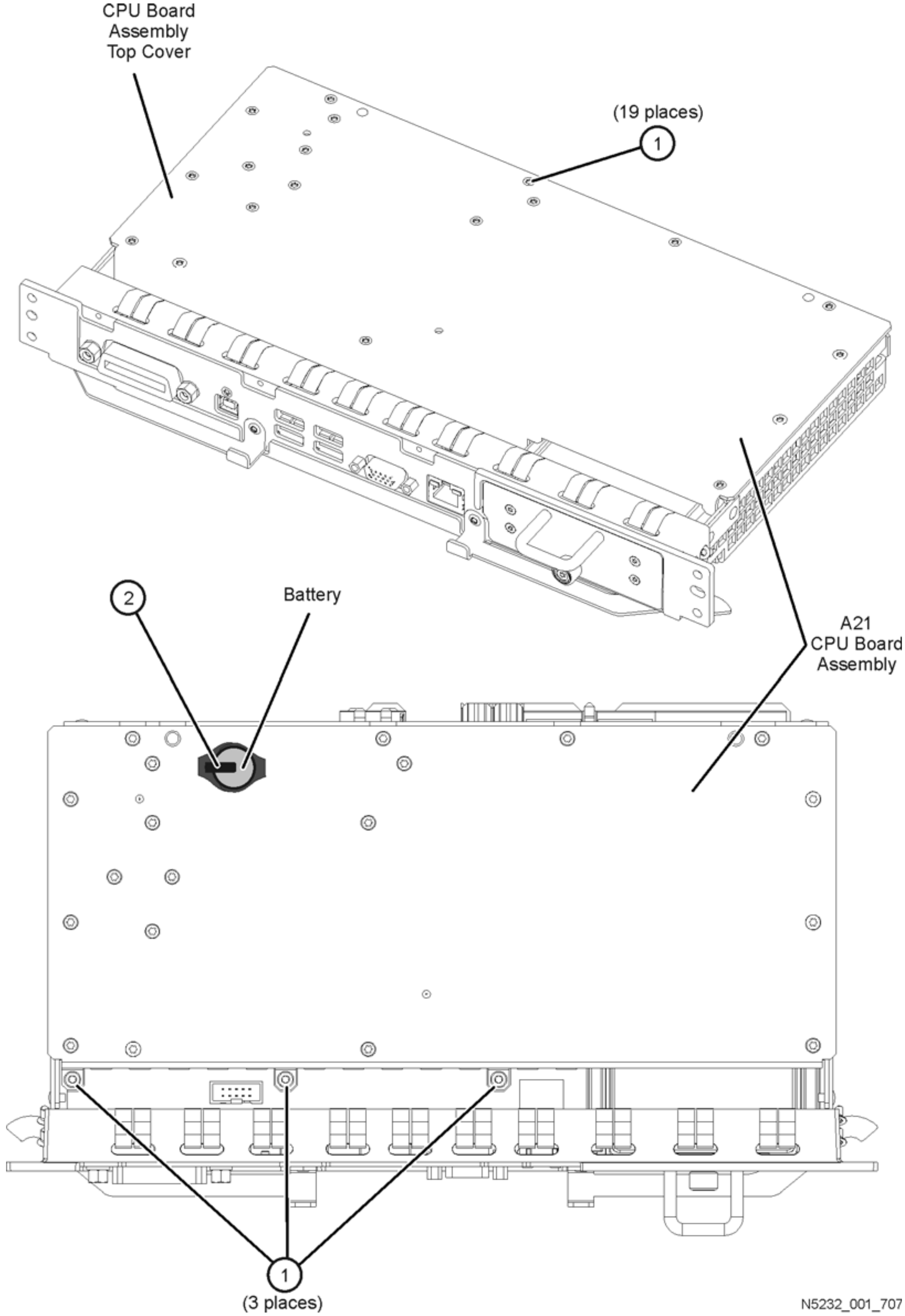
Refer to Figure 7-8 for this procedure.

1. Disconnect the power cord.
2. Remove the solid state drive assembly (SSDA) from the A17 CPU board. Refer to "Removing and Replacing the A51 Solid State Drive (SSD)" on page 7-29.
3. Remove 22 top cover attachment screws (item ①).
4. Remove the top cover from the A17 CPU board.
5. Remove the battery from the battery holder by lifting it at the open end of the holder and then sliding it from under the clip (item ②).
6. DO NOT THROW AWAY THE BATTERY. COLLECT IT AS SMALL CHEMICAL WASTE. Refer to "Removing and Replacing the Lithium Battery" on page 7-35 for additional information on battery disposal.

Replacement Procedure

1. Reverse the order of the removal procedure following all instructions included with the new battery.
2. Perform the post-repair adjustments, verifications, and performance tests that pertain to this removal procedure. Refer to Table 7-2 on page 7-37.

Figure 7-8 Lithium Battery Removal



Post-Repair Procedures

After the replacement of an assembly, you must perform the service procedures in the order listed in Table 7-2.

Procedures referenced in this table are located in Chapter 3, "Tests and Adjustments," unless specified otherwise.

IMPORTANT Keysight personnel: see Figure 1-1 on page 1-5 to review where the calibration stickers should be placed on the PNA.

Table 7-2Related Service Procedures

Replaced Assembly	Adjustments and Other Procedures	Verification, Performance, and Other Tests and Procedures
A1 front panel interface board	No adjustment needed	Front Panel Keypad and RPG Test and A3 Display Test in Chapter 4
A2 USB board/keypad assembly	No adjustment needed	Front Panel Keypad and RPG Test in Chapter 4
A3 display assembly	No adjustment needed	A3 Display Test in Chapter 4
A16 power supply assembly	No adjustment needed	None needed
A9 SPAM board	No adjustment needed	Noise Floor Test Trace Noise Test
A4 13.5 GHz source synthesizer board	Default EE Adjustment[a]	Frequency Accuracy Test The Operator's Check
A10 13.5 GHz LO synthesizer board	Default EE Adjustment[a] (select LO Synthesizer) Source Adjustment	Frequency Accuracy Test The Operator's Check Source Power Accuracy Test
A7 frequency reference board	10 MHz Frequency Reference Adjustment Restore option data (Refer to "Repairing and Recovering Option Data" in Chapter 8 .)	Frequency Accuracy Test
A14 system motherboard	No adjustment needed	Front Panel Keypad and RPG Test and A3 Display Test in Chapter 4 The Operator's Check
A17 CPU board	No adjustment needed	The Operator's Check

Table 7-2Related Service Procedures (Continued)

Replaced Assembly	Adjustments and Other Procedures	Verification, Performance, and Other Tests and Procedures
A19 test set motherboard	Reinstall the serial number. (Refer to "Installing or Changing a Serial Number" in Chapter 8 .) Re-enable all hardware options. (Refer to "Enabling or Removing Options" in Chapter 8 .)	The Operator's Check
A21 MASSY	Source Adjustment	Source Power Accuracy Test The Operator's Check
A20 MASSQuad	Source Adjustment	Source Power Accuracy Test The Operator's Check
A24 Mixer brick (QuintBrick)	Receiver Adjustment	Receiver Compression Test Noise Floor Test Calibration Coefficients Test Dynamic Accuracy Test
A25 – A28 test port bridge couplers	Source Adjustment	Source Maximum Power Output Test Calibration Coefficients Test
A29 and A30 60 dB source step attenuators	Source Adjustment	Source Maximum Power Output Test Calibration Coefficients Test
A51 solid state drive assembly (SSDA)	Restore previously saved receiver calibration data[b] (or perform Receiver Adjustment)	Read and write to the drive
Fan	No adjustment needed	Check for fan operation
USB hub	No adjustment needed	Check for proper operation
Battery	No adjustment needed	None

a. This adjustment is intended for Keysight personnel only and requires a password to run.
b. If a backup copy of receiver calibration data from the faulty disk drive is available, it can be copied to the new disk drive. If not, new data must be generated by performing the "Receiver Adjustment."

8 General Purpose Maintenance Procedures

Information in This Chapter

Chapter Eight at-a-Glance

Error Terms

Using Error Terms as a Diagnostic Tool

By examining error terms, you can monitor system performance for preventive maintenance and troubleshooting purposes.

The magnitude and shape of the error terms are affected by:

- calibration kit devices
- cables
- adapters and accessories
- the assemblies from the signal separation group of the analyzer

Calibration kit devices, cables, and adapters and accessories are the most common cause of error term anomalies. Make sure of the following:

- Connectors must be clean, gaged, and within specification.
- Use proper connection technique during measurement and calibration. For information on connection technique and on cleaning and gaging connectors, refer to "Review the Principles of Connector Care" on page 3-5 or to the calibration kit's user's and service guide.

Preventive Maintenance

If you print or plot the error terms at set intervals (weekly, monthly and so forth), you can compare current error terms to these records. A stable system should generate repeatable error terms over long intervals, (for example, six months). Look for the following:

- A long-term trend often reflects drift, connector and cable wear, or gradual degradation, indicating the need for further investigation and preventive maintenance. Yet, the system may still conform to specifications. The cure is often as simple as cleaning and gaging connectors and cables.
- A sudden shift in error terms may indicate the need for troubleshooting.

Troubleshooting

You can use the error terms as a tool to isolate faulty assemblies in the signal separation group of your analyzer. You can compare the current values to preventive maintenance records or to the typical values listed in Table 8-1 on page 10.

To find assemblies related to error term failures, refer to error term descriptions in "Error Term Data" on page 8-10. Each plot description lists common assemblies related to each error term. Identify the assembly and refer to Chapter 4, "Troubleshooting".

NOTE Always suspect calibration devices, cables, or improper connector maintenance as the primary cause of an error term anomaly.

Performing Measurement Calibration

A calibration must be performed to allow the analyzer to calculate the error terms before they can be used as a tool:

CAUTION Perform the following procedure only at a static-safe workstation, and wear a grounded wrist strap.

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

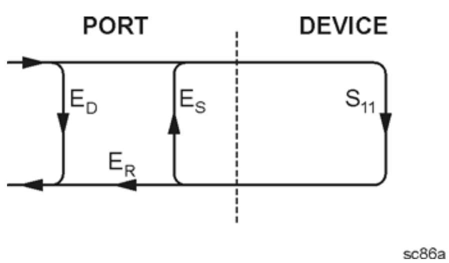
To reduce the chance of electrostatic discharge, follow all of the recommendations outlined in "Electrostatic Discharge Protection" on page 1-6, when performing the following calibration.

1. Connect a test cable to Port 2.
2. Perform a full 2-port calibration, **FULL SOLT 2-Port**. Refer to embedded help in the analyzer if necessary.

Using Flowgraphs to Identify Error Terms

Flowgraphs are a graphical representation of signal flow through the measurement path. The flowgraphs in Figure 8-1, Figure 8-2, Figure 8-3, and Figure 8-4 illustrate the error terms associated with measurement calibration for 1-port, 2-port, 3-port, and 4-port configurations respectively.

Figure 8-1 Flowgraph of One-Port Error Terms for Port 1



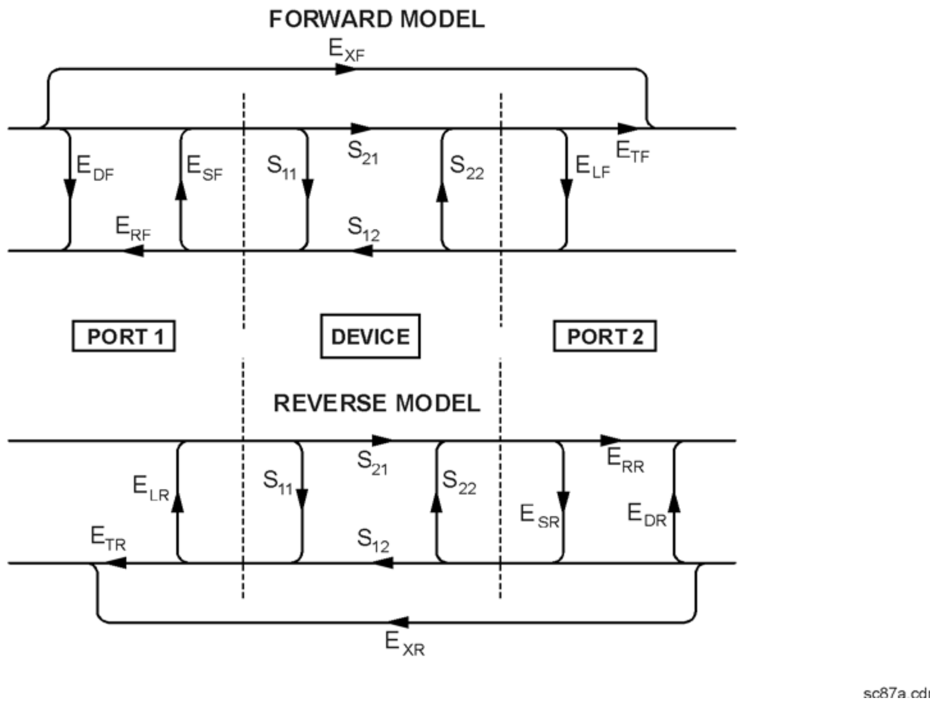
where:

E = Error term

Subscript:
- D = Directivity
- S = Source Match
- R = Reflection Tracking

The error terms are the same for a one port measurement on Port 2 (S_{22}).

Figure 8-2 Flowgraph of Two-Port Error Terms



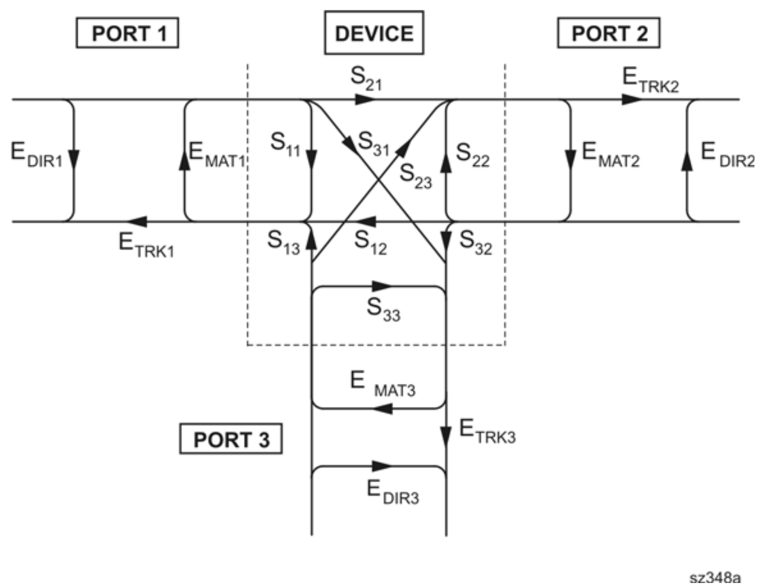
where:

E = error term

1st Subscript:
- D = Directivity
- S = Source Match
- R = Reflection Tracking
- X = Crosstalk (Isolation)
- L = Load Match
- T = Transmission Tracking

2nd Subscript:
- F = forward measurement (Port 1 to Port 2)
- R = reverse measurement (Port 2 to Port 1)

Figure 8-3 Flowgraph of Three-Port Error Terms



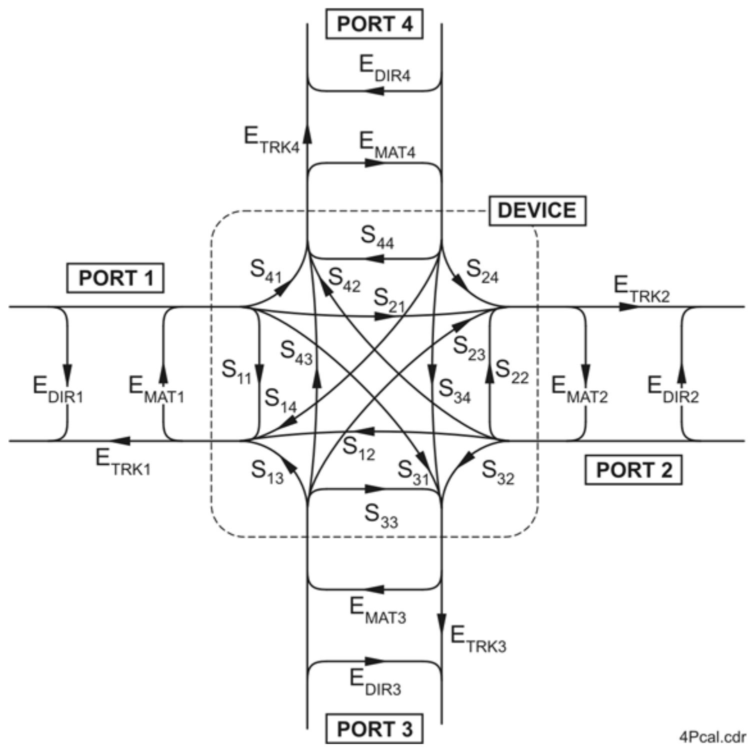
where:

E = error term
DIR = Directivity
MAT = Forward Source Match and Reverse Load Match
TRK = Forward Reflection Tracking and Reverse Transmission Tracking

For the case of a full 3-port calibration, port 1 has
three Match error terms:
S11 source match
S12 load match
S13 load match
and three Tracking error terms:
S11 reflection tracking
S12 transmission tracking
S13 transmission tracking

There are six isolation terms not shown.

Figure 8-4 Flowgraph of Four-Port Error Terms



where:

E = error term
DIR = Directivity
MAT = Forward Source Match and Reverse Load Match
TRK = Forward Reflection Tracking and Reverse Transmission Tracking

For the case of a full 4-port calibration, port 1 has
four Match error terms:
S11 source match
S12 load match
S13 load match
S14 load match
and four Tracking error terms:
S11 reflection tracking
S12 transmission tracking
S13 transmission tracking
S12 transmission tracking

There are eight isolation (crosstalk) terms not shown.

Accessing Error Terms

Error terms can be accessed either manually or programmatically:

Manually

- "Front Panel Access to Error Terms" on page 8-8

Programmatically

- "GPIB Access to Error Terms" on page 8-9
- "COM/DCOM Access to Error Terms" on page 8-9

Manual Access to Error Terms

Front Panel Access to Error Terms

NOTE	Ensure the calibration correction is active by making sure that **Correction on/OFF** has a check-mark in the **Calibration** menu.

To access the error terms from the front panel, perform the following steps:

1. In the **System** menu, point to **Service**, **Utilities**, and then click **Cal Set Viewer**.

   The **Cal Set Viewer** toolbar appears directly above the trace window.
2. In the **Cal Set** list, select the desired cal set.
3. Click the **Standards/ETerms** button to toggle between viewing the raw measurement data from the standard or the corrected error term data. Note that the title of the center box in the tool bar will toggle between **Standard** and **Error Term**.
4. In the **Standard** or **Error Term** list, select the standard or error term to view. Click the **View** check box.
5. Compare the displayed measurement trace to the equivalent data trace plots that start in "Error Term Data" on page 8-10, to previously measured data, or to the uncorrected performance specifications listed in Table 8-1 on page 10.
6. Print numerical data or print a plot of the measurement results.

Programmatic Access to Error Terms

GPIB Access to Error Terms You can access error terms by way of GPIB with Standard Commands for Programmable Instruments (SCPI).

For more information on GPIB and SCPI, refer to the embedded help in the analyzer. Type in keyword “errors, systematic” in the index.

COM/DCOM Access to Error Terms

You can access error terms by way of Component Object Model (COM) or Distributed Component Object Model (DCOM) software architecture.

For more information on COM and DCOM, refer to the embedded help in the analyzer. Type in keyword “errors, systematic” in the index.

Error Term Data

The error term descriptions in this section include the following information:

- a table of the error terms
- description and significance of each error term
- measurements affected by each error term
- typical cause of failure for each error term

The same description applies to both the forward (F) and reverse (R) terms.

IMPORTANT Data are listed here as a convenience only. Detailed instrument specifications are listed in the embedded help in the network analyzer.

Table 8-1 Error Term Data[a]

Frequency Range	Directivity	Source Match	Load Match	Crosstalk[b]
300 kHz to 1 MHz	-12	-6	-6	-80
1 MHz to 5 MHz	-12	-9	-9	-85
5 MHz to 45 MHz	-12	-9	-9	-95
45 MHz to 500 MHz	-24	-17	-22	-110
500 MHz to 2 GHz	-27	-15	-16	-122
2 GHz to 8.5 GHz	-19	-10	-10	-122
8.5 GHz to 10.5 GHz				-122
10.5 GHz to 13.5 GHz				-115
13.5 GHz to 20 GHz	-15	-8	-9	-108

a. The data in this table are uncorrected system performance. The values apply over an environmental temperature range of 25 °C ±5 °C, with less than 1 °C deviation from the calibration temperature.

b. All crosstalk values are typical.

If Error Terms Seem Worse than Expected

To verify that the system still conforms to specifications, perform a system verification. Refer to Chapter 3, “Tests and Adjustments”.

Directivity (E_{DF} and E_{DR})

E_{DF} and E_{DR} are the uncorrected forward and reverse directivity error terms of the system. The directivity error of the test port is determined by measuring the S_{11} and S_{22} reflection of the calibration kit load. The load has a much better return loss specification than does the uncorrected test port. Therefore, any power detected from this measurement is assumed to be from directivity error.

The measurements most affected by directivity errors are measurements of low reflection devices.

Typical Cause of Failure The *calibration kit load* is the most common cause of directivity specification failure.

If the load has been gaged and its performance independently verified, suspect the analyzer *test port coupler*.

To troubleshoot, refer to "Checking the Signal Separation Group" on page 4-35.

Source Match (E_{SF} and E_{SR})

E_{SF} and E_{SR} are the forward and reverse uncorrected source match terms of the driven port. They are obtained by measuring the reflection (S_{11}, S_{22}) of an open, and a short that are connected directly to the ports. Source match is a measure of the match of the coupler, as well as the match between all components from the source to the output port.

The measurements most affected by source match errors are reflection and transmission measurements of highly reflective DUTs.

Typical Cause of Failure The *calibration kit open or shor*t is the most common cause of source match specification failure.

If the open or short performance has been independently verified, then suspect the analyzer *switch splitter, step attenuator, or coupler*.

To troubleshoot, refer to "Checking the Signal Separation Group" on page 4-35.

Load Match (E_{LF} and E_{LR})

Load match is a measure of the impedance match of the test port that terminates the output of a 2-port device. The match of test port cables is included in this response. Load match error terms are characterized by measuring the S_{11} and S_{22} responses of a "thru" configuration during the calibration procedure.

The measurements most affected by load match errors are all transmission measurements, and reflection measurements of a low insertion loss two-port device, such as an airline.

Typical Cause of Failure The *calibration kit load or a bad "thru" cable* is the most common cause of load match specification failure.

If the load and cable performance are independently verified, then suspect the analyzer *test port coupler, step attenuator, or the test receiver* at the bad port.

To troubleshoot, refer to "Checking the Receiver Group" on page 4-38 or to "Checking the Signal Separation Group" on page 4-35.

Reflection Tracking (E_{RF} and E_{RR})

Reflection tracking is the difference between the frequency response of the reference path (R1 or R2path) and the frequency response of the reflection test path (A or B input path). These error terms are characterized by measuring the reflection (S_{11}, S_{22}) of the open and the short during the measurement calibration.

All reflection measurements are affected by the reflection tracking errors.

Typical Cause of Failure The *calibration kit open or short* is the most common cause of reflection tracking specification failure.

If the open or short performance has been independently verified, suspect the following:

- If both E_{RF} and E_{RR} fail
  — suspect the analyzer *switch splitter*
- If one of the track term specification fails
  — suspect the *coupler, step attenuator, or the test receiver* of the failed port

To troubleshoot, refer to “Checking the Receiver Group” on page 4-38 or to “Checking the Signal Separation Group” on page 4-35.

Transmission Tracking (E_{TF} and E_{TR})

Transmission tracking is the difference between the frequency response of the reference path (including the R input) and the frequency response of the transmission test path (including the A or B input) while measuring transmission. The response of the test port cables is included. These terms are characterized by measuring the transmission (S_{21}, S_{12}) of the “thru” configuration during the measurement calibration.

All transmission measurements are affected by transmission tracking errors.

Typical Cause of Failure The *test port cable* is the most common cause of transmission tracking specification failure.

If the test port cable performance has been independently verified, suspect the following:

- If both E_{TF} and E_{TR} fail
  — suspect the analyzer *switch splitter*
- If one of the track term specification fails
  — suspect the *coupler, step attenuator, or the test receiver* of the failed port

To troubleshoot, refer to “Checking the Receiver Group” on page 4-38 or to “Checking the Signal Separation Group” on page 4-35.

Isolation (E_{XF} and E_{XR})

Isolation, or crosstalk, is the uncorrected forward and reverse isolation error terms that represent leakage between the test ports and the signal paths. The isolation error terms are characterized by measuring transmission (S_{21}, S_{12}) with loads attached to both ports during the measurement calibration.isolation errors affect transmission measurements primarily where the measured signal level is very low.

The measurements most affected by isolation error terms are DUTs with large insertion loss. Since these terms are low in magnitude, they are usually noisy (not very repeatable).

Typical Cause of Failure A *loose cable connection or leakage between components* in the test set are the most likely cause of isolation problems.

After verifying the cable and its connections, suspect the analyzer *switch splitter, step attenuator, coupler, or receivers, and associated cabling*.

To troubleshoot, refer to "Checking the Receiver Group" on page 4-38 or to "Checking the Signal Separation Group" on page 4-35.

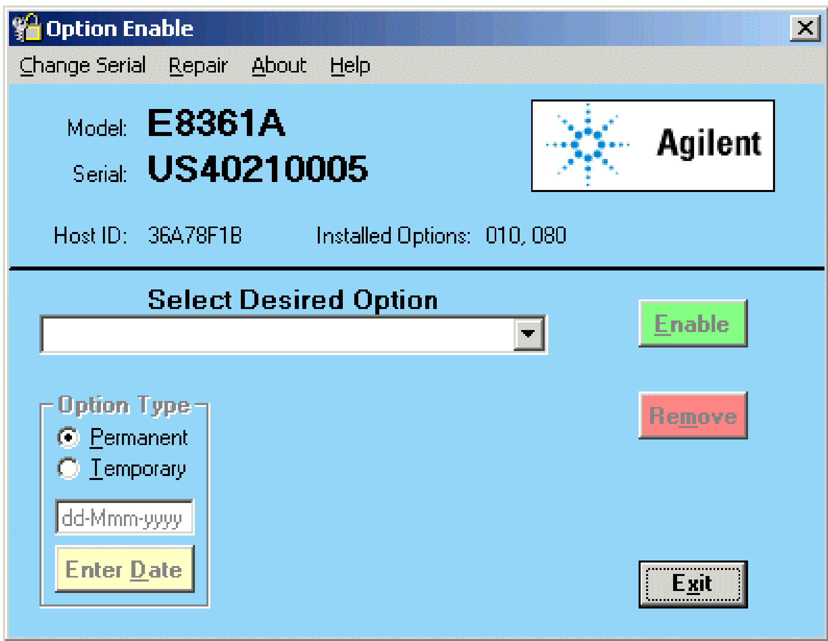
Option Enable Utility

Accessing the Option Enable Utility

To start the option enable utility:

- On the **System** menu, point to **Service**, and then click **Option Enable**.
- The dialog box illustrated in Figure 8-5 is displayed.

Figure 8-5 Option Enable Dialog Box



Option Entitlement Certificate

If you have received an "Option Entitlement Certificate", follow the instructions on the certificate, under "HOW TO USE THIS CERTIFICATE:", to obtain license key(s) for the option(s) listed on the certificate. See the important note below.

NOTE When upgrading from one model number to another, a new option entitlement certificate will be issued. When this certificate is redeemed for a license key, the automated system will ask for the instrument's Host ID. Be sure to use the new Host ID that is associated with the new model number. Using the current Host ID will cause a license to be generated that will not work with the instrument. To determine the new Host ID, use the utility at the below listed web site with the new model number.

http://na.support.keysight.com/pna/upgrades.html

Enabling or Removing Options

There are two types of options:

- Hardware: Hardware options involve adding additional hardware to the analyzer. After the proper hardware has been installed in the analyzer, the option can be enabled using the option enable utility.

  It is necessary to re-enable all hardware options if the test set motherboard is replaced.

- Software: Software options add features or functionality to the analyzer without the need for additional hardware. These options are enabled using a special keyword. They are enabled using the option enable utility.

  It is necessary to backup all installed software options if the frequency reference board is replaced.

NOTE Some applications require a license key that is provided by Keysight. If you do not have the required license key, contact Keysight for assistance. Refer to "Contacting Keysight" on page 2-7.

To enable or remove an option:

1. Start the option enable utility. Refer to "Accessing the Option Enable Utility" on page -14.
2. Click the arrow in the **Select Desired Option** box. A list of available options, similar to the list below, will appear.

   010 - Time Domain

   014 - Configurable Test Set

   080 - Frequency Offset Mode

   ??? - Enter Unlisted Option
3. Click on the option that you wish to either enable or remove, and then click **Enable** or **Remove**, whichever is appropriate.
4. If the desired option is not available in the list, select **Enter Unlisted Option**. A dialog box appears that will allow you to enter the option number. Enter the option number and follow the instructions on the display.

Repairing and Recovering Option Data

License, option, and model number data are stored in an EEPROM on the frequency reference board and written into the gen.lic file on the hard disk drive. If the data stored in either of these items is lost, it can be recovered from the other item.

NOTE If the data on both the hard disk drive and the frequency reference board is lost, it can not be recovered. Contact Keysight for assistance. Refer to "Contacting Keysight" on page 2-7.

Recovery of Data After Repair

- If the frequency reference board is replaced, use the **Repair** selection to recover data that has been lost as a result of the repair:
  1. Select **Repair** from the **Option Enable** menu bar (see Figure 8-5 on page 8-14).
  2. Click the **Freq Ref board has been replaced** check box.
  3. Click **Begin Repair**. The data is written from the gen.lic file into the EEPROM.
- If the hard disk drive is replaced, a new gen.lic file is automatically created when the **Network Analyzer** application starts, by retrieving the data from the EEPROM.

Recovery of Data if Option or Model Numbers are Incorrect

If the analyzer option or model numbers are not listed correctly on the analyzer display, in either the Option Enable Dialog Box or the About Network Analyzer display, you should regenerate the options license file, gen.lic:

1. Exit the **Network Analyzer** application.
2. Remove (or rename) the existing gen.lic file:
   a. Open **Windows Explorer** and navigate to C:\Program Files\Keysight\Network Analyzer.
   b. Delete (or rename) gen.lic.
3. Exit the **Windows Explorer** application.
4. Open the **Network Analyzer** application. The application will generate a new gen.lic file when it starts.
5. Check the option listing:
   a. On the **System** menu, point to **Service**, and then click **Option Enable**, or
   b. On the **Help** menu, click **About Network Analyzer**.

NOTE If the options are still not listed correctly, contact Keysight for assistance. Refer to "Contacting Keysight" on page 2-7.

Installing or Changing a Serial Number

It is necessary to reinstall the instrument serial number if the test set motherboard is replaced.

IMPORTANT Use extreme care when entering the serial number, as only one attempt is allowed.

1. To change a serial number, select **Change Serial** from the **Option Enable** menu bar (see Figure 8-5 on page 8-14). The current serial number is displayed. If no serial number has previously been entered, the word “NONE” will be displayed.
2. VERY CAREFULLY, type the new serial number into the space provided and then click **Change**.
3. If an error is made in entering the serial number, obtain a clear code from Keysight, enter the clear code in the space provided, and then click **Clear**. The correct serial number can then be entered.

NOTE To change an incorrect serial number, a clear-code password is required. Contact Keysight to obtain the clear-code. Refer to “Contacting Keysight” on page 2-7.

Firmware Upgrades

How to Check the Current Firmware Version

1. With the **Network Analyzer** application running, click **Help**, **About Network Analyzer**.

   A dialog box showing the current installed Application Code Version is displayed.

2. To determine if a firmware update is available, proceed to "Downloading from the Internet."

Downloading from the Internet

If your network analyzer is connected to the Internet, there are two methods available for checking the availability of, and downloading, new firmware:

- Download directly from: http://www.keysight.com/find/pna. (Select your analyzer's model number in this website to view available upgrades.)
- On the **System** menu, point to **Service**, and then click **AgileUpdate**. **AgileUpdate** compares the firmware revision currently installed in your network analyzer to the latest version available and assists you in downloading and installing the most recent version.

Operating System Recovery

Recovering from Hard Disk Drive Problems

If you suspect that you have a hard disk drive problem, go to the "Hard Drive Recovery" link on the Keysight PNA Series: Service & Support Home Page on the Internet.

The URL for the Keysight PNA Series: Service & Support Home Page is:

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

The URL for the Hard Drive Recovery page is:

http://na.support.keysight.com/pna/hdrecovery.html

Correction Constants

The analyzer stores many correction constants in non-volatile EEPROM memory. These constants enable the analyzer to produce accurate, leveled source signals and receive clean test signals.

Storing Correction Constants

After performing any adjustment listed on page 3-40 in this manual, store the correction constants to a backup file on the analyzer hard disk drive by performing these steps:

- Navigate to the EEPROM Backup Utility, located at:
  C:\Program Files\Keysight\Network Analyzer\Service\eebackup.exe
- **Run** the program.
- Click **Backup EEPROM**.
- Click **Exit** when the program has finished.

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KEYSIGHT
TECHNOLOGIES

This information is subject to change without notice.

December 1, 2014

N5232-90001
www.keysight.com