

Maintenance Manual

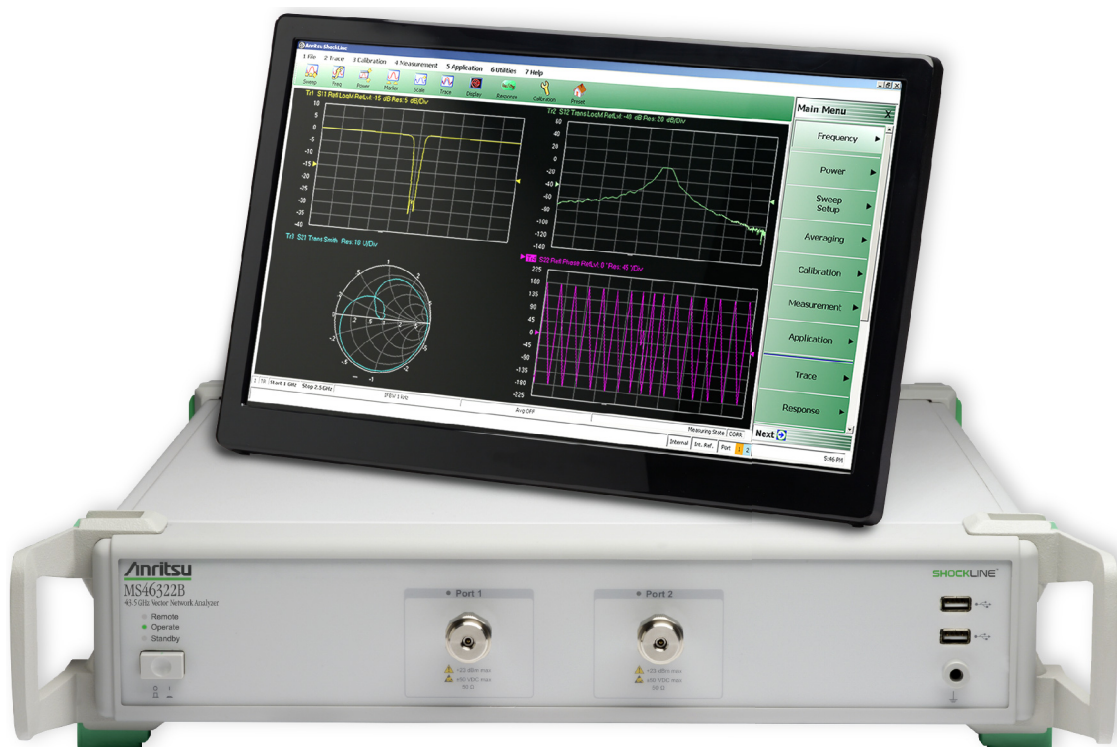
ShockLine™ Vector Network Analyzer

MS46322A

1 MHz to 4 GHz
1 MHz to 8 GHz
1 MHz to 14 GHz
1 MHz to 20 GHz
1 MHz to 30 GHz
1 MHz to 43.5 GHz

MS46322B

1 MHz to 8 GHz
1 MHz to 20 GHz
1 MHz to 43.5 GHz



Anritsu

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UPDATES

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Chapter 1 — General Information

1-1 Introduction

This manual provides service and maintenance information for the Anritsu ShockLine MS46322A/B Vector Network Analyzer. The information includes product description, performance verification procedures, parts removal and replacement procedures, and troubleshooting information.

1-2 Description

The ShockLine MS46322A/B Vector Network Analyzer is an instrument system that contains a built-in source, test set, and analyzer. Designed for manufacturing applications, the ShockLine MS46322A/B supports remote test programming through LAN communications. Test results can be displayed real time on an external video monitor.

Standard Accessories

Each instrument includes:

- Power Cord

Available Options

The main system options of MS46322A are:

- MS46322A-001 – Rack Mount
- MS46322A-002 – Time Domain
- MS46322A-004 – Frequency Option, 1 MHz to 4 GHz, type N(f) test ports
- MS46322A-010 – Frequency Option, 1 MHz to 8 GHz, type N(f) test ports
- MS46322A-014 – Frequency Option, 1 MHz to 14 GHz, type K(m) test ports
- MS46322A-020 – Frequency Option, 1 MHz to 20 GHz, type K(m) test ports
- MS46322A-030 – Frequency Option, 1 MHz to 30 GHz, type K(m) test ports
- MS46322A-040 – Frequency Option, 1 MHz to 43.5 GHz, type K(m) test ports

The main system options of MS46322B are:

- MS46322B-001 – Rack Mount
- MS46322B-002 – Time Domain
- MS46322B-010 – Frequency Option, 1 MHz to 8 GHz, type N(f) test ports
- MS46322B-020 – Frequency Option, 1 MHz to 20 GHz, type K(m) test ports
- MS46322B-024 – Universal Fixture Extraction Option
- MS46322B-040 – Frequency Option, 1 MHz to 43.5 GHz, type K(m) test ports
- MS46322B-043 – Frequency Option, 1 MHz to 43.5 GHz, type K(m) test ports

Identification Number

All Anritsu MS46322A/B instruments are assigned a seven-digit ID number (Serial Number), such as “1334203”. This number appears on a decal affixed to the rear panel.

When corresponding with Anritsu Customer Service, please use this identification number with reference to the specific instrument model number and installed options.

For example, a MS46322A/B, Option 2, Option 10, Serial Number 1234567.

1-3 Related Documents

Other documents are available for the MS46322A/B at the Anritsu web site at: www.anritsu.com

- ShockLine MS46322A VNA Technical Data Sheet – part number 11410-00751
- ShockLine MS46322B VNA Technical Data Sheet – part number 11410-00996
- ShockLine MS46322A/B VNA Operation Manual – part number 10410-00335
- ShockLine MS46122A/B, MS46131A, MS46322A/B VNA Calibration and Measurement Guide – part number 10410-00336
- ShockLine MS46121A/B, MS46122A/B, MS46131A, MS46322A/B VNA User Interface Reference Manual – part number 10410-00337
- ShockLine MS4612xA/B, MS46131A, MS46322A/B, MS4652xB VNA Programming Manual – part number 10410-00746
- ShockLine Product Information, Compliance, and Safety – 10100-00067

1-4 Basic Maintenance

Maintain Operating System Integrity

The Microsoft Windows Embedded operation system on the ShockLine MS46322A/B is configured for optimum performance when the instrument leaves the factory. To maintain the system's operating integrity, follow proper Windows shutdown procedure and DO NOT modify the operating system configuration, the firewall settings, the system registry, the solid state drive partitions, or the Anritsu user account.

Antivirus Protection – Best Practices

If the VNA is attached to a network, best practices recommend installing antivirus software. Anritsu recommends connecting the instrument only to a secure network.

The user assumes the responsibility to provide virus protection because this is not supplied with the instrument. Contact your network administrator for information about your network security and antivirus protection policies.

Note	Stability of the system is not guaranteed with all antivirus software.
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Windows OS Updates

Not all Microsoft updates are compatible with the ShockLine MS46322A/B VNA and, if installed, may affect the performance of the instrument.

Caution	Changing some of the default Windows settings may cause a loss of instrument control or undesired instrument behavior. Changing the Windows Regional and Language Options settings may cause unstable menu operation. These settings must be maintained as English (United States) as is set at the factory by default.
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Solid State Drive Data Backup

Anritsu recommends that you make a backup copy of your critical data stored on the VNA solid state drive as often as possible.

Note

Anritsu reserves the right to reformat or replace the VNAs solid state drive as part of the repair. In such incidence, all user data on the drive will be erased.

Performance Verification

Test instruments are often put on a regular interval to re-verify their performance to ensure accuracy, reliability, and cost of ownership. The details of the performance verification procedures are included in [Chapter 2 — MS46322A Performance Verification](#) and [Chapter 3 — MS46322B Performance Verification](#).

Repair Service

In the event that the MS46322A/B VNA requires repair, contact your local Anritsu Service Center. See [Section 1-5 “Anritsu Customer Service Centers”](#) for contact information. When contacting Anritsu Service Center, please provide the following information:

- Your company name and address
- The model number and serial number of the instrument
- A detailed description of the problem

1-5 Anritsu Customer Service Centers

For the latest service and sales information in your area, please visit the following URL:

<https://www.anritsu.com/contact-us>

Choose a country for regional contact information.

1-6 Recommended Test Equipment

The following test equipment is recommended for use in testing and maintaining the ShockLine MS46322A (Table 1-1) and MS46322B (Table 1-2).

Table 1-1. Recommended Test Equipment for MS46322A (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
Calibration Tee (For Opt. 4 or 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8	P
Calibration Tee (For Opt. 4 or 10)	Frequency: DC to 8 GHz Connector: N(f)	Anritsu Model OSLN50A-8 or TOSLN50A-8	P
Verification Kit (For Opt. 4 or 10)	Connector: N Type	Anritsu Model 3663-2 (Includes Verification Software)	P
Torque Wrench	3/4 in Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200	P, A
Adapter (For Opt. 4 or 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50	P, A
Adapter (For Opt. 4 or 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50	P, A
RF Coaxial Cable	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2	P, A
Calibration Tee (For Opt. 14, 20, 30, or 40)	Frequency: DC to 40 GHz Connector: K(m)	Anritsu Model TOSLK50A-40	P
Calibration Tee (For Opt. 14, 20, 30, or 40)	Frequency: DC to 40 GHz Connector: K(f)	Anritsu Model TOSLK50A-40	P
Verification Kit (For Opt. 14, 20, 30 or 40)	Connector: K Type	Anritsu Model 3668-2 (Includes Verification Software)	P
Torque Wrench (For Opt. 14, 20, 30, or 40)	5/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201	P, A
Torque Wrench (For Opt. 14, 20, 30, or 40)	13/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-203	P
Adapter (For Opt. 14, 20, 30, or 40)	Connector: K(m) to K(f)	Anritsu Model 33KKF50B	P
Adapter (For Opt. 14, 20, 30, or 40)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50B	P, A
Interface Cable	Ethernet: RJ45, cross-over, Cat.5E Ethernet: RJ45, Cat.5E	Anritsu Part Number 3-806-152 Anritsu Part Number 2000-1371-R	P
Personal Computer	Operating System: Windows 7 Interface: Ethernet (RJ45) Software: National Instruments VISA version 4.4.1 or later	Any	P
Calibration Kit (For Opt. 4 or 10)	Frequency: DC to 18 GHz Connector: N Type	Anritsu Model 3653A	A
Calibration Kit (For Opt. 14, 20, 30, or 40)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model 3652A	A
Frequency Counter	Frequency: 10 MHz to 20 GHz	Anritsu Model MF2412B with Option 3 or MF2412C with Option 3	A

Table 1-1. Recommended Test Equipment for MS46322A (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
Power Sensor (For Opt. 4 or 10)	Frequency: 10 MHz to 18 GHz Connector Type: N(m)	Anritsu Model MA24118A	A
Power Sensor (For Opt. 14, 20, 30, or 40)	Frequency: 10 MHz to 40 GHz Connector Type: K(m)	Anritsu Model SC8268	A

a. P = Performance Verification; A = Adjustment

Table 1-2. Recommended Test Equipment for MS46322B (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
Calibration Tee (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8	P
Calibration Tee (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(f)	Anritsu Model OSLN50A-8 or TOSLN50A-8	P
Verification Kit (For Opt. 10)	Connector: N Type	Anritsu Model 3663-3 (Includes Verification Software)	P
Torque Wrench (For Opt. 10)	3/4 in Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200	P, A
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50	P, A
Adapter (For Opt. 10, 40, or 43)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50	P, A
RF Coaxial Cable (For Opt. 10, 20 or 40)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2	P, A
Calibration Tee (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m)	Anritsu Model TOSLK50A-40	P
Calibration Tee (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f)	Anritsu Model TOSLK50A-40	P
Verification Kit (For Opt. 20 or 40)	Connector: K Type	Anritsu Model 3668-4 (Includes Verification Software)	P
Calibration Tee (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(m)	Anritsu Model TOSLK50A-43.5	P
Calibration Tee (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSLK50A-43.5	P
Verification Kit (For Opt. 43)	Connector: K type	Anritsu Model 3668-4 (Includes Verification Software)	P
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50A-2	P, A
Torque Wrench (For Opt. 20, 40, or 43)	5/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201	P, A
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-203	P

Table 1-2. Recommended Test Equipment for MS46322B (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
Adapter (For Opt. 20 or 40)	Connector: K(m) to K(f)	Anritsu Model 33KKF50B	P
Adapter (For Opt. 20 or 40)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50B	P, A
Adapter (For Opt. 43)	Connector: K(m) to K(f)	Anritsu Model 33KKF50C	P
Adapter (For Opt. 43)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50C	P, A
Interface Cable	Ethernet: RJ45, cross-over, Cat.5E Ethernet: RJ45, Cat.5E	Anritsu Part Number 3-806-152 Anritsu Part Number 2000-1371-R	P
Personal Computer	Operating System: Windows 7 or higher Interface: Ethernet (RJ45) Software: National Instruments VISA version 4.4.1 or later	Any	P
Calibration Kit (For Opt. 10)	Frequency: DC to 18 GHz Connector: N Type	Anritsu Model 3653A	A
Calibration Kit (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model 3652A	A
Frequency Counter	Frequency: 10 MHz to 20 GHz	Anritsu Model MF2412B with Option 3 or MF2412C with Option 3	A
Power Sensor (For Opt. 10)	Frequency: 10 MHz to 18 GHz Connector Type: N(m)	Anritsu Model MA24118A	A
Power Sensor (For Opt. 20, 40, or 43)	Frequency: 10 MHz to 40 GHz Connector Type: K(m)	Anritsu Model SC8268	A
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A	P
Power Sensor (For Opt. 10)	Frequency: 100 kHz to 18 GHz Connector Type: N(m)	Anritsu Model SC7400	P
Power Sensor (For Opt. 20, 40, or 43)	Frequency: 100 kHz to 40 GHz Connector Type: K(m)	Anritsu Model SC7413	P
Termination (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector Type: K(m)	Anritsu Model 28K50A	P

a. P = Performance Verification; A = Adjustment

1-7 Replaceable Parts and Assemblies

To ensure that the correct options are provided on the replacement assembly when ordering a VNA Module Assembly, all installed instrument options must be declared on the order.

The installed options are listed on a label on the rear panel of the MS46322A/B. They can also be viewed in the ShockLine application About box display (Select 9 Help | 1.About Anritsu).

[Table 1-3](#) and [Table 1-4](#) below summarize the available replaceable parts and assemblies. Refer to [Chapter 6, “Assembly Removal and Replacement”](#) for detailed procedures.

Table 1-3. MS46322A Replaceable Parts and Assemblies (1 of 2)

Part Number	Description
ND81295-RFB	VNA Module Assembly for MS46322A instruments with Option 4
ND81296-RFB	VNA Module Assembly for MS46322A instruments with Option 10
ND81297-RFB	VNA Module Assembly for MS46322A instruments with Option 14
ND81298-RFB	VNA Module Assembly for MS46322A instruments with Option 20
ND81299-RFB	VNA Module Assembly for MS46322A instruments with Option 30
ND81300-RFB	VNA Module Assembly for MS46322A instruments with Option 40
ND80983-RFB	CPU Assembly
ND80984-RFB	Solid State Drive with Operating System software
ND80997-RFB	Solid State Drive with Operating System software (For Revision 2 instrument only)
ND80994-RFB	Back Plane PCB Assembly
ND80995-RFB	IO Handler PCB Assembly (For Revision 2 instrument only)
ND81163	Front Panel LED PCB Assembly
ND80986	Fan Assembly, Right
ND80987	Fan Assembly, Left
ND80989	Fan Assembly, Rear
3-40-191	Power Supply Assembly
ND80990	19V CPU Main Board Cable Assembly
ND80991	5V Power Supply Cable Assembly
ND80992	12V and 3.3V Power Supply Cable Assembly
ND81711	VNA Module 12V Power Cable
3-513-122	N female Test Port Adapter (For Instruments with Options 4 or 10)
3-75651	K male Test Port Adapter (For Revision 1 Instruments with Options 14, 20, 30 or 40)
3-71353	K male Test Port Adapter (For Revision 2 Instruments with Options 14, 20, 30 or 40)
3-806-279	RF Cable, SMA(m) to SMA(m), N female Test Port Adapter to VNA Module Assembly (For instruments with Options 4 or 10)

Table 1-3. MS46322A Replaceable Parts and Assemblies (2 of 2)

Part Number	Description
3-806-283	RF Cable, BNC(f) to MCX(m), 10 MHz Ref In or Trigger TTL
3-806-288	Interface Cable, USB Mini B to 4 pin header, VNA Module Assembly to CPU Module
3-806-315	RF Cable, K(f) to K(m), K male Test Port Adapter to VNA Module Assembly (For Revision 1 Instruments with Options 14, 20, 30 or 40)
3-806-362	RF Cable, K(m) to K(m), K male Test Port Adapter to VNA Module Assembly (For Revision 2 Instruments with Options 14, 20, 30 or 40)

Table 1-4. MS46322B Replaceable Parts and Assemblies (1 of 2)

Part Number	Description
3-ND83420-RFB	VNA Module Assembly for MS46322B instruments with Option 10 with serial number < 1822002.
3-ND83985-RFB	VNA Module Assembly for MS46322B instruments with Option 10 with serial number ≥ 1822002.
3-ND83421-RFB	VNA Module Assembly for MS46322B instruments with Option 20 with serial number < 1822002, except for 1819001
3-ND83986-RFB	VNA Module Assembly for MS46322B instruments with Option 20 with serial number ≥ 1822002, including for 1819001
3-ND83422-RFB	VNA Module Assembly for MS46322B instruments with Option 40 with serial number < 1822002.
3-ND83987-RFB	VNA Module Assembly for MS46322B instruments with Option 40 with serial number ≥ 1822002.
3-ND84774-RFB	VNA Module Assembly for MS46322B instruments with Option 43
3-ND83587-RFB	CPU Assembly for Rev 1 and 2 instruments with serial number < 2234001
3-ND87247-RFB	CPU Assembly for Rev 3 instruments with serial number ≥ 2234001
3-ND87278	CPU Assembly Conversion Kit for Rev 1 and 2 Instruments to Rev 3 Instrument
3-ND83423	Solid State Drive with Operating System Software (Win 7)
3-ND85711	Solid State Drive with Operating System Software (Win 10)
3-ND80994	Back Plane PCB Assembly for Rev 1 and 2 instruments with serial number < 2234001
3-ND87249-RFB	Back Plane PCB Assembly for Rev 3 instruments with serial number ≥ 2234001
3-ND80995-RFB	IO Handler PCB Assembly
3-ND81163	Front Panel LED PCB Assembly
3-ND80986	Fan Assembly, Right
3-ND80987	Fan Assembly, Left
3-ND83585	Fan Assembly, Rear
3-40-191	Power Supply Assembly
3-ND83586	19V CPU Main Board Cable Assembly

Table 1-4. MS46322B Replaceable Parts and Assemblies (2 of 2)

Part Number	Description
3-ND80991	5V Power Supply Cable Assembly
3-ND80992	12V and 3.3V Power Supply Cable Assembly
3-ND81711	VNA Module 12V Power Cable
3-513-122	N female Test Port Adapter (For Instruments with Option 10)
3-71353	K male Test Port Adapter (For Instruments with Options 20 or 40)
3-84738	K male Test Port Adapter (For Instruments with Option 43)
3-806-279	RF Cable, SMA(m) to SMA(m), N female Test Port Adapter to VNA Module Assembly (For instruments with Option 10)
3-806-362	RF Cable, K(m) to K(m), K male Test Port Adapter to VNA Module Assembly (For Instruments with Options 20, 40, or 43)
3-806-283	RF Cable, BNC(f) to MCX(m), 10 MHz Ref In or Trigger TTL
3-806-288	Interface Cable, USB Mini B to 4 pin header, VNA Module Assembly to CPU Module

Chapter 2 — MS46322A Performance Verification

2-1 Introduction to Performance Verification

This chapter provides procedures to be used to verify the performance of ShockLine MS46322A.

There are many levels to the concept of VNA “verification”.

On the explicit VNA hardware level are operational checkout items such as port power and noise levels.

On the calibrated instrument level (which includes the VNA and the calibration kit or AutoCal™ Automatic Calibrator) are the system residual specifications (corrected directivity, source match, load match, and tracking) which are measured using airlines (traceable impedance standards).

An intermediate level which can look at overall system behavior (VNA, calibration kit, cables, environment) in a traceable fashion is through the use of a verification kit. While not intended for day-to-day use, the verification kit can provide a periodic check on system behavior without going through the rigor needed for full residual analysis (which can usually be done less often).

While there are many ways of verifying VNA performance, sometimes simpler procedures are desired. The use of verification kit, available from Anritsu, is a simpler method of verifying the measurement capabilities of the instrument by analyzing the measurement of artifacts that are traceable to International System of Units (SI) via national metrology institutes.

2-2 VNA Traceability and Uncertainty

Vector network analyzers (VNAs) are precision instruments for making high frequency and broadband measurements in devices, components, and instrumentations. The accuracy of these measurements is affirmed by demonstrated and adequate traceability of measurement standards. Metrological traceability, per International Vocabulary of Metrology, JCGM 200:2012, is property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. For the accuracy of VNAs and quality assurance by users, two standard approaches were created to ensure sound metrology traceability. One is to construct tight uncertainty budget and specifications in three tiers from the ground up, and the other is to develop a calibration hierarchy for systematic verification. The three-tier process is depicted in the sections below.

First Tier of Uncertainty – The VNA Calibration

A traceable VNA itself requires proper calibration for several key quantities, e.g., frequency, power level, and high level noise, via traceable standards to the SI units. Each contributing uncertainty was evaluated at the time of instrument calibration.

The inception of a precision VNA is accuracy-enhanced 50 ohm impedance, which is characterized in lieu of coaxial transmission lines all with proper propagation properties throughout the whole measurement systems including the device-under-test. A transmission line for VNAs is best represented by a coaxial airline, which was precisely selected and machined based on the electromagnetic properties such as conductivity, skin depth, and etc. Therefore, the dimensional measurement accuracy of the airline gives out the first tier of measurement uncertainty of impedance quantity.

Second Tier of Uncertainty – Systematic Measurement Errors

The second tier of uncertainty, corrected or residual uncertainty, is the result of the accuracy enhancement of VNA calibration to remove systematic errors. Systematic measurement errors are components of measurement error that in replicate measurements remains constant or values in a predictable manner. This accuracy enhancement is usually the function of calibration kits. The choice of calibration kits used will dictate the level of uncertainties for the intended measurements or applications.

Third Tier of Uncertainty – Random Measurement Error

The third tier of uncertainty is random measurement error that in replicate measurements varies in an unpredictable manner. The examples are connector repeatability, cable stability, and etc. Random measurement error equals measurement error minus systematic measurement error.

Standards and Verification

Most often instrument end users demand system verifications in order to provide quality check or assurance. This is accomplished by utilizing a set of known or characterized devices, e.g., verification kit, for comparison. It can also be done by using devices that are different from the calibration kit. The calibration hierarchy of verification uncertainty is built through unbroken chain comparisons with the national standards, as illustrated in Figure 2-1.

- Physical standards → airline dimensionality → impedance standard → residuals and port parameters
- Basic power standards → power sensors → power accuracy specifications
- Basic time standards → frequency reference source → frequency accuracy

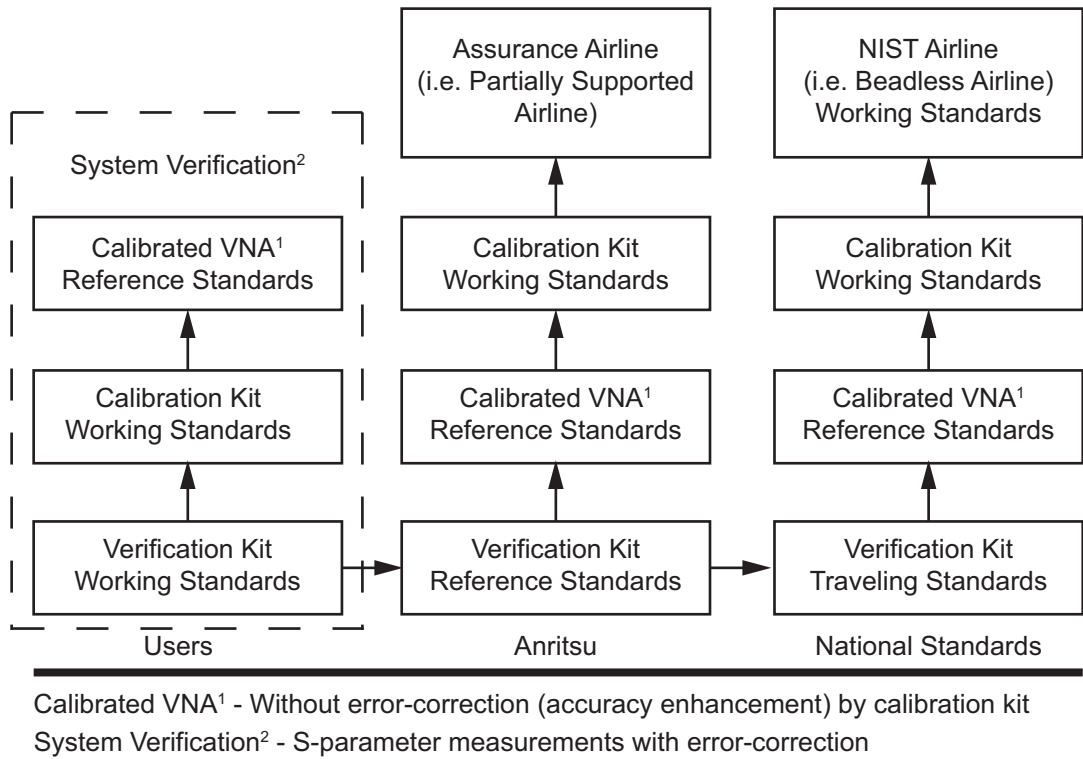


Figure 2-1. VNA Traceability

2-3 Electrostatic Discharge Prevention

A VNA is a precision electronic instrument consisting of components and/or circuitries that are sensitive to electrostatic discharge (ESD). In order to prevent intrusion of electrostatic charge and mitigate risk of costly ESD damage, it is important to take preventive measures to protect against ESD before and during usage. For example, prior to connecting a test port cable to the VNA test port, take steps to eliminate the static charges built up on the test port cable. This can be done by terminating the open end of the cable with the short from the calibration kit and then grounding the outer conductor of the connector on the cable.

2-4 Calibration and Measurement Conditions

The surrounding environmental conditions and the condition and stability of the test port connectors, thru cable, and calibration kit determine system measurement integrity to a large extent.

These are all user controlled conditions, and as such, should be evaluated periodically for impact on system performance.

The standard conditions specified below must be observed when performing any of the operations in this chapter – both during calibration and during measurement.

- Warm-up Time:
 - 30 minutes
- Environmental Conditions
 - Temperature
 - $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, with $< 1\text{ }^{\circ}\text{C}$ variation from calibration temperature
 - Relative Humidity
 - 20-50% recommended

Using best measurement practices and maintaining environmental conditions within specified limits during calibration and measurements are critical requirements for performing system verification that involves reliable high-quality measurements with associated measurement uncertainties. Note that both of these key factors affect the measurement uncertainty.

2-5 System Verification

The system verification procedures verify the measurement capabilities of the VNA, calibration kit, test port cables, and any required adapters as a system by analyzing the measurement of artifacts that are traceable to national standards laboratories. The procedures are automated by using the automated System Verification Software (PVS), in conjunction with the appropriate Anritsu Calibration and Verification Kits listed in the table below.

Table 2-1. Equipment Required for MS46322A System Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
Calibration Kit (For Opt. 4 or 10)	Frequency: DC to 8 GHz Connector: N (m)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Calibration Kit (For Opt. 4 or 10)	Frequency: DC to 8 GHz Connector: N (f)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Verification Kit (For Opt. 4 or 10)	Connector: N Type	Anritsu Model 3663-2 (Includes System Verification Software)
Adapter (For Opt. 4 or 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50
Adapter (For Opt. 4 or 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Torque Wrench (For Opt. 4 or 10)	3/4 in Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Calibration Tee (For Opt. 14, 20, 30 or 40)	Frequency: DC to 40 GHz Connector: K(m)	Anritsu Model TOSLK50A-40
Calibration Tee (For Opt. 14, 20, 30 or 40)	Frequency: DC to 40 GHz Connector: K(f)	Anritsu Model TOSLKF50A-40
Verification Kit (For Opt. 14, 20, 30 or 40)	Connector: K Type	Anritsu Model 3668-2 (Includes System Verification Software)
Torque Wrench (For Opt. 14, 20, 30 or 40)	5/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Torque Wrench (For Opt. 14, 20, 30 or 40)	13/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-203
Adapter (For Opt. 14, 20, 30 or 40)	Connector: K(m) to K(f)	Anritsu Model 33KKF50B
Adapter (For Opt. 14, 20, 30 or 40)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50B
RF Coaxial Cable	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2
Interface Cable	Ethernet: RJ45, cross-over, Cat.5E Ethernet: RJ45, Cat.5E	Anritsu Part Number 3-806-152 Anritsu Part Number 2000-1371-R
Personal Computer	Operating System: Windows 7 or higher Interface: Ethernet, RJ45 Software: National Instruments VISA version 4.4.1 or later	Any

Caution: The use of non-Anritsu calibration kits or verification kits is not supported.

The System Performance Verification Software guides the user to perform a full 12-term calibration on the VNA using the appropriate calibration kit, measure the S-parameters of the impedance transfer standards in the verification kit, and confirm that the measured values are within the specified measurement uncertainty.

The verification kit consists of four impedance transfer standards, and each are supplied with S-parameter data. Each standard verifies a primary S-parameter with uncertainty windows provided at each data point as follows:

- 20 dB Attenuation Standard – S_{21} , S_{12} Magnitude and Phase
- 50 dB Attenuation Standard – S_{21} , S_{12} Magnitude and Phase
- 50 Ohm Air Line Standard – S_{21} , S_{12} Phase
- 25 Ohm Mismatch (Beatty) Standard – S_{11} , S_{22} Magnitude

Pass/Fail status of the measurements is displayed on the computer. The software can also provide hardcopy (printout) of the test reports which include the measured data, the measurement uncertainties, and the Pass/Fail status.

Verification Result Determination

The software verification process compares the measured S-parameter data of the impedance transfer standards against the original standard (characterization) data for those devices that was obtained using the Factory Standard Vector Network Analyzer (at Anritsu).

The Factory Standard Vector Network Analyzer system is traceable to International System of Units (SI) through the impedance Standards of the Anritsu Calibration laboratory. These standards are traceable to International System of Units (SI) through precision mechanical measurements, microwave theory impedance derivation methods, and electrical impedance comparison measurements.

At each frequency point, the verification measurement is compared to the characterization measurement in the context of the uncertainties. If the delta between the two measurements is consistent with the uncertainty window, the measurement is considered acceptable at that point.

The metric of comparison, termed E_n , is a check to see if the measurement differences are consistent with the uncertainty windows of both the characterization and the verification measurements. The quantity is shown in the following formula:

$$E_n = \frac{|X_{xy}^{\text{char}} - X_{xy}^{\text{ver}}|}{\sqrt{(U_{xy}^{\text{char}})^2 + (U_{xy}^{\text{ver}})^2}}$$

Equation 2-1

where:

- The numerator contains the magnitude or phase of S-parameters measured during characterization (by Anritsu) and during verification (by the user).
- The denominator contains the respective uncertainties.

These uncertainties are calculated based on the VNA, the calibration kit, and repeatability. If this quantity E_n is less than 1, then the measurements during the two phases are within the overlap of the uncertainties and one can consider the measurements “equivalent” and, in some sense, verified.

The quality of the verification results is very dependent on the degree of care taken by the user in maintaining, calibrating, and using the system. The most critical factors are:

- The stability and quality of the devices in the calibration kit and verification kit.
- The condition of the VNA test port connectors and test port cables.

- The pin depths of all connectors and the proper torquing of connections. These same factors also affect the VNA measurement quality.

Consult the reference manual supplied with Anritsu Calibration Kits and Verification Kits for proper use, care, and maintenance of the devices contained in these kits.

2-6 System Verification Procedure

The System Verification procedure is described below. The procedure assumes that the System Verification Software has been installed to an External Personal Computer running Microsoft Windows Operating System and the National Instruments VISA runtime.

Equipment Required

- Personal Computer:
 - With Microsoft Windows Operating System
 - With National Instruments VISA runtime
 - Ethernet interface cable
- Anritsu Calibration Kit (Refer to [Table 2-1, “Equipment Required for MS46322A System Verification” on page 2-4](#))
- Anritsu Verification Kit (Refer to [Table 2-1](#))
- Anritsu Test Port Cables (Refer to [Table 2-1](#))

Special Precautions

When performing the procedures, observe the following precautions:

- Minimize vibration and movement of the system, attached components, and test cables.
- Clean and check the pin depth and condition of all adapters, test port cables, calibration components, and impedance transfer standards.
- Pre-shape the test cables so as to minimize their movement during calibration and measurement activities.

Procedure

1. Turn on power to the PC controller.
2. Install the MS46322A system verification software, which can be found on the USB flash drive supplied with the 366x-2 verification kit, to the PC controller. Refer to Section 6 of the ShockLine Series Vector Network Analyzers Verification Kits and Performance Verification Software Quick Start Guide, PN 10410-00740, for instructions.
3. Use a Cat5-E Ethernet cable to connect the ShockLine MS46322A to a Local Area Network port that is close to the PC controller using DHCP server of the LAN for obtaining an IP address. Alternatively, use a Cat5-E Ethernet Crossover cable to connect the ShockLine MS46322A directly to the PC Controller Ethernet port using static IP address. Refer to the Section 3-6 of MS46322A/B Operation Manual, PN 10410-00335, for setup procedures.
4. Turn on the ShockLine MS46322A and allow the instrument to warm up for 30 minutes.
5. For Instruments with N(f) Test Ports, prepare the test equipment as follows:
 - a. Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.
 - b. Install the Thru Cable with the Adapter to Port 2 of the ShockLine MS46322A.

6. For Instruments with K(m) Test Ports, prepare the test equipment as follows:
 - a. Install the 33KKF50B adapter to the male end of the 3670K50-2 Thru Cable. Use torque wrench to tighten the K(m) to K(f) connection so it does not work itself loose during the test.
 - b. Install the female end of the Thru Cable to Port 2 of the ShockLine MS46322A.
 - c. Install the 33KFKF50B adapter to Port 1 of the ShockLine MS46322A.
7. Run the ShockLine MS46322A Verification software on the PC controller. Click the **Begin VNA Verification** button to start.
8. On the displayed dialog box, select VXI-11 and then set the IP Address to that of the instrument.
9. Click on **Check VNA Connection** button to verify that the PC controller is communicating with the ShockLine MS46322A. Click the **Next** button and then enter the Operator information.
10. Insert the USB flash drive that is supplied with the verification kit to an available USB port on the PC controller. Click the **Next** button and then set the data location of the verification software to the USB flash drive when prompted. Click the **Next** button to continue.
11. Select the appropriate VNA Model series and Test Definition Descriptor. Click the **Next** button to continue.
12. Enter the Calibration Kit info and then click the **Next** button twice to continue.
13. Click the **Start VNA Measurements** button and then follow the directions that are displayed on the computer to perform calibration with the appropriate calibration kit.

Caution	Use an appropriate torque wrench to ensure proper connection of calibration devices during calibration.
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14. Follow the directions on the computer to perform measurements of the four impedance transfer standards of the verification kit.

Note	<p>The user can run all the automated tests in a consecutive fashion or run individual test selectively. If all are selected, the test sequences is:</p> <ul style="list-style-type: none">• VNA Calibration• Airline (DAT) Measurements• Airline (UNC) Uncertainty Computation [Pass/Fail Determination]• Beatty Airline (DAT) Measurements• Beatty Airline (UNC) Uncertainty Computation• 20 dB Offset (Pad) (DAT) Measurements• 20 dB Offset (Pad) (UNC) Uncertainty Computation• 50 dB Offset (Pad) (DAT) Measurements• 50 dB Offset (Pad) (UNC) Uncertainty Computation
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15. After all tests have been completed, print the test results and attach the printouts to the test record in [Appendix A, “ShockLine MS46322A/B System Performance Test Record”](#).

Each test generates a data report file in TEXT (ASCII) file format. The data report files can be viewed and printed either using the software built-in “Print” function or other software applications, such as Notepad or other word processors. The data report files are:

Note

- 20 DB OFFSET (UNC) #VER.TXT
- 50 DB OFFSET (UNC) #VER.TXT
- AIRLINE (UNC) #VER.TXT
- BEATTY (UNC) #VER.TXT

These files can be found in the following folder on the hard drive of the PC controller:

C:\Anritsu ShockLine Verification\VNA_Reports\MS46322A_xxxxxxx

[where xxxxxx is the serial number of the ShockLine MS46322A being tested]

If Verification Fails

If the verification fails, then check the quality, cleanliness, and installation methods for the calibration and verification components. Specifically, check:

- The VNA test port connectors
- The calibration tee
- The impedance transfer standards
- The test port cables, for damage and cleanliness
- The test port cables, for proper connection and torquing
- The test port cables, for phase stability

These are the most common causes for verification failures.

Chapter 3 — MS46322B Performance Verification

3-1 Introduction to Performance Verification

This chapter provides procedures to be used to verify the performance of ShockLine MS46322B.

There are many levels to the concept of VNA “verification”.

On the explicit VNA hardware level are operational checkout items such as port power and noise levels.

On the calibrated instrument level (which includes the VNA and the calibration kit or AutoCal Automatic Calibrator) are the system residual specifications (corrected directivity, source match, load match, and tracking) which are measured using airlines (traceable impedance standards).

An intermediate level which can look at overall system behavior (VNA, calibration kit, cables, environment) in a traceable fashion is through the use of a verification kit. While not intended for day-to-day use, the verification kit can provide a periodic check on system behavior without going through the rigor needed for full residual analysis (which can usually be done less often).

While there are many ways of verifying VNA performance, sometimes simpler procedures are desired. The use of verification kit, available from Anritsu, is a simpler method of verifying the measurement capabilities of the instrument by analyzing the measurement of artifacts that are traceable to International System of Units (SI) via national metrology institutes.

3-2 VNA Traceability and Uncertainty

Vector network analyzers (VNAs) are precision instruments for making high frequency and broadband measurements in devices, components, and instrumentations. The accuracy of these measurements is affirmed by demonstrated and adequate traceability of measurement standards. Metrological traceability, per International Vocabulary of Metrology, JCGM 200:2012, is property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. For the accuracy of VNAs and quality assurance by users, two standard approaches were created to ensure sound metrology traceability. One is to construct tight uncertainty budget and specifications in three tiers from the ground up, and the other is to develop a calibration hierarchy for systematic verification. The three-tier process is depicted in the sections below.

First Tier of Uncertainty – The VNA Calibration

A traceable VNA itself requires proper calibration for several key quantities, e.g., frequency, power level, and high level noise, via traceable standards to the SI units. Each contributing uncertainty was evaluated at the time of instrument calibration.

The inception of a precision VNA is accuracy-enhanced 50 ohm impedance, which is characterized in lieu of coaxial transmission lines all with proper propagation properties throughout the whole measurement systems including the device-under-test. A transmission line for VNAs is best represented by a coaxial airline, which was precisely selected and machined based on the electromagnetic properties such as conductivity, skin depth, and etc. Therefore, the dimensional measurement accuracy of the airline gives out the first tier of measurement uncertainty of impedance quantity.

Second Tier of Uncertainty – Systematic Measurement Errors

The second tier of uncertainty, corrected or residual uncertainty, is the result of the accuracy enhancement of VNA calibration to remove systematic errors. Systematic measurement errors are components of measurement error that in replicate measurements remains constant or values in a predictable manner. This accuracy enhancement is usually the function of calibration kits. The choice of calibration kits used will dictate the level of uncertainties for the intended measurements or applications.

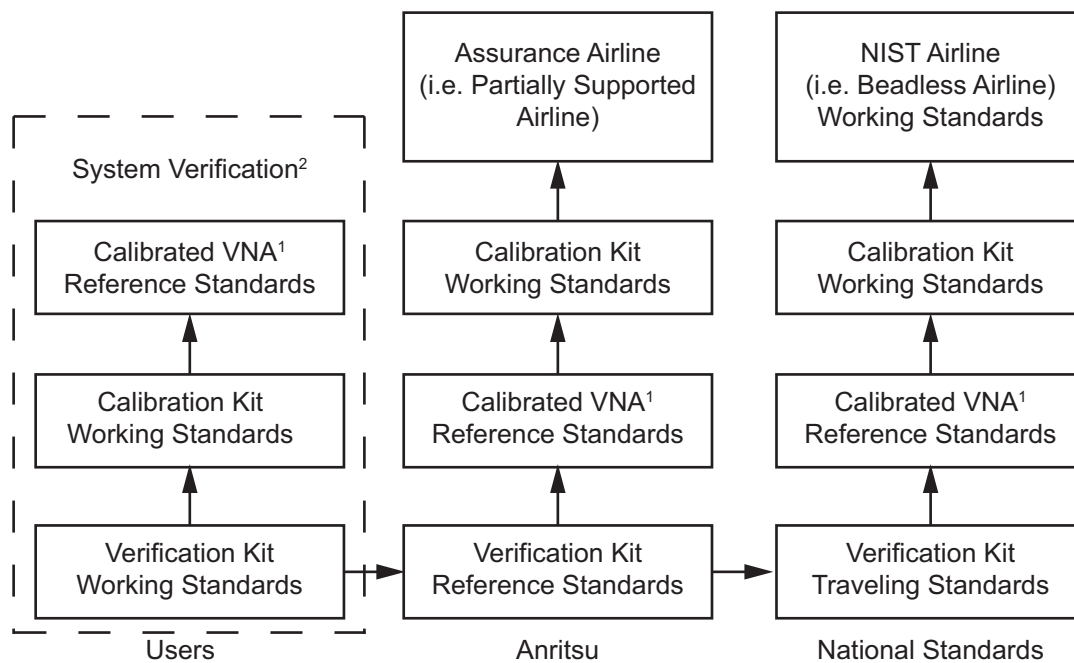
Third Tier of Uncertainty – Random Measurement Error

The third tier of uncertainty is random measurement error that in replicate measurements varies in an unpredictable manner. The examples are connector repeatability, cable stability, and etc. Random measurement error equals measurement error minus systematic measurement error.

Standards and Verification

Most often instrument end users demand system verifications in order to provide quality check or assurance. This is accomplished by utilizing a set of known or characterized devices, e.g., verification kit, for comparison. It can also be done by using devices that are different from the calibration kit. The calibration hierarchy of verification uncertainty is built through unbroken chain comparisons with the national standards, as illustrated in [Figure 3-1](#).

- Physical standards → airline dimensionality → impedance standard → residuals and port parameters
- Basic power standards → power sensors → power accuracy specifications
- Basic time standards → frequency reference source → frequency accuracy



Calibrated VNA¹ - Without error-correction (accuracy enhancement) by calibration kit
 System Verification² - S-parameter measurements with error-correction

Figure 3-1. VNA Traceability

3-3 Electrostatic Discharge Prevention

A VNA is a precision electronic instrument consisting of components and/or circuitries that are sensitive to electrostatic discharge (ESD). In order to prevent intrusion of electrostatic charge and mitigate risk of costly ESD damage, it is important to take preventive measures to protect against ESD before and during usage. For example, prior to connecting a test port cable to the VNA test port, take steps to eliminate the static charges built up on the test port cable. This can be done by terminating the open end of the cable with the short from the calibration kit and then grounding the outer conductor of the connector on the cable.

3-4 Calibration and Measurement Conditions

Extremes in the surrounding environmental conditions and the condition and stability of the test port connectors, thru cable, and calibration kit determine system measurement integrity to a large extent.

These are all user controlled conditions, and as such, should be evaluated periodically for impact on system performance. If these conditions vary significantly with time, the system verification procedures should be performed more often than the recommended annual cycle.

The standard conditions specified below must be observed when performing any of the operations in this chapter – both during calibration and during measurement.

- Warm-up Time:
 - 30 minutes
- Environmental Conditions
 - Temperature
 - For System Verification, $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, with $< 1\text{ }^{\circ}\text{C}$ variation from calibration temperature
 - For other tests, $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
 - Relative Humidity
 - 20-50% recommended

Using best measurement practices and maintaining environmental conditions within specified limits during calibration and measurements are critical requirements for performing system verification that involves reliable high-quality measurements with associated measurement uncertainties. Note that both of these key factors affect the measurement uncertainty.

3-5 Performance Verification

The Performance of MS46322B VNA can be verified using either verification procedures below:

- System Verification Procedure in [“System Verification” on page 3-4](#)
 - The VNA, calibration kit, test cable, and any required adapter(s) are verified as a system
- Instrument Key Performance Parameter Verification procedure in [“Instrument Key Parameter Performance Tests” on page 3-9](#)
 - The VNA is verified as an independent instrument

3-6 System Verification

The system verification procedures verify the measurement capabilities of the VNA, calibration kit, test port cables, and any required adapters as a system by analyzing the measurement of artifacts that are traceable to national standards laboratories. The procedures are automated by using the automated System Verification Software, in conjunction with the appropriate Anritsu Calibration and Verification Kits listed in the table below.

Table 3-1. Equipment Required for System Verification (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N (m)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N (f)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Verification Kit (For Opt. 10)	Connector: N Type	Anritsu Model 3663-3 (Includes System Verification Software)
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Torque Wrench (For Opt. 10)	3/4 in Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Calibration Tee (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m)	Anritsu Model TOSLK50A-40
Calibration Tee (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f)	Anritsu Model TOSLK50A-40
Verification Kit (For Opt. 20 or 40)	Connector: K Type	Anritsu Model 3668-4 (Includes System Verification Software)
Calibration Tee (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(m)	Anritsu Model TOSLK50A-43.5
Calibration Tee (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSLK50A-43.5
Verification Kit (For Opt. 43)	Connector: K Type	Anritsu Model 3668-4 (Includes System Verification Software)
Torque Wrench (For Opt. 20 or 40)	5/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-203
Adapter (For Opt. 20 or 40)	Connector: K(m) to K(f)	Anritsu Model 33KKF50B
Adapter (For Opt. 20 or 40)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50B
Adapter (For Opt. 43)	Connector: K(m) to K(f)	Anritsu Model 33KKF50C
Adapter (For Opt. 43)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50C
RF Coaxial Cable (For Opt. 10, 20, or 40)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2

Table 3-1. Equipment Required for System Verification (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50A-2
Interface Cable	Ethernet: RJ45, cross-over, Cat.5E Ethernet: RJ45, Cat.5E	Anritsu Part Number 3-806-152 Anritsu Part Number 2000-1371-R
Personal Computer	Operating System: Windows 7 or higher Interface: Ethernet, RJ45 Software: National Instruments VISA version 4.4.1 or later	Any

Caution: The use of non-Anritsu calibration kits or verification kits is not supported.

The System Performance Verification Software guides the user to perform a full 12 Term calibration on the VNA using the appropriate calibration kit, measure the S-parameters of the impedance transfer standards in the verification kit, and confirm that the measured values are within the specified measurement uncertainty.

The verification kit consists of four impedance transfer standards and each are supplied with S-parameter data. Each standard verifies a primary S-parameter with uncertainty windows provided with each data point as follows:

- 20 dB Attenuation Standard – S_{21} , S_{12} Magnitude and Phase
- 50 dB Attenuation Standard – S_{21} , S_{12} Magnitude and Phase
- 50 Ohm Air Line Standard – S_{21} , S_{12} Phase
- 25 Ohm Mismatch (Beatty) Standard – S_{11} , S_{22} Magnitude

Pass/Fail status of the measurements is displayed on the computer. The software can also provide hardcopy (printout) of the test reports which include the measured data, the measurement uncertainties, and the Pass/Fail status.

Verification Result Determination

The software verification process compares the measured S-parameter data of the impedance transfer standards against the original standard (characterization) data for those devices that was obtained using the Factory Standard Vector Network Analyzer (at Anritsu).

The Factory Standard Vector Network Analyzer system is traceable to International System of Units (SI) through the impedance Standards of the Anritsu Calibration laboratory. These standards are traceable to International System of Units (SI) through precision mechanical measurements, microwave theory impedance derivation methods, and electrical impedance comparison measurements.

At each frequency point, the verification measurement is compared to the characterization measurement in the context of the uncertainties. If the delta between the two measurements is consistent with the uncertainty window, the measurement is considered acceptable at that point.

The metric of comparison, termed E_n , is a check to see if the measurement differences are consistent with the uncertainty windows of both the characterization and the verification measurements. The quantity is shown in the following formula:

$$E_n = \frac{|X_{xy}^{\text{char}} - X_{xy}^{\text{ver}}|}{\sqrt{(U_{xy}^{\text{char}})^2 + (U_{xy}^{\text{ver}})^2}}$$

Equation 3-1

where:

- The numerator contains the magnitude or phase of S-parameters measured during characterization (by Anritsu) and during verification (by the user).
- The denominator contains the respective uncertainties.

These uncertainties are calculated based on the VNA, the calibration kit, and repeatability. If this quantity E_n is less than 1, then the measurements during the two phases are within the overlap of the uncertainties and one can consider the measurements “equivalent” and, in some sense, verified.

The quality of the verification results is very dependent on the degree of care taken by the user in maintaining, calibrating, and using the system. The most critical factors are:

- The stability and quality of the devices in the calibration kit and verification kit.
- The condition of the VNA test port connectors and test port cables.
- The pin depths of all connectors and the proper torquing of connections. These same factors also affect the VNA measurement quality.

Consult the reference manual supplied with Anritsu Calibration Kits and Verification Kits for proper use, care, and maintenance of the devices contained in these kits.

3-7 System Verification Procedure

The System Verification procedure is described below. The procedure assumes that the System Verification Software (PVS) has been installed to an External Personal Computer running Microsoft Windows Operating System and the National Instruments VISA runtime.

Equipment Required

- Personal Computer:
 - With Microsoft Windows Operating System
 - With National Instruments VISA runtime
 - Ethernet interface cable
- Anritsu Calibration Kit (Refer to [Table 3-1, “Equipment Required for System Verification” on page 3-4](#))
- Anritsu Verification Kit (Refer to [Table 3-1](#))
- Anritsu Test Port Cables (Refer to [Table 3-1](#))

Special Precautions

When performing the procedures, observe the following precautions:

- Minimize vibration and movement of the system, attached components, and test cables.
- Clean and check the pin depth and condition of all adapters, test port cables, calibration components, and impedance transfer standards.
- Pre-shape the test cables so as to minimize their movement during calibration and measurement activities.

Verification Procedure

1. Turn on power to the PC controller.
2. Install the MS46322B system verification software, which can be found on the USB flash drive supplied with the 366x-3 or 3668-4 verification kit, to the PC controller. Refer to Section 5 of the ShockLine Series Vector Network Analyzers Verification Kits and Performance Verification Software Quick Start Guide, PN 10410-00766, for instructions.
3. Use a Cat5-E Ethernet cable to connect the ShockLine MS46322B to a Local Area Network port that is close to the PC controller using DHCP server of the LAN for obtaining an IP address. Alternatively, use a Cat5-E Ethernet Crossover cable to connect the ShockLine MS46322B directly to the PC Controller Ethernet port using static IP address. Refer to the Section 3-6 of MS46322A/B Operation Manual, PN 10410-00335, for setup procedures.
4. Turn on the ShockLine MS46322B and allow the instrument to warm up for 30 minutes.
5. When verifying an MS46322B with Option 10:
 - a. Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use a torque wrench to tighten the K connectors to ensure that the connections do not become loose during the test.
 - b. Install the Thru Cable with the adapter to Port 2 of the ShockLine MS46322B.
6. When verifying an MS46322B with Option 20, 40, or 43:
 - a. Install the 33KFKF50x adapter to Port 1 of the ShockLine MS46322B.
 - b. Install the Thru Cable to Port 2 of the ShockLine MS46322B.
 - c. Install the 33KKF50x adapter on the open end of the Thru Cable.
7. Run the MS46322B VNA verification software on the PC controller.
8. Insert the USB flash drive that is supplied with the 366x-x verification kit to an available USB port on the PC controller. Follow the instructions in Section 6 of the ShockLine Series Vector Network Analyzers Verification Kits and Performance Verification Software Quick Start Guide, PN 10410-00766, to add the four impedance transfer standards to the verification tools database.
9. Follow the instructions in Section 6 of the Quick Start Guide to add the calibration kits to the verification tools database.
10. On the VNA, select: MAIN MENU | System | Network Interface.
11. Read the DHCP assigned IP Address when connecting the instrument to a Local Area Network, or enter the Static IP address to be used (e.g. 10.0.0.2) when connecting the instrument to the PC controller directly.
12. On the verification software graphic user interface (GUI) displayed on the PC controller, locate the Select Interface field and then select TCP/IP using the drop-down menu.
13. Enter the IP Address of the instrument into the Address field of the verification software GUI.
14. Follow the instructions in Section 7 of the Quick Start Guide to start the performance verification testing.

Caution

Use an appropriate torque wrench to ensure proper connection of calibration devices during calibration.

After all tests have been completed, print the test results and attach the printouts to the test record in [Appendix A, “ShockLine MS46322A/B System Performance Test Record”](#).

If Verification Fails

If the verification fails, then check the quality, cleanliness, and installation methods for the calibration and verification components. Specifically, check:

- The VNA test port connectors
- The calibration tee
- The impedance transfer standards
- The test port cables, for damage and cleanliness
- The test port cables, for proper connection and torquing
- The test port cables, for phase stability

These are the most common causes for verification failures.

3-8 Instrument Key Parameter Performance Tests

The Instrument Key Parameter Performance tests verify the key performance parameter of the MS46322B Vector Network Analyzer as an independent instrument.

The Instrument Key Performance tests consist of the following:

- Frequency Accuracy
- Output Power – High and Low Power Characterization (Operational Test)
- System Dynamic Range
- High Level Noise (Operational Test)

PASS/FAIL Determination for Instrument Key Parameter Performance Tests

Figure 3-2 shows the rule that is used to determine the pass/fail status of test results that are associated with warranted specifications.

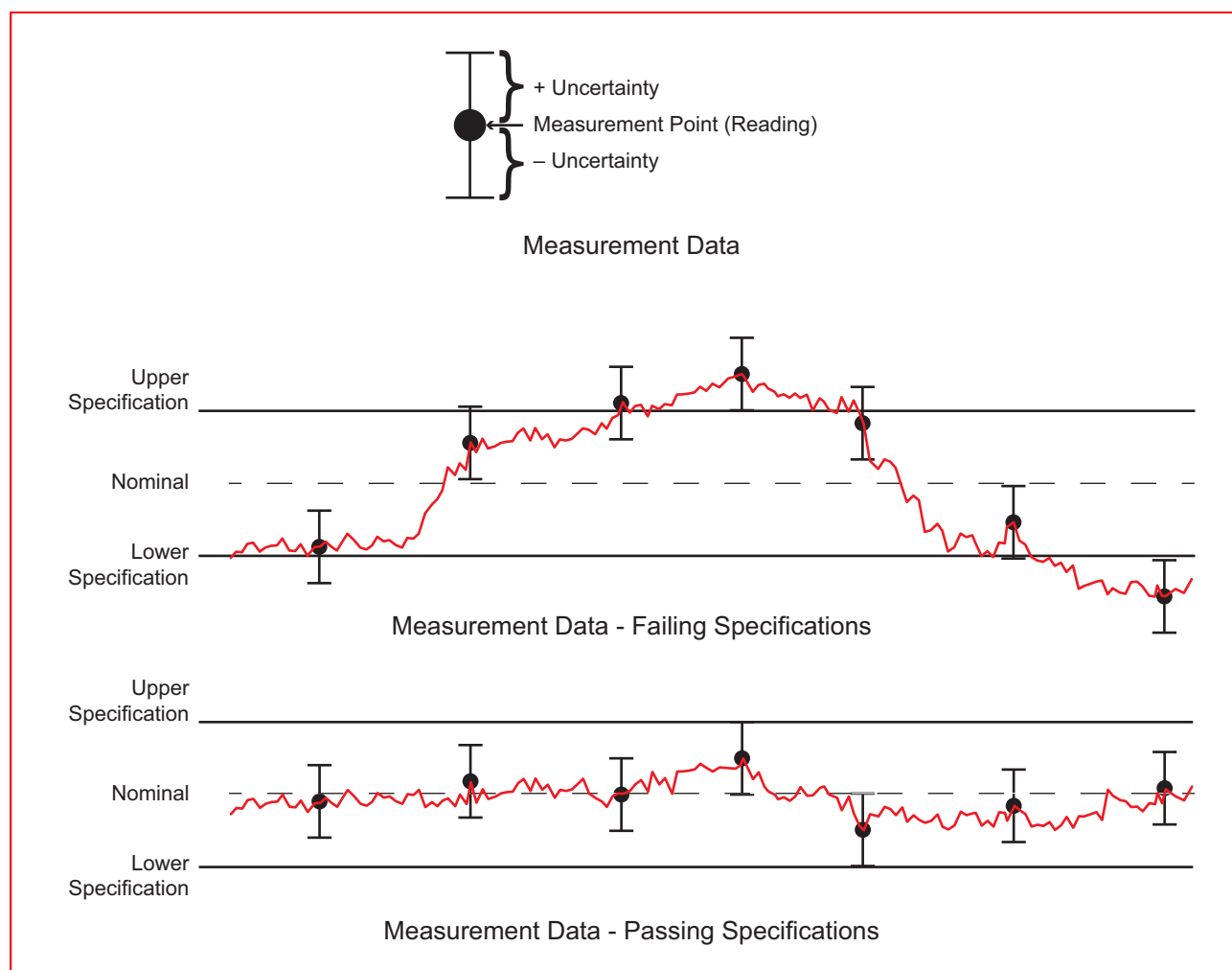


Figure 3-2. Pass/Fail Determination

The measurement uncertainty listed in each test record includes the best estimate of the errors contributed by the measurement, test equipment, standards, and other correction factors (for example, calibration factors and mismatch errors) based on the suggested equipment, the equipment setup, and the prescribed test procedure. Most of the uncertainties are type-B per ISO/IEC Guide 98-3, Guide to the Expression of Uncertainty in Measurement (GUM).

3-9 Frequency Accuracy

This test verifies the internal time base of the MS46322B.

Equipment Required

Equipment required for Frequency Accuracy verification is listed in [Table 3-2](#).

Table 3-2. Equipment Required for Frequency Accuracy Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
Frequency Reference	Frequency: 10 MHz	Symmetricon Model RubiSource T&M
Frequency Counter	Frequency: 10 MHz to 20 GHz	Anritsu Model MF2412B or MF2412C with Option 3
Adapter	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50
Adapter	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
RF Coaxial Cable	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2
RF Coaxial Cable	Frequency: 10 MHz Impedance: 50 ohm Connector: BNC(m) to BNC(m)	Anritsu Model 2000-1627-R

Procedure

1. Connect the BNC cable between the output BNC(f) connector of the external Time Base Reference to the Reference Input BNC(f) connector of the Frequency Counter.
2. Install the Thru Cable to Input 1 N(f) connector of the Frequency Counter with appropriate adapters.
3. Power on both the external Time Base Reference and Frequency Counter.
4. Setup the Frequency Counter as follows:
 - a. Press the **Preset** key to restore the factory setting
 - b. Set the **Resolution** to 0.1 Hz
 - c. set the **Sample rate** to 11 ms.
5. Power on the MS46322B and allow the instrument to warm up for 30 minutes.
6. Select **Preset** button on the Icon Bar and then the **OK** button.
7. Set up the VNA display as follows:
 - a. Select **Averaging**
 - b. Change **IFBW** to 100 Hz
 - c. Select **Trace**
 - d. Change **# of Traces** to 1
 - e. Select **Trace Max**

- f. Select Frequency and then turn CW Mode to ON (Note: CW Frequency is defaulted to 10 MHz)
 - i. Change # of Points to 801
 - ii. Change Start Frequency to 1 GHz (This changes the CW Frequency to 1 GHz.)
8. Connect the Thru Cable from the Frequency Counter to VNA Port 1.
9. Record the Frequency Counter reading to [Table A-1, "Frequency Accuracy" on page A-3.](#)

3-10 Output Power (Operational Test)

The section provides the procedure to characterize the output power at each VNA port of the MS46322B.

Equipment Required

Equipment required for Output Power Accuracy characterization is listed in [Table 3-3](#).

Table 3-3. Equipment Required for Output Power Characterization

Equipment	Critical Specification	Recommended Manufacturer/Model
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A
Power Sensor (For Opt. 10)	Frequency: 100 kHz to 18 GHz Connector Type: N(m)	Anritsu Model SC7400
Power Sensor (For Opt. 20, 40, or 43)	Frequency: 100 kHz to 40 GHz Connector Type: K(m)	Anritsu Model SC7413
Adapter (For Opt. 20, 40, or 43)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Adapter (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B
Torque Wrench (For Opt. 10)	3/4 in (0.75 in) Open End 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Torque Wrench (For Opt. 20, 40, or 43)	5/16 in (0.3125 in) Open End 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in (0.8125 in) Open End 8 lbf·in (0.90 N·m)	Anritsu Model 01-203

Procedure

1. Power on the MS46322B and ML2438A. Allow both instruments to warm up for 30 minutes.

Note	Connect SC7400 or SC7413 to Channel A input of the Power Meter.
-------------	---

2. Preset the VNA as follows:
 - a. Select Preset button on the Icon Bar and then the OK button.
3. Set up the VNA display as follows:
 - a. Select Trace.
 - b. Change # of Traces to 1.
 - c. Select Trace Max.
 - d. Select Frequency and then turn CW Mode to ON (Note: CW Frequency is defaulted to 10 MHz).
 - e. Change # of Points to 801.
4. Zero and calibrate the Power Sensor(s) on the Power Meter.

High Power Characterization

5. Connect the Power Sensor to VNA Port 1.

Note	For MS46322B with Options 20, 40, or 43, install a 33KFKF50B adapter to the power sensor input.
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6. On the VNA, set the Start Frequency to the test frequency in [Table 3-4](#). (e.g. Set Start Frequency to 1 MHz when it is the first time that this step is executed). The CW Frequency will match the Start Frequency after the change.

Note

The ShockLine VNA software has a minimum sweep span limit of 20 Hz so it does not allow the CW Frequency to match the Start Frequency when entering the last test frequency. Instead, select CW Frequency to set the proper test CW frequency.

Table 3-4. Test Frequency List for Output Power Accuracy Characterization

Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
1	8000	19000	30000
10	9000	20000	31000
45	10000	21000	32000
100	11000	22000	33000
1000	12000	23000	34000
2000	13000	24000	35000
3000	14000	25000	36000
4000	15000	26000	37000
5000	16000	27000	38000
6000	17000	28000	39000
7000	18000	29000	40000

7. On the Power Meter, press the **Sensor** key, the Cal Factor soft key, and then the Freq soft key. Use the keypad to enter the value matching the CW frequency of the VNA as the input signal frequency, which sets the power meter to the proper power sensor calibration factor. Press **System** key to display the power reading.
8. Record the power meter reading in [Table A-2, “High Output Power”](#) on page A-3.

Note

For Low Power measurement, record the power meter reading in [Table A-3, “Low Output Power”](#) on page A-5.

9. Repeat [Step 6](#) through [Step 8](#) for the next frequency point in [Table 3-4](#) until it reaches the appropriate end frequency point of the VNA being tested (8000 MHz for Option 10 unit, 20000 MHz for Option 20 unit, or 40000 MHz for Option 40 or Option 43 unit).
10. Change the VNA display as follows:
- Click on Tr1 on the top of the S11 trace on the screen.
 - Select Response and then S22. Verify that Tr1 is displaying S22 response.
11. Connect the power sensor to VNA Port 2.
12. Repeat [Step 6](#) through [Step 9](#).

Low Power Characterization

13. Select Home, Power and then Low Power.
14. Change the VNA display as follows:
 - a. Click on Tr1 on the top of the S22 trace on the screen.
 - b. Select Response and then S11. Verify that Tr1 is displaying S11 response.
15. Repeat [Step 5](#) through [Step 12](#).

3-11 System Dynamic Range

This section provides the procedure to measure the System Dynamic Range of the MS46322B.

Equipment Required

Equipment required for the System Dynamic Range test is listed in [Table 3-5](#).

Table 3-5. Equipment Required for System Dynamic Range Test

Equipment	Critical Specification	Recommended Manufacturer/Model
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B
Adapter (For Opt. 43)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C
Torque Wrench (For Opt. 10)	3/4 in (0.75 in) Open End 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Torque Wrench (For Opt. 20, 40, or 43)	5/16 in (0.3125 in) Open End 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in (0.8125 in) Open End 8 lbf·in (0.90 N·m)	Anritsu Model 01-203
RF Coaxial Cable (For Opt. 10, 20, or 40)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50A-2
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(m) Type	Anritsu Model OSLN50A-8
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(f) Type	Anritsu Model OSLNF50A-8
Calibration Kit (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) Type	Anritsu Model TOSLKF50A-40
Calibration Kit (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f) Type	Anritsu Model TOSLKF50A-43.5
Calibration Kit (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K(m) Type	Anritsu Model 28K50A

Procedure

1. Power on the MS46322B and allow the instrument to warm up for 30 minutes.
2. Preset the VNA as follows:
 - a. Select Preset button on the Icon Bar and then the OK button.

3. Prepare the Thru Cable or the MS46322Bas follows:
 - a. For ShockLine MS46322B with Option 10:
Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.
 - b. For ShockLine MS46322B with Option 20, 40, or 43:
Install the 33KFKF50x Adapter to the VNA Port 1.
4. Install the Thru Cable to Port 2.
5. Set up the VNA for segmented sweep as follows:
 - a. Select Sweep Setup.
 - b. Select Freq-based Seg. Sweep Setup.
 - c. Enter the data from the first row of [Table 3-6](#) into the setup table on the bottom of the VNA display.
 - d. Select Add.
 - e. Enter the data in the next row of [Table 3-6](#) into the VNA.
 - f. Repeat [Step d](#) through [Step e](#) until F2 = 8000 MHz for Option 10 unit, F2 = 20000 MHz for Option 20 unit, F2 = 40000 MHz for Option 40 unit, or F2 = 43500 MHz for Option 43 unit.
 - g. Select Back.
 - h. Select Sweep type and then Segmented Sweep (Freq-based).
 - i. Select Back.
 - j. This completes the Segmented Sweep setup.

Table 3-6. VNA Segmented Sweep Setup for System Dynamic Range Test

F1	F2	# of Pts	IFBW	Src Pwr	Avg
1 MHz	550 MHz	201	10 Hz	High	1
648 MHz	4005 MHz	40	10 Hz	High	1
4105 MHz	8000 MHz	41	10 Hz	High	1
8000.001 MHz	14000 MHz	61	10 Hz	High	1
14000.001 MHz	20000 MHz	60	10 Hz	High	1
20000.001 MHz	30000 MHz	102	10 Hz	High	1
30000.001 MHz	40000 MHz	101	10 Hz	High	1
40000.001 MHz	43500 MHz	36	10 Hz	High	1

6. Perform a Transmission Response calibration as follows:
 - a. Select Calibration.
 - b. Select Calibrate and then Manual Cal.
 - c. Select Transmission Freq. Response.
 - d. Select Thru/Recip.
 - e. Connect the Thru Cable from Port 2 to Port 1.
 - f. Select Thru 1-2 and then allow the VNA to complete the measurements.
 - g. Click on the OK button on the displayed dialog.

- h. Disconnect the Thru Cable from Port 1.
 - i. Select Isolation (Optional).
 - j. Install Loads to Port 1 and Port 2 (at the end of the Thru Cable).
 - k. Select Isolation 1-2 and then allow the VNA to complete the measurements.
 - l. Select Back.
 - m. Select Done.
 - n. This completes the 2-port Transmission Response calibration.
 - o. Leave the Loads connected to both Port 1 and Port 2.
7. Set up the VNA display as follows:
 - a. Select Trace and then set # of Traces to 2.
 - b. Select Response and then S12. Verify that Tr1 is displaying S12 response.
 - c. Select Display and set Trace Format to Linear Mag.
 - d. Click on Tr2 on the top of the S21 trace on the screen and then set Trace Format to Linear Mag.
8. Select Sweep, select Hold Functions and then select Single Sweep & Hold.
9. Select File and then Save Data.
10. Change the Type of File to Active Channel TXT File (*.txt).
11. Change the file name to SDR#1.txt and then click the Save button. Note the location of the data file being saved to.
12. Repeat [Step 8](#) through [Step 11](#) seven (7) more times. When saving the data, increment the number at the end of the file name by one (e.g. SDR#2.txt, SDR#3.txt and etc.).
13. Copy the saved data files off the MS46322B onto a USB flash drive for transferring to a Personal Computer.
14. On a separate Windows Personal Computer, import the saved data from the SDR#n.txt into Microsoft Excel so the rms values can be calculated.
15. There are many ways one can set up Microsoft Excel for calculating the System Dynamic Range in dB rms values. Below is an example:
 - a. Assume the data are in an Excel worksheet as follows -
 - Row 1 is the header – Freq, Data1 through Data8, rms Linear Mag, rms Log Mag, SDR.
 - Column A – Freq (Imported from the SDR#n.txt files).
 - Column B through Column I – Data1 through Data8 (Imported from the SDR#n.txt files).
 - Column J – Calculated Linear Mag rms values.
 - Column K – Calculated Log Mag rms values.
 - Column L – Calculated Noise Floor values.
 - Column M – High Power values. +5 dBm from 1 MHz to 8 GHz and -3 dBm from > 8 GHz to 43.5 GHz.
 - Column N – Calculated System Dynamic Range values.
 - b. Import the frequency data from the SDR#n.txt file.
 - c. Set up Cell J2 to calculate the rms value in Linear Mag by entering the following formula into the Cell:
$$= \text{SQRT}(\text{SUMSQ}(\text{B2:I2})/8)$$
 - d. Copy the formula to the next cell on Column J until it reaches the last frequency point.

- e. Set up Cell K2 to calculate the rms value in Log Mag by entering the following formula into the Cell:
$$= 20 * \text{LOG}(J2, 10)$$
 - f. Copy the formula to the next cell on Column K until it reaches the last frequency point.
 - g. Set up Cell L2 to calculate Noise Floor in dBm by entering the following formula into the cell:
$$= -K2$$
 - h. Copy the formula to the next cell on Column L until it reaches the last frequency point.
 - i. Set up Cell N2 to calculate the System Dynamic Range by entering the following formula in the cell:
$$= M2 - L2$$
 - j. Rename 'Sheet 1' to 'SDR S12' by right-clicking on the Sheet 1 tab, selecting **Rename** and typing in the new name.
 - k. Copy 'SDR S12' sheet by right-clicking on the SDR S12 tab, selecting **Move or Copy...**, selecting (move to end), checking the **Create a copy** checkbox and then clicking **OK**.
 - l. Rename the new sheet as 'S21 Magnitude'.
 - m. Import the S12 data and S21 data to appropriate Excel worksheet for System Dynamic Range calculation.
16. Record the worst case calculated SDR value of each frequency band in [Table A-4, "S12 System Dynamic Range" on page A-7](#) and [Table A-5, "S21 System Dynamic Range" on page A-7](#).

3-12 High Level Noise (Operational Test)

This test checks the High Level Noise performance of the MS46322B.

Equipment Required

Equipment required for High Level Noise test is listed in [Table 3-7](#)

Table 3-7. Equipment Required for High Level Noise Test

Equipment	Critical Specification	Recommended Manufacturer/Model
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C
Torque Wrench (For Opt. 10)	3/4 in (0.75 in) Open End 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Torque Wrench (For Opt. 20, 40, or 43)	5/16 in (0.3125 in) Open End 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in (0.38125 in) Open End 8 lbf·in (0.90 N·m)	Anritsu Model 01-203
RF Coaxial Cable (For Opt. 10, 20, or 40)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50A-2

Procedure

1. Power on the MS46322B and allow the instrument to warm up for 30 minutes.
2. Preset the VNA as follows:
 - a. Select Preset button on the Icon Bar and then the OK button.
3. Prepare the Thru Cable or the MS46322B as follows:
 - a. For ShockLine MS46322B with Option 10:
Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.
 - b. For ShockLine MS46322B with Option 20, 40, or 43:
Install the 33KFKF50x Adapter to VNA Port 1.
4. Install the Thru Cable to Port 2.

5. Set up the VNA for segmented sweep as follows:

- a. Select Sweep Setup.
- b. Select Freq-based Seg. Sweep Setup.
- c. Enter the data from the first row of [Table 3-8](#) into the setup table on the bottom of the VNA display.
- d. Select Add.
- e. Enter the data in the next row of [Table 3-8](#) into the VNA.
- f. Repeat [Step d](#) through [Step e](#) until F2 = 8000 MHz for Option 10 unit, F2 = 20000 MHz for Option 20 unit, or F2 = 43500 MHz for Option 40 or 43 unit.
- g. Select Back.
- h. Select Sweep type and then Segmented Sweep (Freq-based).
- i. Select Back.
- j. This completes the Segmented Sweep setup.

Table 3-8. VNA Segmented Sweep Setup for High Level Noise Test

F1	F2	# of Pts	IFBW	Src Pwr	Avg
1 MHz	10 MHz	10	100 Hz	High	1
15 MHz	100 MHz	2	100 Hz	High	1
250 MHz	501 MHz	2	100 Hz	High	1
701 MHz	1000 MHz	2	100 Hz	High	1
1101 MHz	1501 MHz	5	100 Hz	High	1
1550 MHz	2450 MHz	19	100 Hz	High	1
2499.99 MHz	2500.01 MHz	2	100 Hz	High	1
2600 MHz	3900 MHz	14	100 Hz	High	1
3975 MHz	4001 MHz	2	100 Hz	High	1
4100 MHz	8000 MHz	40	100 Hz	High	1
8100 MHz	20000 MHz	120	100 Hz	High	1
21000 MHz	40000 MHz	191	100 Hz	High	1
41000 MHz	43500 MHz	51	100 Hz	High	1

6. Perform a Transmission Response calibration as follows:

- a. Select Calibration.
- b. Select Calibrate and then Manual Cal.
- c. Select Transmission Freq. Response.
- d. Select Thru/Recip.
- e. Connect the Thru Cable from Port 2 to Port 1.
- f. Select Thru 1-2 and then allow the VNA to complete the measurements.
- g. Click on the OK button on the displayed dialog.
- h. Select Done.
- i. This completes the 2-port Transmission Response calibration.
- j. Leave the Thru Cable connected between Port 1 and Port 2.

7. Set up the VNA display as follows:
 - a. Select Trace and then set # of Traces to 2.
 - b. Select Response and then S12. Verify that Tr1 is displaying S12 response.
 - c. Select Display and set Trace Format to Linear Mag And Phase.
 - d. Click on Tr2 on the top of the S21 trace on the screen and then set Trace Format to Linear Mag And Phase.
8. Select Sweep and then Hold Functions. Select Single Sweep & Hold.
9. Select File and then Save Data.
10. Change the Type of File to Active Channel TXT File (*.txt).
11. Change the file name to HLN#1 and then click the Save button. Note the location of the data file being saved to.
12. Repeat [Step 8](#) through [Step 11](#) thirty-nine (39) more times. When saving the data, increment the number at the end of the file name by one (e.g. HLN#2, HLN#3 and etc.).
13. Copy the thirty-nine (39) saved data files off the MS46322B onto a USB flash drive for transferring to a Personal Computer.
14. On a separate Windows Personal Computer, import the saved data from the HLN#n files into Microsoft Excel so the rms values can be calculated.
15. There are many ways one can set up Microsoft Excel for calculating the rms values. Below is an example:
 - a. Assume the data are in an Excel worksheet as follows:
 - Row 1 is the header – Freq, Data1 through Data40, rms Linear Mag, rms Log Mag (or rms Deg)
 - Column A – Freq (Imported from the HLN#n files)
 - Column B through Column AO – Data1 through Data40 (Imported from the HLN#n files)
 - b. Set up Cell AP2 to calculate the rms value in Linear Mag by entering the following formula into the Cell:

$$=STDEV.P(B2:AO2)$$
 - c. Copy the formula to the next cell on Column AP until it reaches the last frequency point.
 - d. For magnitude measurements only,
 - i. Set up Cell AQ2 to calculate the rms value in Log Mag by entering the following formula into the Cell:

$$=20*LOG(AP2+1,10)$$
 - ii. Copy the formula to the next cell on Column AQ until it reaches the last frequency point.
 - e. Rename 'Sheet 1' to 'S12 Magnitude' by right-clicking on the Sheet 1 tab, selecting Rename and typing in the new name.
 - f. Copy 'S12 Magnitude' sheet by right-clicking on the S12 Magnitude tab, selecting Move or Copy..., selecting (move to end), checking the Create a copy checkbox and then clicking OK.
 - g. Rename the new sheet as 'S21 Magnitude'.
 - h. Use the Move or Copy... in Excel to create as many new sheets as required for both magnitude and phase measurements. Rename the sheets as necessary to indicate which measurement is being computed on the worksheet (e.g. S12 Phase, and etc.).
 - i. Import the Magnitude and Phase data to the appropriate worksheet for rms value calculation as required.
16. Record the calculated rms value of each frequency point listed in [Table A-6, "High Level Noise – S12 Magnitude" on page A-8](#) through [Table A-9, "High Level Noise – S21 Phase" on page A-12](#).

Chapter 4 — Adjustment

4-1 Introduction

This chapter contains procedures that are used to restore and optimize the operation of the MS46322A/B Vector Network Analyzer.

4-2 IF Adjustment Procedure

This section provides the procedure to restore or optimize the operation of MS46322A/B related to the IF level in the VNA Receivers.

Note

Performing IF adjustment procedure is normally not required after the VNA module assembly has been replaced. Each replacement VNA module is fully pre-calibrated / pre-adjusted prior to shipping from the factory.

Equipment Required

- For Instruments with N(f) test ports:
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 34NK50 N(m) to K(m) Adapter
 - Anritsu Model 34NKF50 N(m) to K(f) Adapter
- For Instruments with K(m) test ports:
 - Anritsu Model 3670K50-2 or 3670K50A-2 (For Opt 43) Thru Cable
 - Anritsu Model 33KFKF50B or 33KFKF50C (For Opt 43) K(f) to K(f) Adapter

Procedure

1. Power on the VNA and allows the instrument to warm up for at least 45 minutes.
2. Connect the Thru Cable between Port 1 and Port 2.
3. Select the Calibration button on the right side menu.
4. Select IF Cal button and follow the prompt to perform the calibration.
5. Select File | Exit to shut down the ShockLine application software.
6. Launch the ShockLine application software from the Windows desktop. The new calibration coefficients will take effect afterward.

4-3 Time Base Adjustment Procedure

This section provides the procedure to adjust the internal Time Base in the MS46322A/B.

Note

Performing Time Base adjustment procedure is normally not required after the VNA module assembly has been replaced. Each replacement VNA module is fully pre-calibrated / pre-adjusted prior to shipping from the factory.

Equipment Required

- For Instruments with N(f) test ports:
 - Anritsu Model MF2412x Frequency Counter with Option 3
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 34NK50 N(m) to K(m) Adapter
 - Anritsu Model 34NKF50 N(m) to K(f) Adapter
- For Instruments with K(m) test ports:
 - Anritsu Model MF2412x Frequency Counter with Option 3
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 33KFKF50B K(f) to K(f) Adapter

Procedure

1. Power on the Frequency Counter and then press the Preset key.
2. Power on the VNA and allow the instrument to warm up for at least 45 minutes.
3. Connect the Thru Cable between the Frequency Counter Input 1 and VNA Port 1.
4. On the VNA, select the System button on the right-side menu.
5. Select the Diagnostics button.
6. The DIAGNOSTICS ACCESS dialog box appears providing an entry field to enter the diagnostics access password as shown below in [Figure 4-1](#).

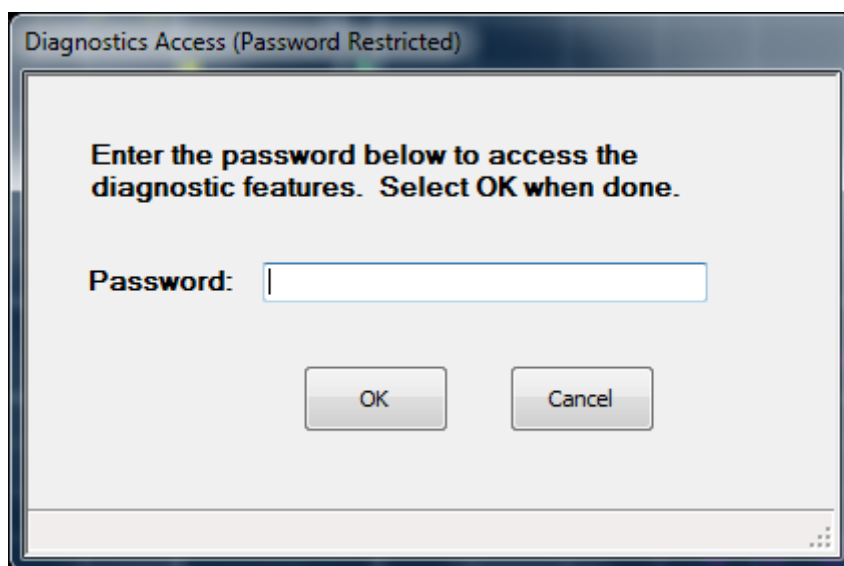


Figure 4-1. DIAGNOSTICS ACCESS Dialog Box

7. Enter the password ModVna in the Password field and click OK.
8. Select Hardware Cal button, then the Time Base Cal button.
9. Change the DAC Number value in the TIME BASE CALIBRATION dialog box as shown in [Figure 4-2](#) so that the frequency displayed on the frequency counter is within $5\text{ GHz} \pm 2\text{ kHz}$.

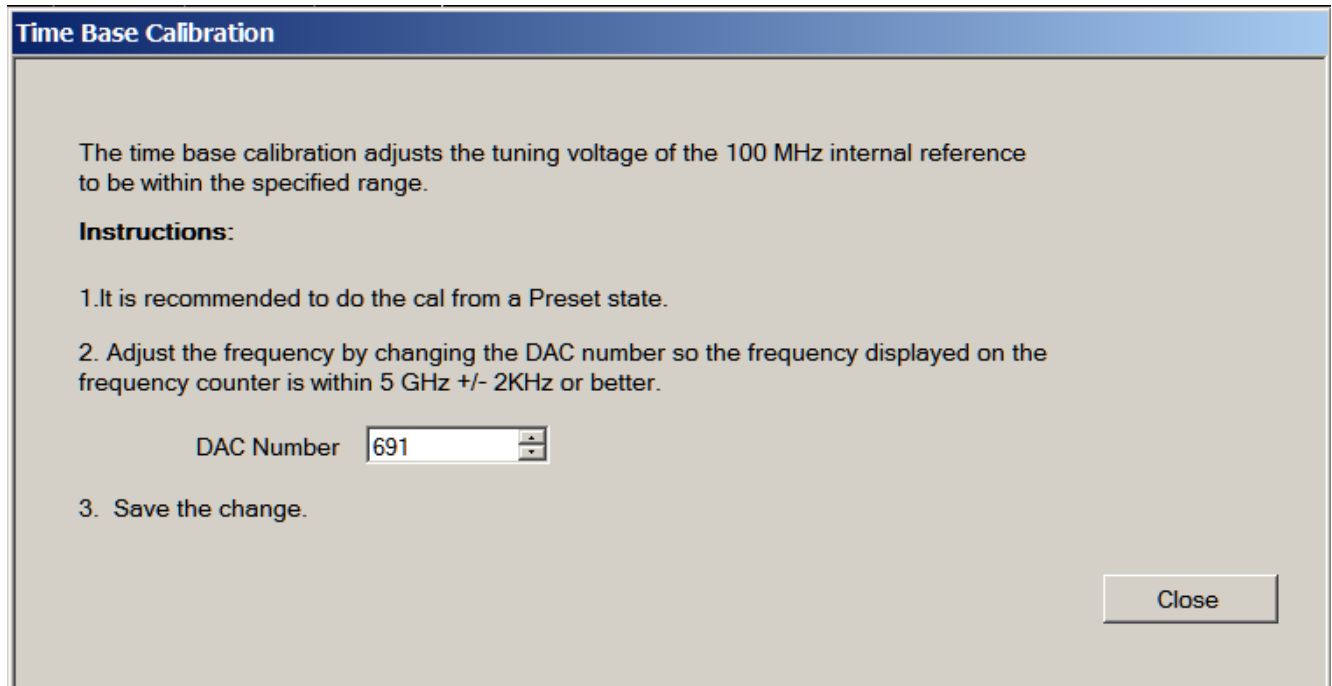


Figure 4-2. TIME BASE CALIBRATION Dialog Box

10. Click the Close button when done.

4-4 Factory RF Calibration (RF Cal)

The Factory RF Calibration represents a subset of a 12-term calibration so that simple reflection and transmission standards will read somewhat close to their true value, even without a User Measurement Calibration.

Equipment Required

- For Instruments with N(f) test ports:
 - Anritsu Model 3653A N Connector Calibration Kit
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 34NK50 N(m) to K(m) Adapter
 - Anritsu Model 34NKF50 N(m) to K(f) Adapter
- For Instruments with K(m) test ports:
 - Anritsu Model 3652A K Connector Calibration Kit
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 33KFKF50B K(f) to K(f) Adapter

Procedure

1. Power on the VNA and allows the instrument to warm up for at least 45 minutes.
2. If the length of the thru line cable is not known, perform the Length Determination Procedure in Section [“Thru Line Length Determination Procedure”](#) on page 4-6.
3. Preset the VNA and then select the **System** button on the right-side menu.
4. Select the **Diagnostics** button.
5. The DIAGNOSTICS ACCESS dialog box appears providing an entry field to enter the diagnostics access password as shown in [Figure 4-1](#).
6. Enter the password ModVna in the Password field and click OK button.
7. Select **Factory Cal** button to display the **FACTORY CAL** menu ([Figure 4-3](#)).
8. Select the **Modify Setup** button to display the **FACTORY RF CAL SETUP** dialog box.

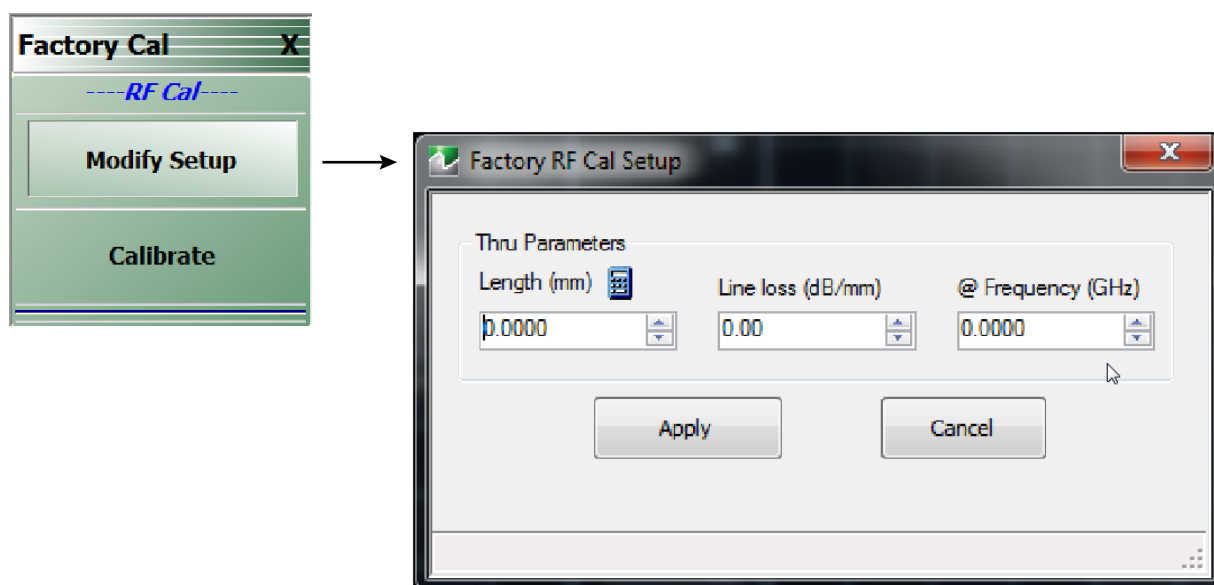


Figure 4-3. FACTORY CAL MENU and FACTORY RF CAL SETUP Dialog

9. Change the parameters in the dialog box as shown in the table below, then click the **Apply** button when done.

Table 4-1. Parameters Changes for Factory RF Calibration

Thru Length (mm)	Line Loss (dB/mm)	@ Frequency (GHz)
Actual length of thru including adapters, if used.	0.009 After the value above is entered, it will round up to 0.01.	70

10. Connect each calibration standard from the calibration kit in sequence to the appropriate port. Click the appropriate button when ready.
11. When all seven (7) calibration standards have been measured, click the **Done** button to complete the procedure.

4-5 Thru Line Length Determination Procedure

This procedure is used to determine the length of the thru line cable (including adapters) that is used for Factory RF Calibration.

Equipment Required

- For Instruments with N(f) test ports:
 - Anritsu Model 3653A N Connector Calibration Kit
- For Instruments with K(m) test ports:
 - Anritsu Model 3652A K Connector Calibration Kit

Procedure

1. Power on and warm up the VNA for at least 45 minutes.
2. Preset the VNA.
3. Select the Frequency button on the right side menu and set the number of points to 801.
4. Select the Calibration button.
5. Insert the USB memory device from the calibration kit into the USB port on the front panel of the instrument. The LED indicator on the USB memory device will flash and then light constantly.
6. Select the Cal Kit/AutoCal Characterization button, then select the Install Kit/Charac button to display the LOAD dialog box (Figure 4-4).

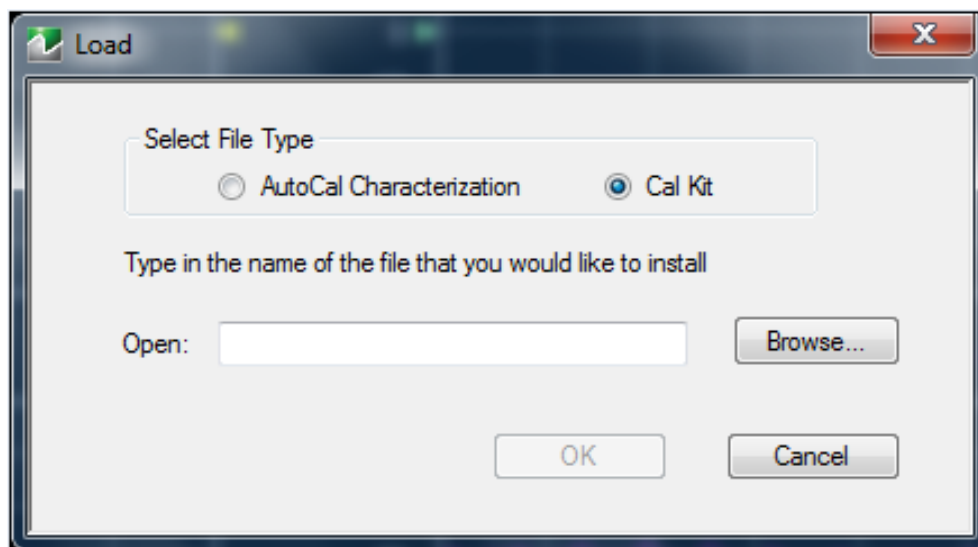


Figure 4-4. LOAD (Characterization/Cal Kit) Dialog Box

7. Select the Cal Kit radio button and then click the Browse button.
8. Locate Removable Disk (x:), where x is the drive letter designated to the USB drive by Windows.
9. Double-click Removable Disk (x:), then select the "xxxxxxxxx.ccf" file, and then click Open.
10. In the LOAD dialog box, click OK to load the coefficients.
11. Click the Back icon to return to the CALIBRATION [TR] menu.
12. Select the Calibrate button and then the Manual Cal button.
13. Select the 1-Port Cal button and then Edit Cal Params button.

14. Uncheck Test Port 2 and change Test Port 1 DUT Connector as follows:
 - a. For Instruments with N(f) Test Ports – N-Conn(M)
 - b. For Instrument with K(m) Test Ports – K-Conn(F)
15. Click the OK button when done, then click on the Back icon to return to the previous men.
16. Select the Port 1 Reflective Devices button.
17. Connect the open calibration standard to VNA Port 1 and then select the Open button to start the measurement. When done, a check mark appears on the Open button to indicate the existence of a calibration.
18. Disconnect the Open, connect the Short calibration standard to VNA Port 1, and then select the Short button to start the measurement.
19. Disconnect the Short, connect the Load calibration standard to VNA Port 1, and then select the Load button to start the measurement.
20. Disconnect the Load from VNA Port 1 and click the Done button.
21. Connect a short to one end of the Thru Cable (DUT).
22. Connect the open end of the Thru Cable to VNA Port 1.
23. Select the Measurement button, then click the Reference Plane button, and then click the Auto button.
24. Subtract the value below from the displayed Distance value. This is the Length of the Thru Cable used for the Factory RF Calibration.
 - a. For N connector thru cable – 8.966 mm
 - b. For K connector thru cable – 5 mm
25. Enter 0 for the Distance button to reset the value.

Chapter 5 — Troubleshooting

5-1 Introduction

This chapter provides information about troubleshooting tests that can be used to check the MS46322A/B Vector Network Analyzer for proper operation. These tests are intended to be used as a troubleshooting tool for identifying the faulty components and checking the functionality of internal components and sub-assemblies in the MS46322A/B VNA.

Only qualified service personnel should replace internal assemblies. Major subassemblies that are shown in the replaceable parts list are typically the items that may be replaced.

Because they are highly fragile, items that must be soldered may not be replaced without special training. Removal of RF shields from PC boards or adjustment of screws on or near the RF shields will de tune sensitive RF circuits and will result in degraded instrument performance.

5-2 General Safety Warnings

Many of the troubleshooting procedures presented in this chapter require the removal of instrument covers to access sub-assemblies and modules. When using these procedures, please observe the warning and caution notices.

Warning

Hazardous voltages are presented inside the instrument when AC line power is connected. Before removing any covers, turn off the instrument and unplug the AC power cord.

Caution

Many assemblies and modules in the MS46322A/B VNA contain static-sensitive components. Improper handling of these assemblies and modules may result in damage to the assemblies and modules. Always observe the static-sensitive component handling precautions.

5-3 Troubleshooting Test – Power Supply DC Check

This procedure verifies that the expected DC voltages are present at the Power Supply and the Back Plane PCB Assembly in the MS46322A/B VNA.

Equipment Required

- Digital Multimeter

Reference Figures

- [Figure 5-1](#) shows the Power Supply +3.3V terminal, +12V terminal and their respective Ground terminals.
- [Figure 5-2](#) shows both the front and back sides of the Back Plane PCB Assembly to help locate the E1 test point and the P16 5V connector.
- [Figure 5-3](#) shows the location of P17 VNA 12V Power Supply connector on the front side of the Back Plane PCB Assembly.

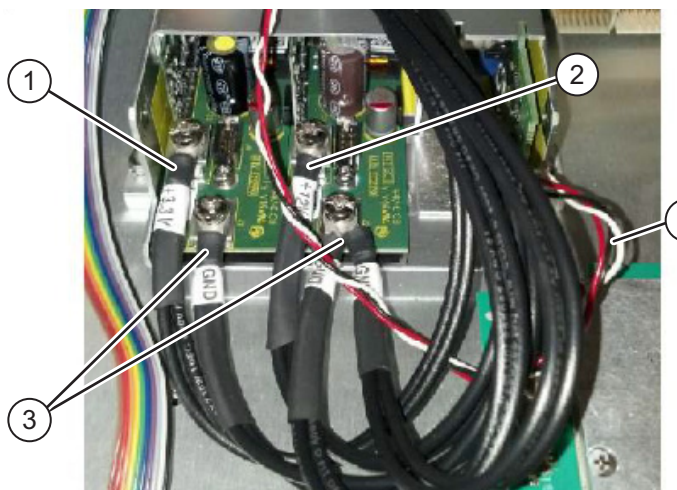


Figure 5-1. Power Supply Output Terminals

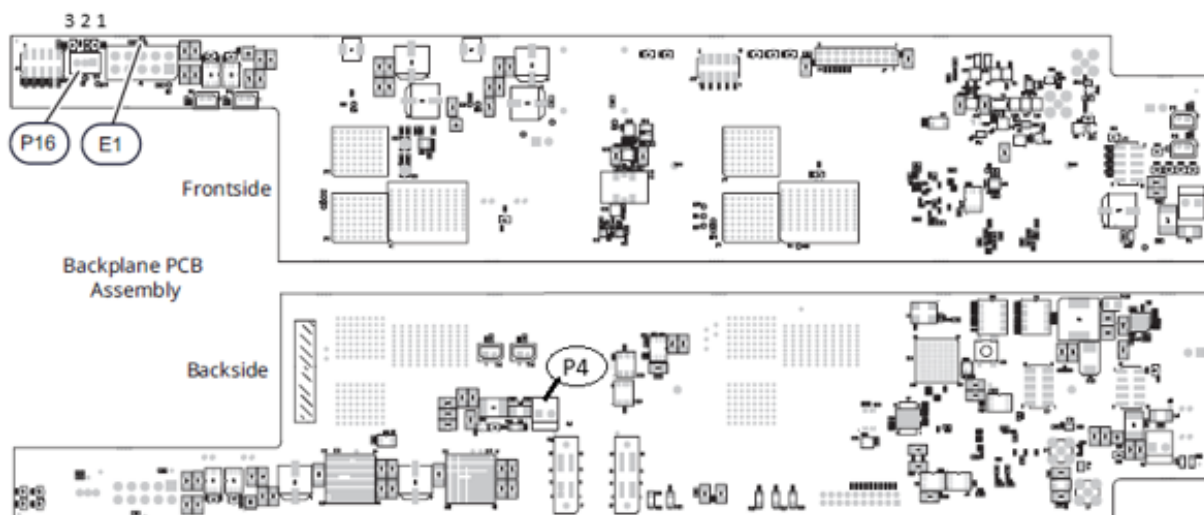


Figure 5-2. Back Plane PCB Assembly – E1 Test Point and P16 +5V Connector

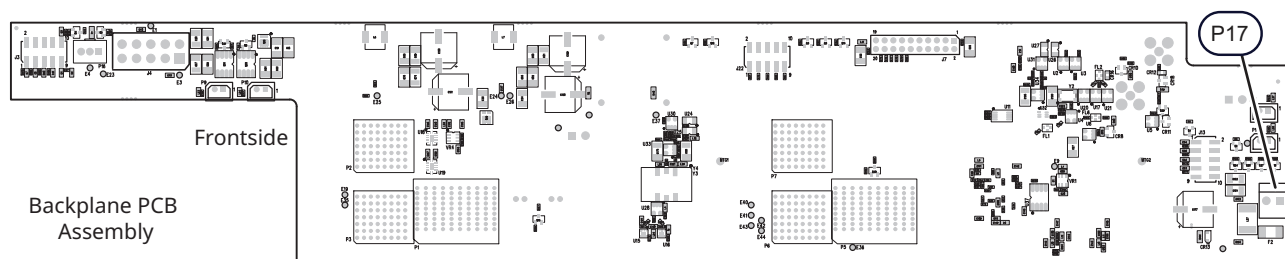


Figure 5-3. Location of P17 VNA 12V Power Supply Connector

Procedure

1. Turn off the MS46322A/B VNA and unplug the AC power cord, mouse, keyboard and external monitor.
2. Remove the top cover.
3. Re-connect the AC power cord, mouse, keyboard and external monitor.
4. Turn the MS46322A/B VNA on.
5. Use the digital multimeter to measure the DC voltages at the test points stated in [Table 5-1](#).

Table 5-1. Expected DC Bias Voltages

Test Point	Common	Expected Voltage
Power Supply +3.3V Terminal	Power Supply +3.3V GND Terminal	+3.3 V
Power Supply +12V Terminal	Power Supply +12V GND Terminal	+12 V
Back Plane PCB Assy P16 pin 3	Back Plane PCB Assy P16 pin 2	+5 V
Back Plane PCB Assy P4 pin 1 (or E2)	Back Plane PCB Assy P4 pin 2	+19 V
Back Plane PCB Assy P17 pin 1	Back Plane PCB Assy P17 pin 2	+12 V

Note When measuring the DC voltage on Back Plane PCB Assembly (except P17), place the test probes on the back side of the specified connector.

6. If the +3.3V or +12V are not present at the terminals, replace the power supply.
7. If the +5 V is not present at P16 of the Back Plane PCB Assembly, replace the power supply.
8. If the +19V is not present at P4, replace the Back Plane PCB Assembly.
9. If the +12V is not present at P17, replace the Back Plane PCB Assembly.

5-4 Troubleshooting Test – Non-Ratio Power Level Check

The Non-Ratio Power Level Check is very useful to verify if the VNA Module Assembly is faulty.

Equipment Required

- For Instruments with N(f) test ports:
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 34NK50 N(m) to K(m) Adapter
 - Anritsu Model 34NKF50 N(m) to K(f) Adapter
- For Instruments with K(m) test ports:
 - Anritsu Model 3670K50-2 or 3670K50A-2 (For Opt 43) Thru Cable
 - Anritsu Model 33KFKF50B or 33KFKF50C (For Opt 43) K(f) to K(f) Adapter

Procedure

1. For instruments with N(f) test ports, install the 34NK50 and 34NKF50 adapters to the 3670K50-2 RF Coaxial Cable to convert both ends into N(m) connector port.
2. For instrument with K(m) test ports, install 33KFKF50B or 33KFKF50C adapter to the male end of the 3670K50-2 RF or 3670K50A-2 Coaxial Cable.
3. Turn on the MS46322A/B.
4. Connect the coaxial cable between test port 1 and test port 2.
5. Select Trace 1 and then select Display | Trace Format. Set Trace Format to Log Mag.
6. Select Response | User-defined. The User-defined menu appears.
7. Set Numerator to A1, Denominator to 1, and Driver Port to Port 1.
8. Use a mouse to move the Reference Line to one graticule below top scale.
9. Repeat [Step 4](#) through [Step 7](#) for Trace 2, setting Numerator to B2, Denominator to 1, and Driver Port to Port 1.
10. Repeat [Step 4](#) through [Step 7](#) for Trace 3, setting Numerator to B1, Denominator to 1, and Driver Port to Port 2.
11. Repeat [Step 4](#) through [Step 7](#) for Trace 4, setting Numerator to A2, Denominator to 1, and Driver Port to Port 2.
12. Observe whether any portions of these traces show any abnormality (e.g. very low power level).

5-5 Troubleshooting Turn-on Problems

Unit Cannot Boot Up

Unit cannot boot up. No activity occurs when the **Operate/Standby** key is pressed:

1. Perform Power Supply DC Check as described in [“Troubleshooting Test – Power Supply DC Check” on page 5-2](#).
 - a. Based on the test results, replace either the Power Supply or the Back Plane PCB Assembly.
2. If all voltages are present and the CPU Fan is not running, then replace the CPU Assembly.

ShockLine Application Stuck on Startup

Unit powers up, but the ShockLine application becomes stuck on the startup screen as shown in [Figure 5-4](#) and does not complete launch.



Figure 5-4. ShockLine Application Startup Screen.

1. Close the application.
2. Right click on ShockLine application icon.
3. Select “Clear Cache” as shown in [Figure 5-5 on page 5-6](#).

4. Re-launch the ShockLine application.

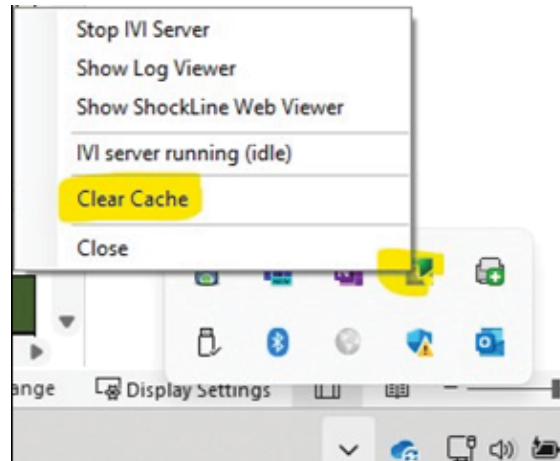


Figure 5-5. ShockLine Application “Clear Cache” Image

Unit Cannot Boot into Windows OS environment

1. Remove the solid state drive from the VNA and attach it to a USB to SATA Adapter.
2. Install the USB to SATA Adapter to a USB port of a Personal Computer that has anti-malware installed.
 - a. If the PC could not recognize the solid state drive, replace it with a new solid state drive.
3. Perform the malware scan.
 - a. If malware is found, remove the malware, then install the solid state drive back to the VNA and verify if the VNA can boot into Windows and launch ShockLine Application.
 - b. If problem still exists, replace the solid state drive.

Unit Cannot Launch ShockLine Application

Unit can boot to Windows but does not launch ShockLine Application:

1. Check if Windows User Account has been changed. It must have Administrator privilege for ShockLine Application Software to run correctly.
2. Check if Windows Language and Regional setting has been changed. It must be set to English (United States).
3. ShockLine Application Software update may not have completed. Re-install software.
4. Verify if the +12V DC is present at P17 of Back Plane PCB Assembly. If not present, replace the Back Plane PCB Assembly.
5. Verify the USB Mini B cable connector is inserted into the USB Mini connector on the VNA Module Assembly.
6. If problem still exists, replace the solid state drive.

5-6 Troubleshooting Operating Problems

Frequency Related Problems

If the instrument exhibits frequency related problem, do the following:

1. Perform [“Adjustment” on page 4-1](#). If it does not help, go to the next step.
2. Apply external 10 MHz Reference to the rear panel 10 MHz Ref In.
3. If the problem does not show with the external reference, the problem is in the internal reference oscillator. Replace the VNA Module Assembly.

RF Power Related Problems

If the instrument exhibits RF power related problems, do the following:

1. Perform [“Troubleshooting Test – Non-Ratio Power Level Check” on page 5-4](#).
2. If the power level shows any abnormality, do the following:
 - a. Verify that the coaxial cable connection between test port adapter and VNA Module Assembly. Re-torque if necessary.
 - b. Verify that the test port adapter is worn or damaged. Replace the test port adapter if necessary.
 - c. Replace VNA Module Assembly.

5-7 Troubleshooting Measurement Problems

If the MS46322A/B measurement quality is suspect, the following paragraphs provide guidelines and hints for determining possible quality problems.

VNA Measurement Quality

The quality of MS46322A/B VNA measurements is determined by the following test conditions and variable:

- The condition of the MS46322A/B.
- The quality and condition of the interface connections and connectors.
- The quality and condition of the calibration components, thru cables, adapters and fixtures.
- The surrounding environmental conditions at the time of the measurement.
- The selection and performance of the calibration for the DUT being measured.

Checking Possible Measurement Problems

When determining possible measurement problems, check the following items:

1. Check the DUT and the calibration conditions:
 - a. Ensure that the Calibration Components Coefficients data has been installed into the VNA for the Calibration Kit in use.
 - b. Ensure that the proper calibration was done for the device being measured:
 - For high insertion-loss device measurements, the calibration should include isolation, high number of averages, and narrow IF Bandwidth setting during calibration.
 - For high return-loss device measurements, a high quality precision load should be used during calibration.
 - c. Check the condition of DUT mating connectors and their pin depth.
 - d. If possible, measure an alternate known good DUT.
 - e. Check if the environment is stable enough for the accuracy required for the DUT measurement.
 - The VNA should not be subjected to variations in temperature.
 - The VNA should not be placed in direct sun light or next to a changing cooling source, such as a fan or air conditioning unit.
2. Check the calibration using known good components from the calibration kit. If measurements of these devices do not produce good results, try the following:
 - a. Check Thru Cable stability including condition and pin depth. Replace with a known good cable, if necessary.
 - b. Check condition and pin depth of calibration kit components. Replace with known good components, if necessary.
 - c. Check condition and pin depth of test port adapters. Replace with known good ones if necessary.
3. Check the system performance as described in [Chapter 2 — MS46322A Performance Verification](#) and [Chapter 3 — MS46322B Performance Verification](#)

Chapter 6 — Assembly Removal and Replacement

6-1 Introduction

This chapter describes the removal and replacement procedures for the various assemblies. Illustrations (drawings or photographs) in this manual may differ slightly from the instrument that you are servicing, but the basic removal and replacement functions will remain as specified. The illustrations are meant to provide assistance with identifying parts and their locations.

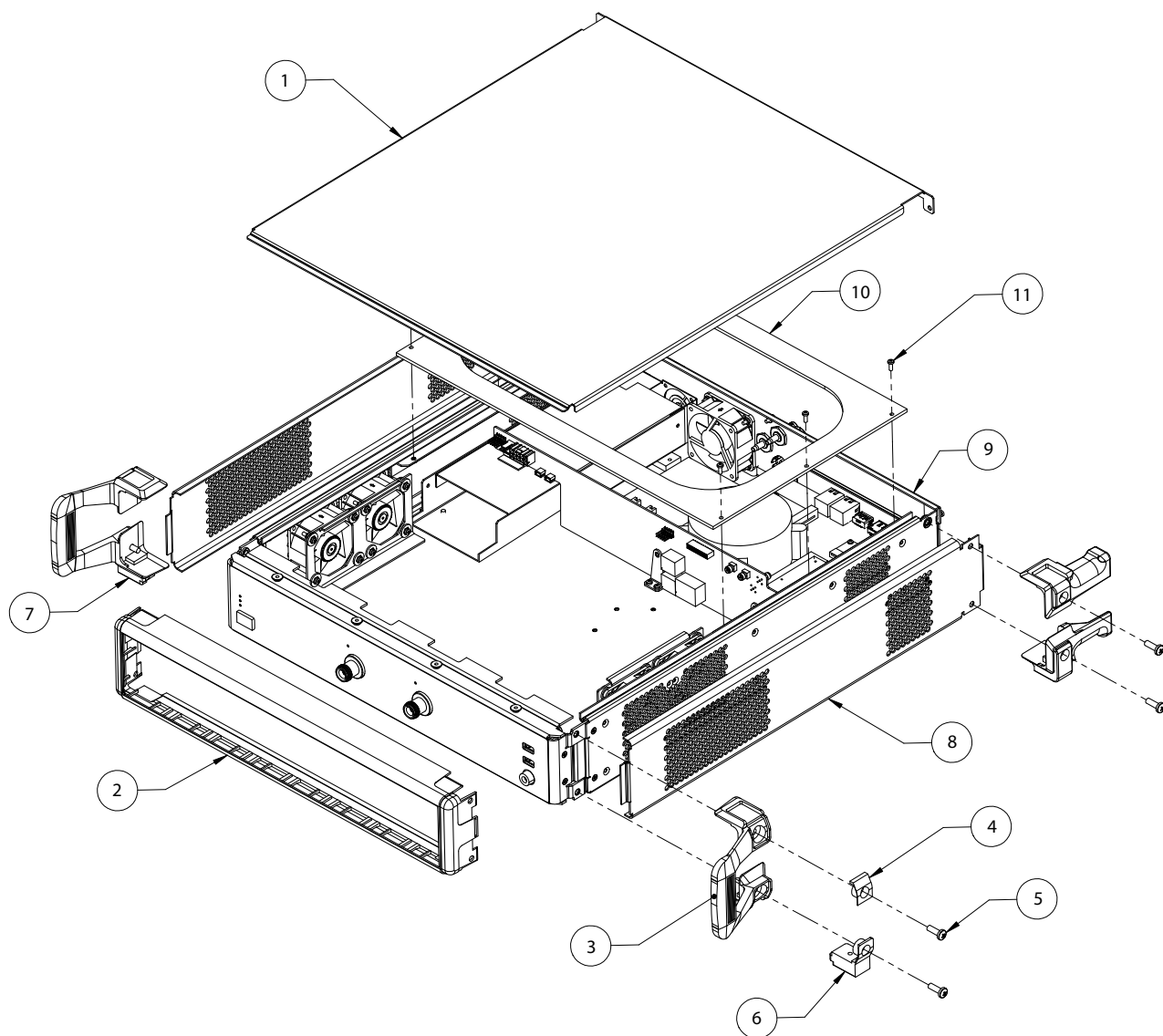
6-2 Electrostatic Discharge Prevention

An ESD safe work area and proper ESD handling procedures that conform to ANSI/ESD S20.20-1999 or ANSI/ESD S20.20-2007 is mandatory to avoid ESD damage when handling subassemblies or components found in the MS46322A/B Vector Network Analyzer.

Warning	All electronic devices, components, and instruments can be damaged by electrostatic discharge. It is important to take preventive measures to protect the instrument and its internal subassemblies from electrostatic discharge.
----------------	---

6-3 Basic Assembly Overview

[Figure 6-1 on page 6-2](#) shows the basic assembly overview of MS46322A/B Vector Network Analyzer.



- 1 – Top Cover
- 2 – Front Panel Bezel
- 3, 4, 5 – Right Handle, Top Handle Insert and Green screw
- 6, 7 – Bottom Handle Foot
- 8 – Side Cover
- 9 – Rear Panel
- 10 – Stiffener plate
- 11 – Stiffener plate mounting screw

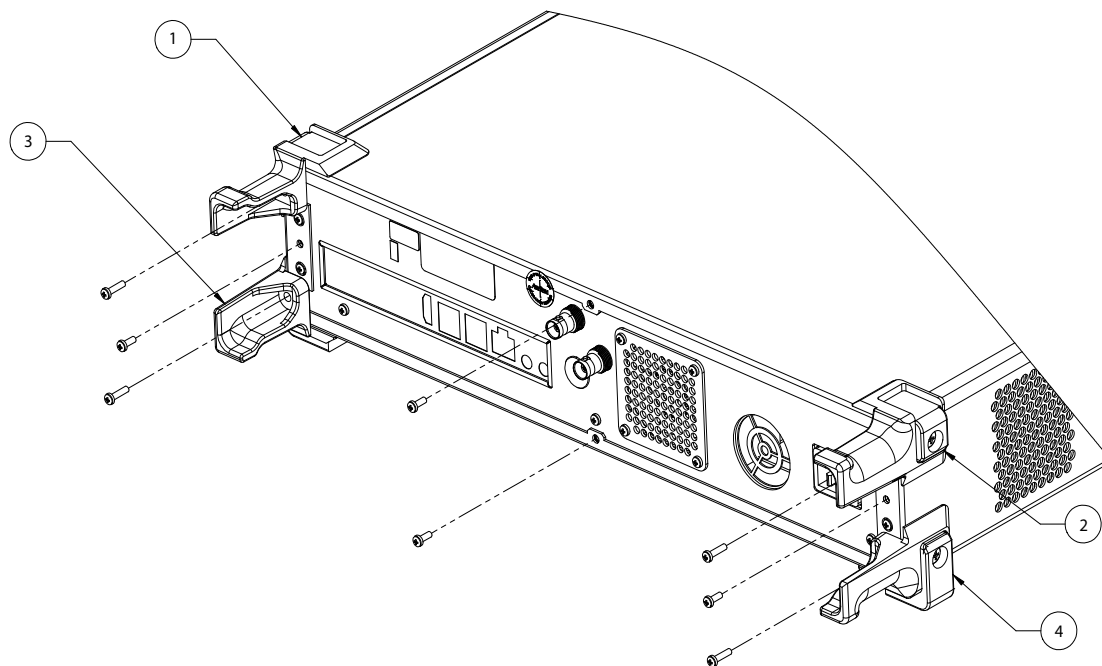
Figure 6-1. MS46322A/B Basic Assembly Overview

6-4 Disassembly Procedure

Use this procedure to prepare the MS46322A/B for removal and replacement procedures for all of its replaceable components. Other than the front panel cables, all replacement components require this common disassembly procedure.

Common Disassembly Procedure

1. Prepare a clean and static free work area. Make sure that the work area is well grounded. Cover the work surface with a soft, clean anti-static mat.
2. Provide all personnel with appropriate anti-static grounding wrist straps and similar equipment.
3. Power down the VNA and unplug the AC power cord.
4. Place the VNA on the anti-static mat.
5. Refer to [Figure 6-2](#) and remove the top cover as follows:
 - a. Remove the two top rear feet.
 - b. Remove the center screw that secures the top cover to the chassis.
 - c. Slide the top cover back and then lift the top cover off the instrument.



1. Top Right Foot
2. Top Left Foot
3. Bottom Right Foot
4. Bottom Left Foot

Figure 6-2. MS46322A/B Rear Panel

6. Remove the six Phillips screws that secure the stiffener plate to the chassis. Refer to [Figure 6-1](#).

7. Removing the bottom cover is required when replacing the Power Supply, the Solid State Drive or the high frequency VNA Module Assembly. Refer to [Figure 6-2](#) and use the following steps to remove the bottom cover:
 - a. Carefully flip over the instrument so the bottom side is now facing upward.
 - b. Remove the two bottom rear feet.
 - c. Remove the center screw that secures the bottom cover to the chassis.
 - d. Slide the top cover back and then lift the bottom cover off the instrument.

6-5 VNA Module Assembly

Use this procedure to replace the VNA Module Assembly. It is secured to the chassis by five (5) Phillips screws and five (5) standoffs.

Replacement Parts

- VNA Module Assembly for MS46322A with Option 4 – ND81295-RFB
- VNA Module Assembly for MS46322A with Option 10 – ND81296-RFB
- VNA Module Assembly for MS46322A with Option 14 – ND81296-RFB
- VNA Module Assembly for MS46322A with Option 20 – ND81298-RFB
- VNA Module Assembly for MS46322A with Option 30 – ND81298-RFB
- VNA Module Assembly for MS46322A with Option 40 – ND81298-RFB
- VNA Module Assembly for MS46322B with Option 10 – 3-ND83420-RFB or 3-ND83985-RFB, depending on serial number
- VNA Module Assembly for MS46322B with Option 20 – 3-ND83421-RFB or 3-ND83986-RFB, depending on serial number
- VNA Module Assembly for MS46322B with Option 40 – 3-ND83422-RFB or 3-ND83987-RFB, depending on serial number
- VNA Module Assembly for MS46322B with Option 43 – 3-ND84774-RFB

Reference Figures

- [Figure 6-3, “Location of VNA Module Cable Clamp” on page 6-5](#)
- [Figure 6-4, “Low Frequency VNA Module Assembly Location Diagram \(MS46322A Options 4 and 10\)” on page 6-6](#)
- [Figure 6-6, “Low Frequency VNA Module Assembly \(MS46322A Options 4 and 10 or MS46322B Option 10\)” on page 6-8](#)
- [Figure 6-7, “High Frequency VNA Module Assembly Location Diagram \(MS46322A Options 14, 20, 30 or 40\)” on page 6-9.](#)

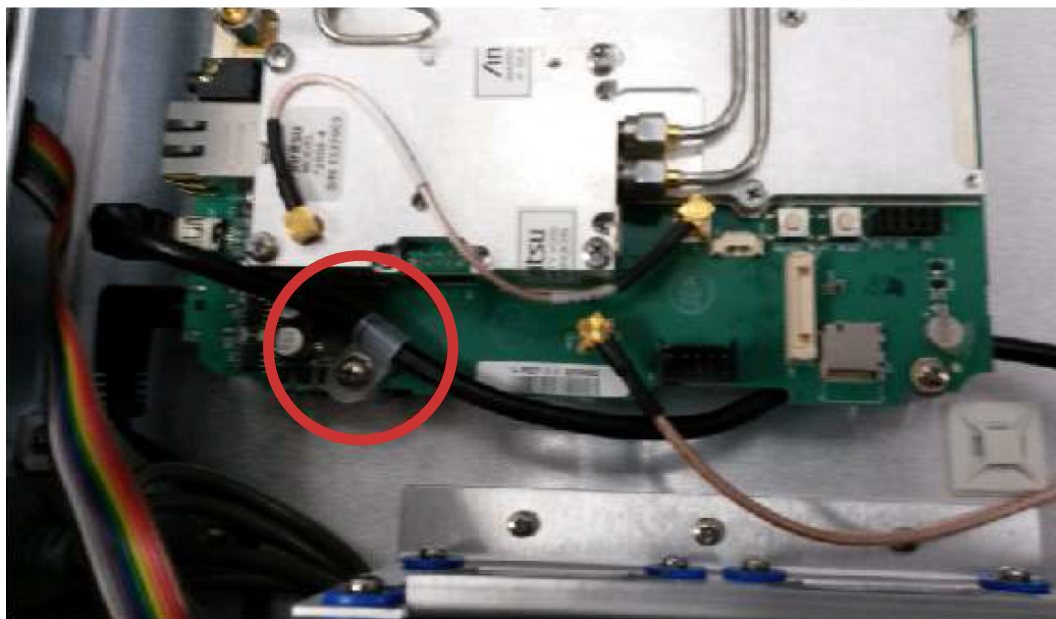
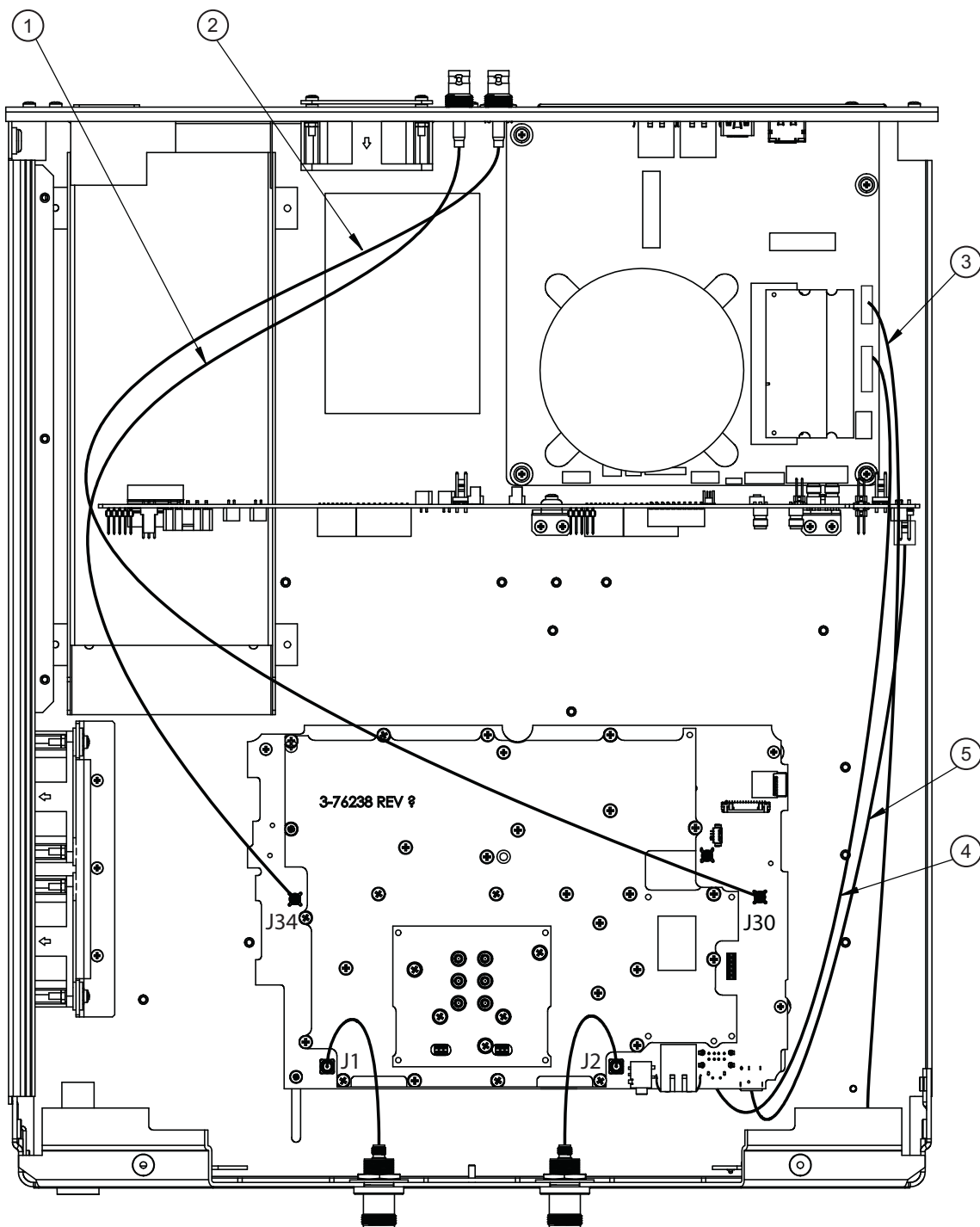
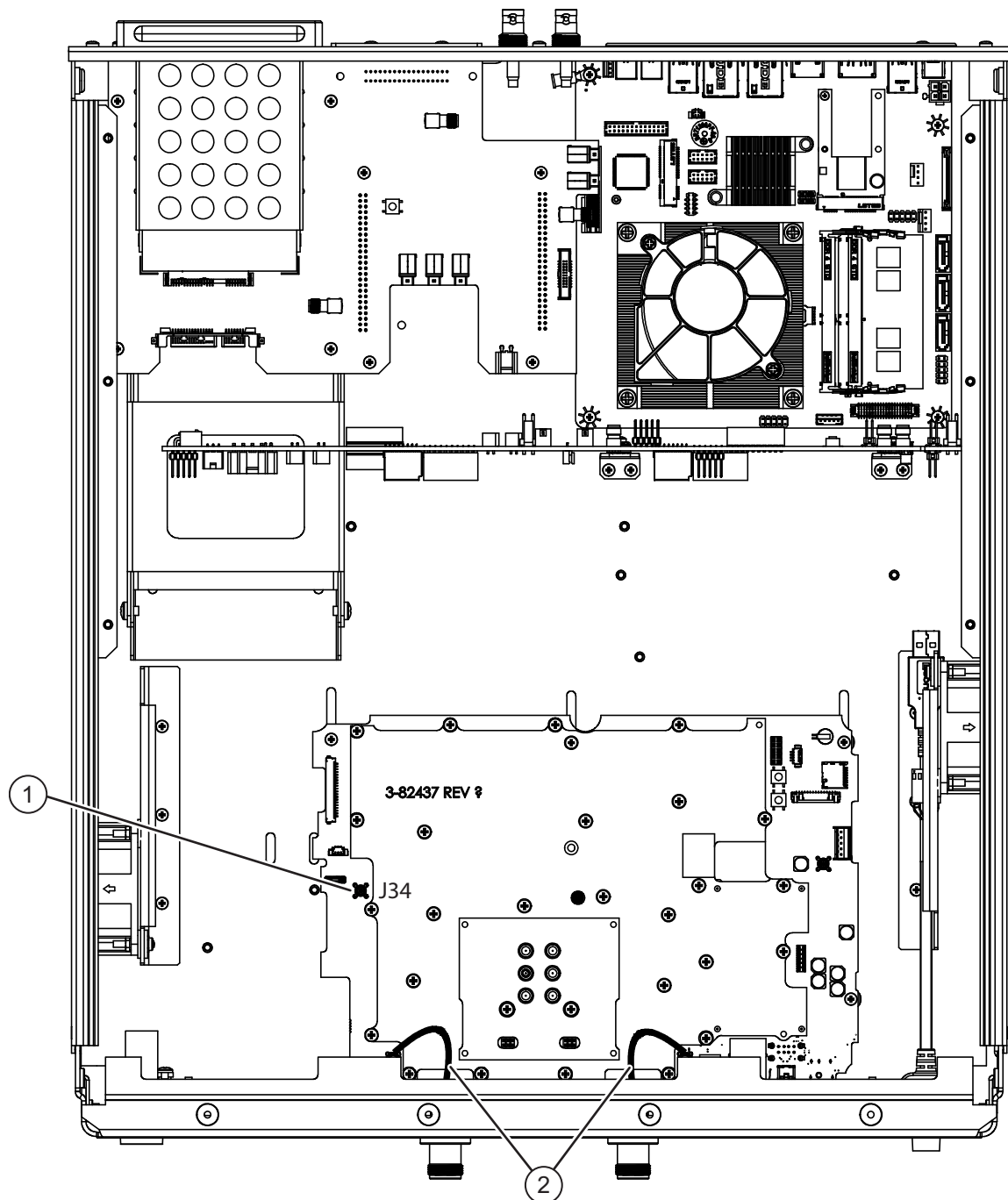


Figure 6-3. Location of VNA Module Cable Clamp



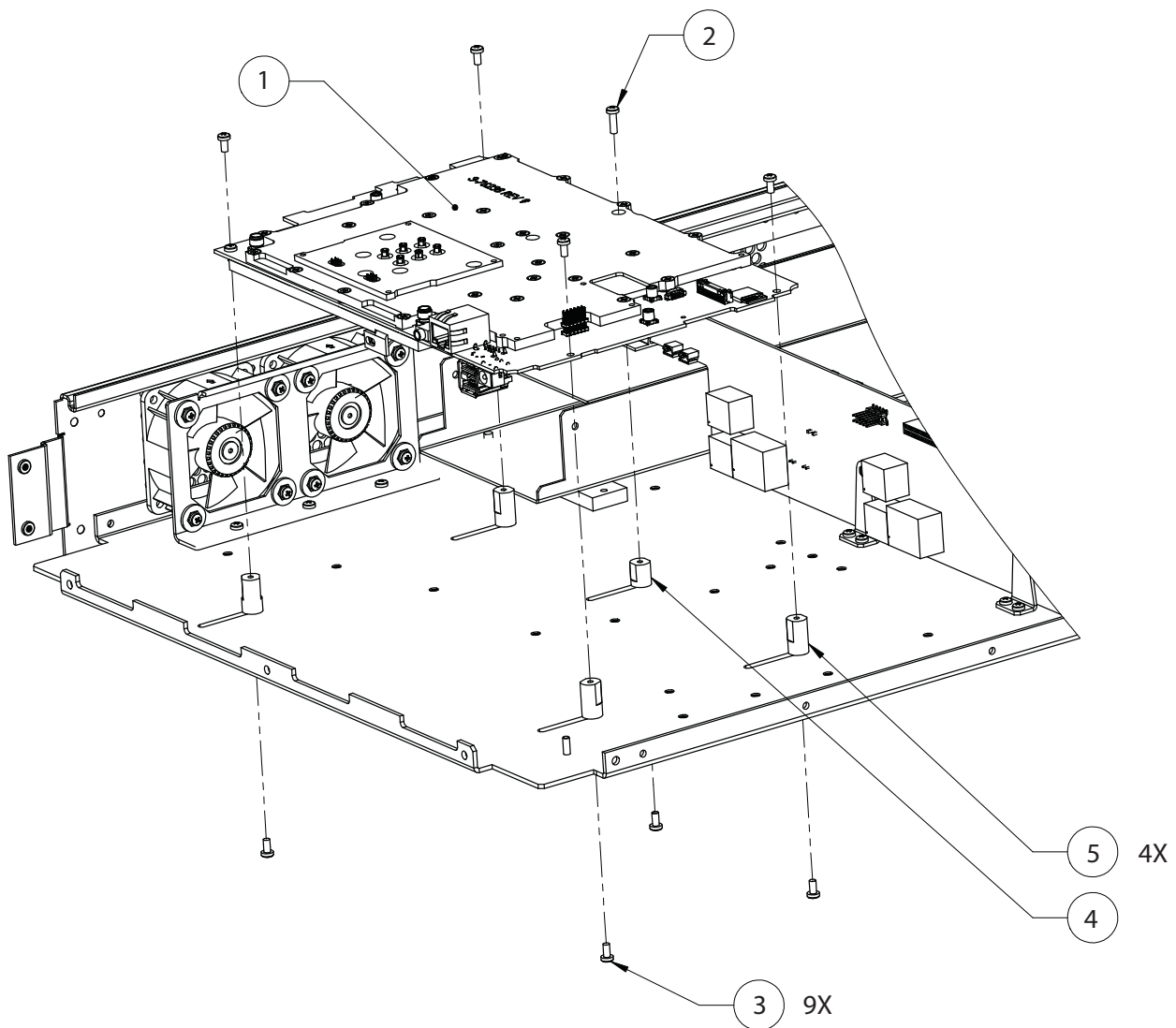
- 1 – 10 MHz Ref In Cable
- 2 – Trigger TTL In Cable
- 3 – Front Panel USB Interface Cable
- 4 – VNA Module Assembly USB Interface Cable
- 5 – VNA Module Assembly +12V Power Supply Cable

Figure 6-4. Low Frequency VNA Module Assembly Location Diagram (MS46322A Options 4 and 10)



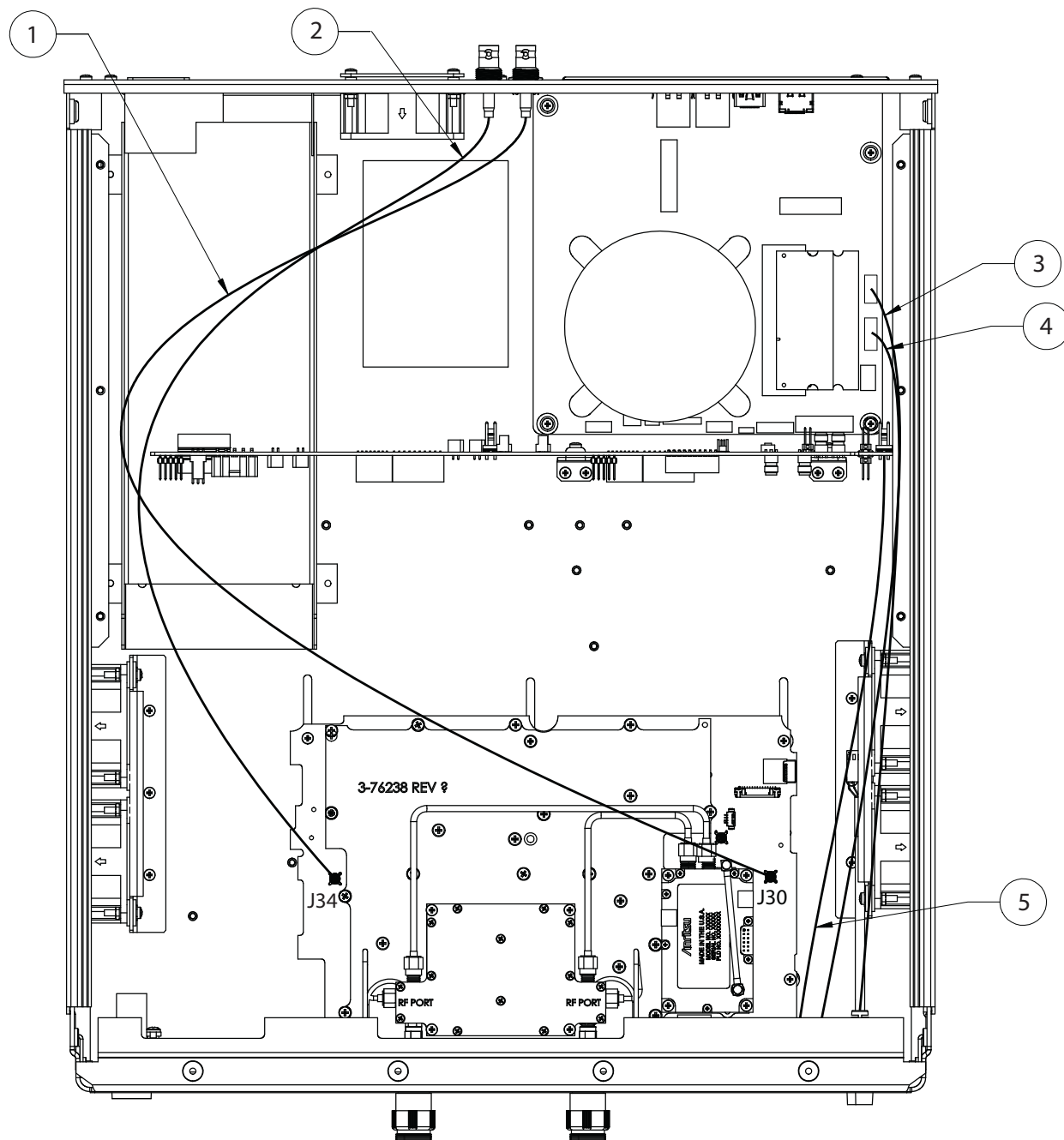
- 1 – 10 MHz Ref In Cable plugged into J34 on the VNA Module Assembly
2 – Test Port Coaxial Cables

Figure 6-5. Low Frequency VNA Module Assembly Location Diagram (MS46322B Option 10)



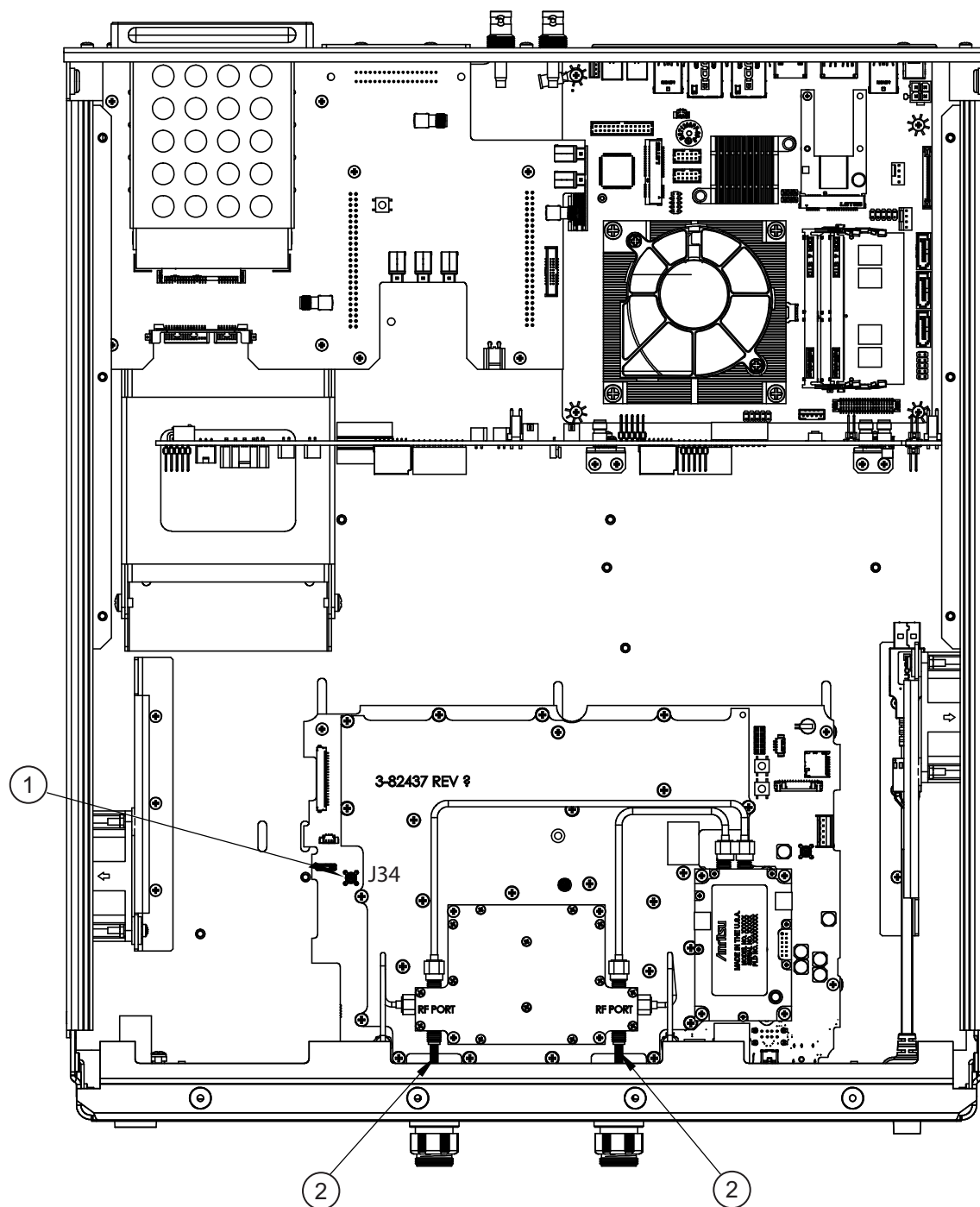
- 1 – VNA Module Assembly
- 2 – Long Mounting Screw (1)
- 3 – Short Mounting screws (9)
- 4 – Short Standoff (1)
- 5 – Tall Standoffs (4)

Figure 6-6. Low Frequency VNA Module Assembly (MS46322A Options 4 and 10 or MS46322B Option 10)



- 1 – 10 MHz Ref In Cable
- 2 – Trigger TTL In Cable
- 3 – Front Panel USB Interface Cable
- 4 – VNA Module Assembly USB Interface Cable
- 5 – VNA Module Assembly +12V Power Supply Cable

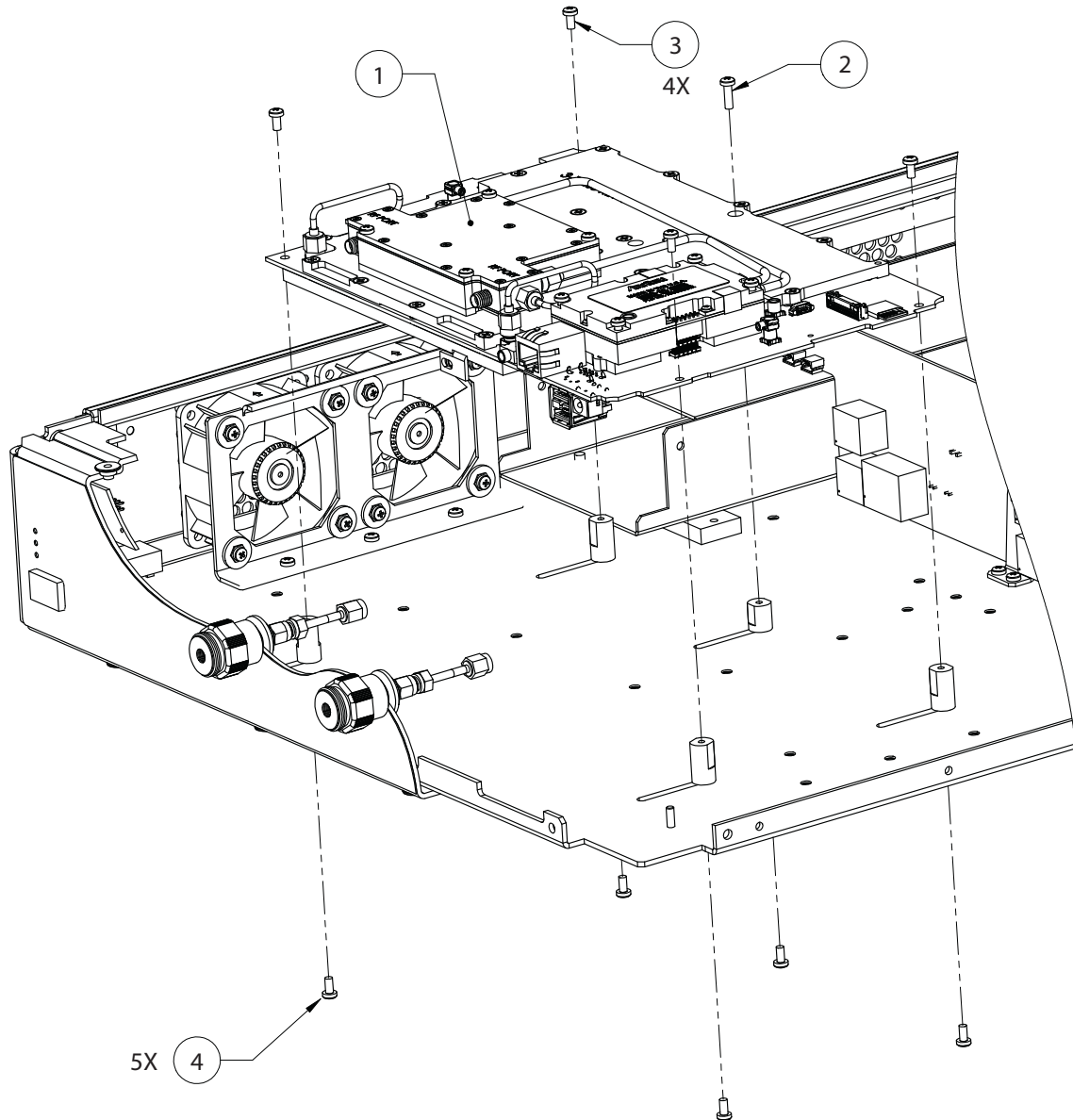
Figure 6-7. High Frequency VNA Module Assembly Location Diagram (MS46322A Options 14, 20, 30 or 40)



1 – 10 MHz Ref In Cable plugged into J34 on the VNA Module Assembly

2 – Trigger TTL In Cable

Figure 6-8. High Frequency VNA Module Assembly Location Diagram (MS46322B Options 20, 40, or 43)



- 1 – VNA Module Assembly
- 2 – Long Mounting screw (1)
- 3 – Short Mounting screws (4)
- 4 – Standoff Mounting screws (5)

Figure 6-9. High Frequency VNA Module Assembly (MS46322A Options 14, 20, 30 or 40, or MS46322B Options 20, 40, or 43)

Replacement Procedure (For instruments with Options 4 or 10)

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the Stiffener Plate.
3. Disconnect the 10 MHz Ref In Cable from J30 of the VNA Module Assembly.
4. Disconnect the Trigger TTL In Cable from J34 of the VNA Module Assembly.
5. Disconnect the VNA Module Assembly 12V Power Supply Cable from P17 of the Back Plane PCB Assembly.
6. Disconnect the VNA Module Assembly USB Interface Cable from the CPU Module.
7. Disconnect the flexible coaxial cables from J1 and J2 of the VNA Module Assembly.
8. Remove the five screws that secure the VNA Module Assembly to the standoffs and then remove the cable clamp from the power supply cable and USB interface cable.
9. Carefully remove the VNA Module Assembly from the chassis.
10. Disconnect the 12V Power Supply Cable from the VNA Module Assembly.
11. Disconnect the USB Interface Cable from the VNA Module Assembly.
12. Connect the 12V Power Supply Cable to the replacement VNA Module Assembly.
13. Connect the USB Interface Cable to the replacement VNA Module Assembly.
14. Place the replacement VNA Module Assembly on the standoffs and secure with screws that were removed in [Step 8](#). Install the cable clamp prior installing the screw that is near the power supply connector. See [Figure 6-3 on page 6-5](#).
15. Connect the flexible coaxial cables to J1 and J2 of the VNA Module Assembly.
16. Torque the connections above to 8 lbf·in.
17. Connect the 10 MHz Ref In Cable to J30 of the VNA Module Assembly.
18. Connect the Trigger TTL In Cable to J34 of the VNA Module Assembly.
19. Connect the VNA Module Assembly 12V Power Supply Cable to P17 of the Back Plane PCB Assembly.
20. Connect the VNA Module Assembly USB Interface Cable to the CPU Module.
21. Install the Stiffener Plate.
22. Install the top cover.

Replacement Procedure (For Instruments with Options 14, 20, 30, 40, or 43)

1. Remove the top and bottom covers as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the Stiffener Plate.
3. Disconnect the 10 MHz Ref In Cable from J30 of the VNA Module Assembly.
4. Disconnect the Trigger TTL In Cable from J34 of the VNA Module Assembly.
5. Disconnect the VNA Module Assembly 12V Power Supply Cable from P17 of the Back Plane PCB Assembly.
6. Disconnect the VNA Module Assembly USB Interface Cable from the CPU Module.
7. Disconnect the flexible coaxial cables from J1 and J2 of the VNA Module Assembly.
8. Loosen the five (5) screws that secure the VNA Module Assembly to the chassis standoffs.
9. Place the instrument on its side and loosen the five (5) screws that secure the standoffs to the chassis on the bottom so that the VNA Module Assembly can be sliding backward.
10. Place the instrument on its bottom.
11. Disconnect the semi-rigid coaxial cables from Port 1 and Port 2 Inputs of the VNA Module Assembly.
12. Carefully slide the VNA Module Assembly backward.
13. Remove the five screws that secure the VNA Module Assembly to the standoffs and then remove the cable clamp from the power supply cable and USB interface cable.
14. Carefully remove the VNA Module Assembly from the chassis.
15. Disconnect the 12V Power Supply Cable from the VNA Module Assembly.
16. Disconnect the USB Interface Cable from the VNA Module Assembly.
17. Connect the 12V Power Supply Cable to the replacement VNA Module Assembly.
18. Connect the USB Interface Cable to the replacement VNA Module Assembly.
19. Place the replacement VNA Module Assembly on the standoffs and secure with screws that were removed in [Step 8](#). Install the cable clamp prior installing the screw that is near the power supply connector. See [Figure 6-3 on page 6-5](#).
20. Connect the semi-rigid coaxial cables to Port 1 and Port 2 of the VNA Module Assembly.
21. Torque the connections above to 8 lbf·in.
22. Place the instrument on its side and tighten the five (5) screws that secure the standoffs.
23. Place the instrument on its bottom.
24. Connect the 10 MHz Ref In Cable to J30 of the VNA Module Assembly.
25. Connect the Trigger TTL In Cable to J34 of the VNA Module Assembly.
26. Connect the VNA Module Assembly 12V Power Supply Cable to P17 of the Back Plane PCB Assembly.
27. Connect the VNA Module Assembly USB Interface Cable to the CPU Module.
28. Install the Stiffener Plate.
29. Install the top and bottom covers.

6-6 CPU Assembly

Use this procedure to replace the CPU Assembly.

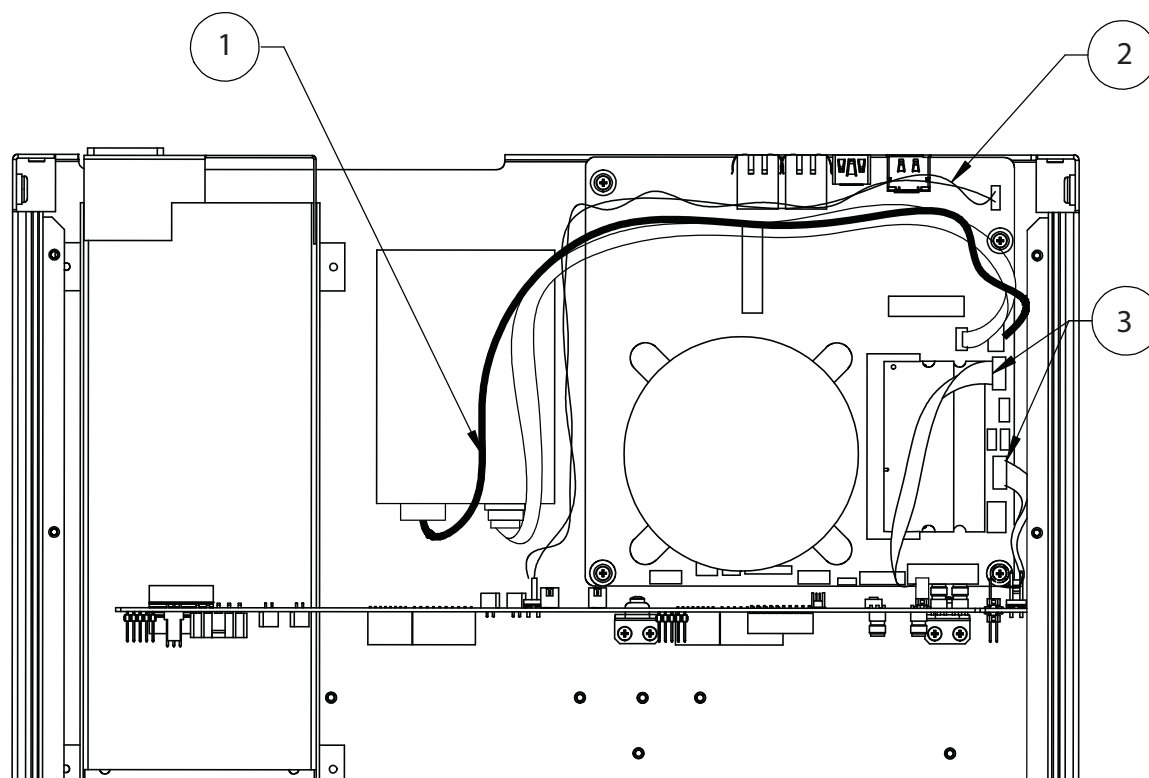
The CPU Assembly has the Main Processor and SODIMM modules already installed and has been pre-tested as a single assembly.

Replacement Part

- MS46322A CPU Assembly – ND80983-RFB
- MS46322B CPU Assembly – 3-ND87247-RFB

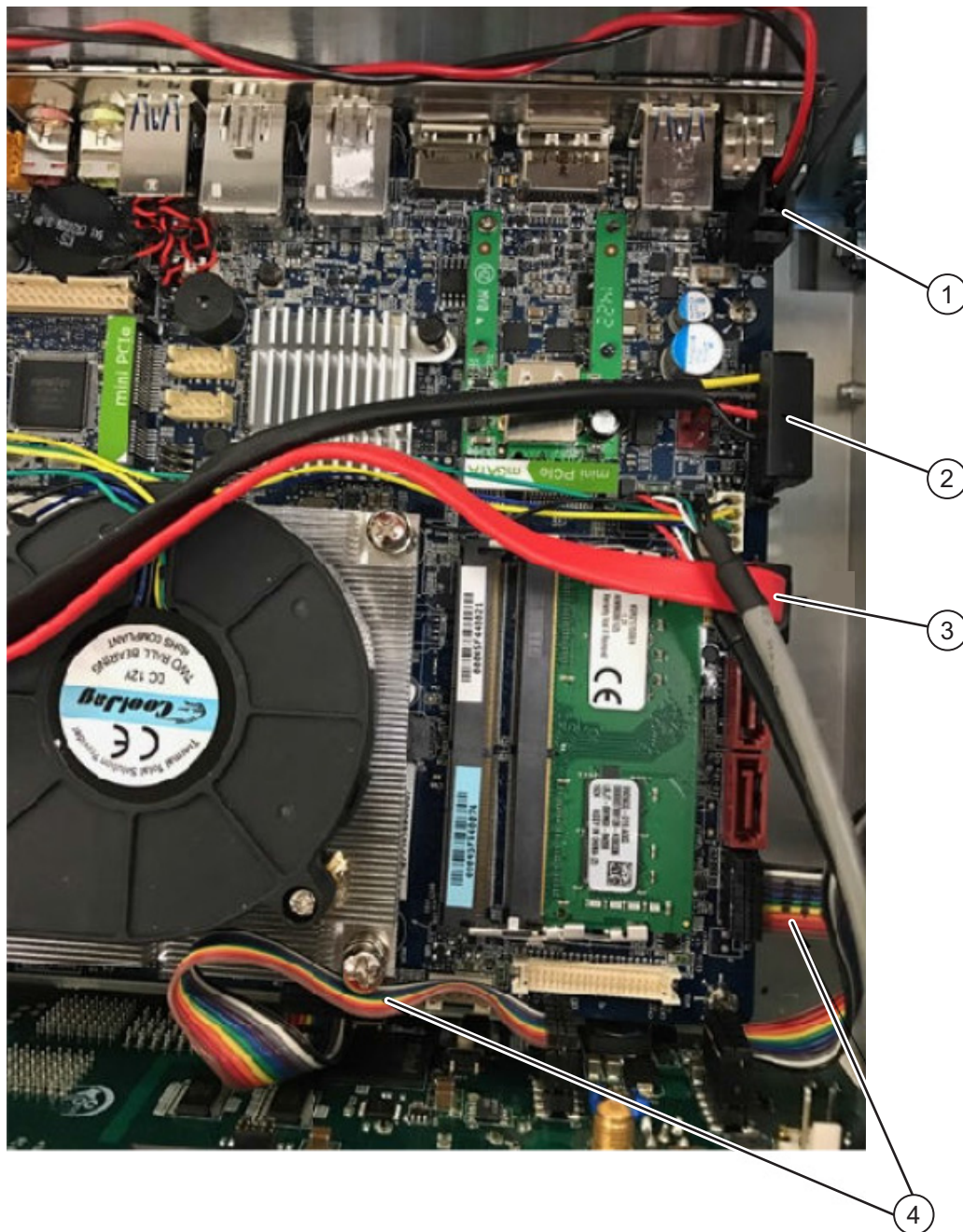
Reference Figures

- [Figure 6-10, “MS46322A CPU Assembly Cable Connections” on page 6-14](#)
- [Figure 6-11, “MS46322B CPU Assembly Cable Connections” on page 6-15](#)
- [Figure 6-12, “CPU Assembly” on page 6-16](#)



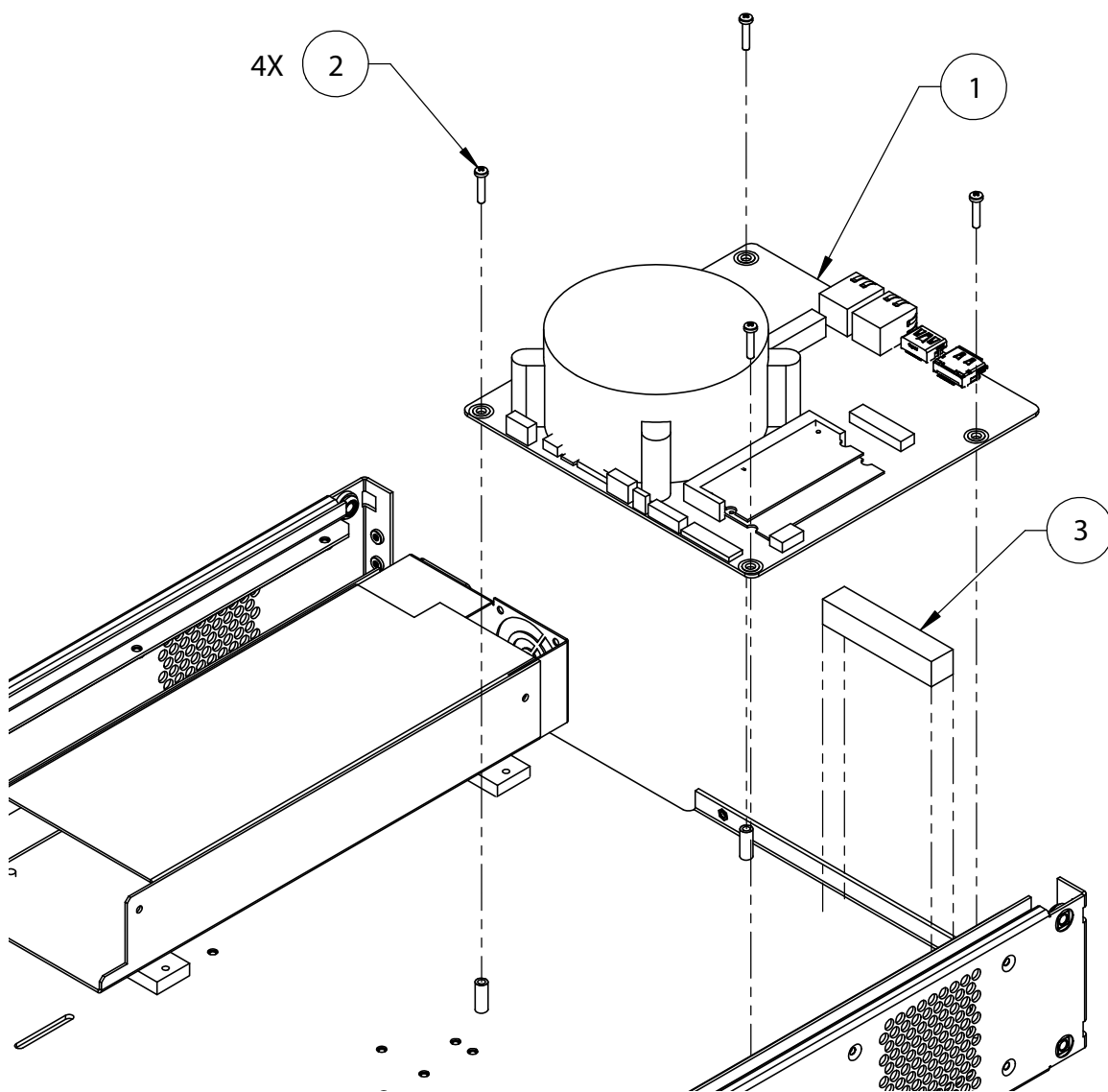
- 1 – Solid State Drive Power Cable
2 – CPU Assembly Power Supply Cable
3 – Ribbon cables linked to Backplane Board

Figure 6-10. MS46322A CPU Assembly Cable Connections



- 1 – CPU Assembly Power Supply Cable
- 2 – Solid State Drive Power Cable
- 3 – Solid State Drive SATA Interface Cable
- 4 – Ribbon cables linked to Back Plane Board

Figure 6-11. MS46322B CPU Assembly Cable Connections



- 1 – CPU Assembly
- 2 – Mounting Screws
- 3 – Silicone block

Figure 6-12. CPU Assembly

Replacement Procedure

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the Stiffener Plate.
3. Unplug all the cable harnesses connected to the CPU Assembly.
4. Remove the four Phillips screws that secure the CPU Assembly to the chassis. For MS46322B, also remove the four Phillips screws that secure the CPU heatsink/cooler to the bottom side of the chassis.
5. Remove the CPU Assembly.

Note

Physically removing screws on the MS46322B Back Plane board and moving it away from the CPU assembly may assist in the removal.

6. Install the replacement CPU Assembly.
7. Secure the CPU Assembly with screws that were removed in [Step 4](#).
8. Re-connect all the cable harnesses.
9. Install the Stiffener Plate.
10. Install the top cover.

6-7 Solid State Drive

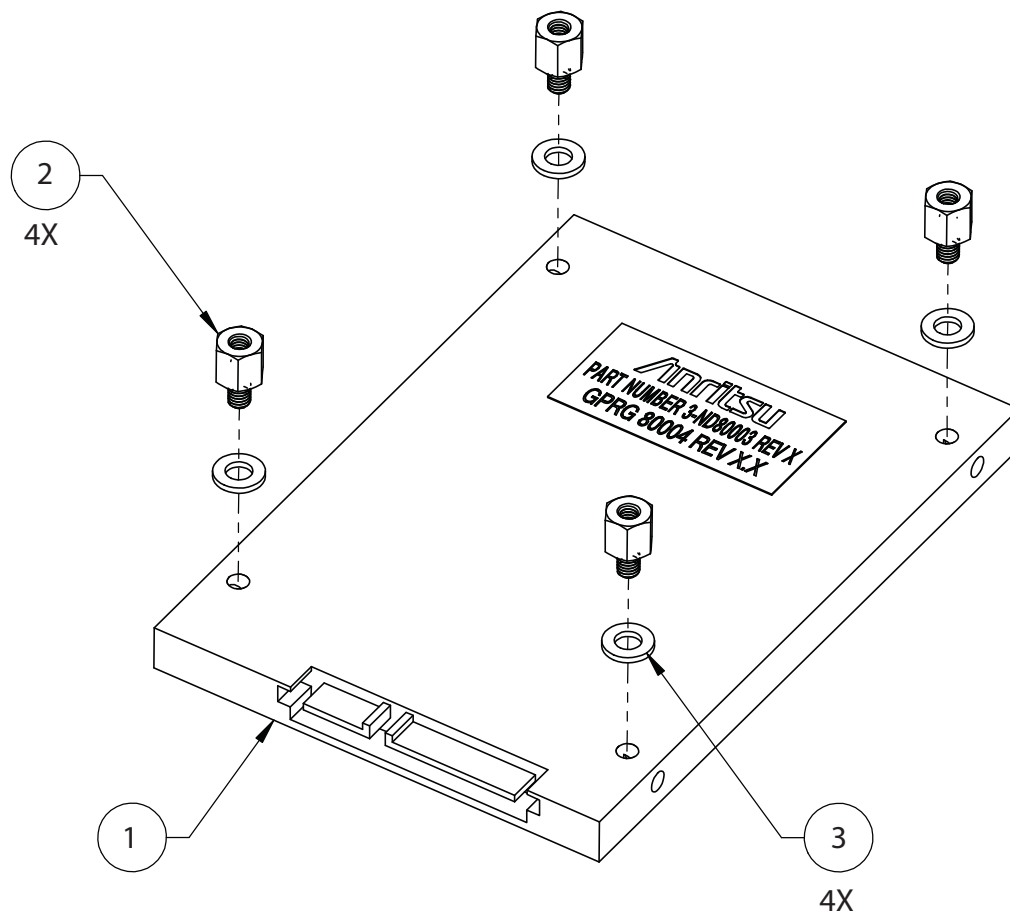
Use this procedure to replace the solid static drive.

Replacement Part

- MS46322A Revision 1 Instrument Solid State Drive – ND80984
- MS46322A Revision 2 Instrument Solid State Drive – ND80997
- MS46322B Solid State Drive – 3-ND83423

Reference Figure

- [Figure 6-13, “MS46322A Revision 1 instrument Solid State Drive”](#)



- 1 – Solid State Drive
- 2 – Washers
- 3 – Standoffs

Figure 6-13. MS46322A Revision 1 instrument Solid State Drive

Replacement Procedure for MS46322A Revision 1 Instrument

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the Stiffener Plate.
3. Unplug the SATA cable and Power cable from the solid state drive.
4. Flip over the instrument with the bottom cover facing upward.
5. Remove the bottom cover.
6. Place the instrument on its left side.
7. Remove the four screws that secure the solid static drive to the chassis. While removing the last screw, use one hand to hold the solid state drive so it will not drop unexpectedly.
8. Remove the standoffs and washers and install them to the replacement solid state drive.
9. Secure the replacement solid state drive to the chassis with the screws that were removed in [Step 7](#).
10. Install the bottom cover.
11. Place the instrument on its bottom side.
12. Re-connect the SATA cable and Power cable to the solid state drive.
13. Install the Stiffener Plate.
14. Install the top cover.

Replacement Procedure for MS46322A Revision 2 Instrument and MS46322B

1. Use a flat head screwdriver to loosen the two captive screws that secure the solid state drive to the rear panel of the instrument.
2. Pulling gently, remove the solid state drive from the chassis.
3. Insert the replacement solid state drive through the drive slot on the rear panel.
4. Press the solid state drive into its mating socket on the IO Handler PCB assembly and gradually tighten the two flat head captive screws with a flat head screwdriver.

6-8 Back Plane PCB Assembly

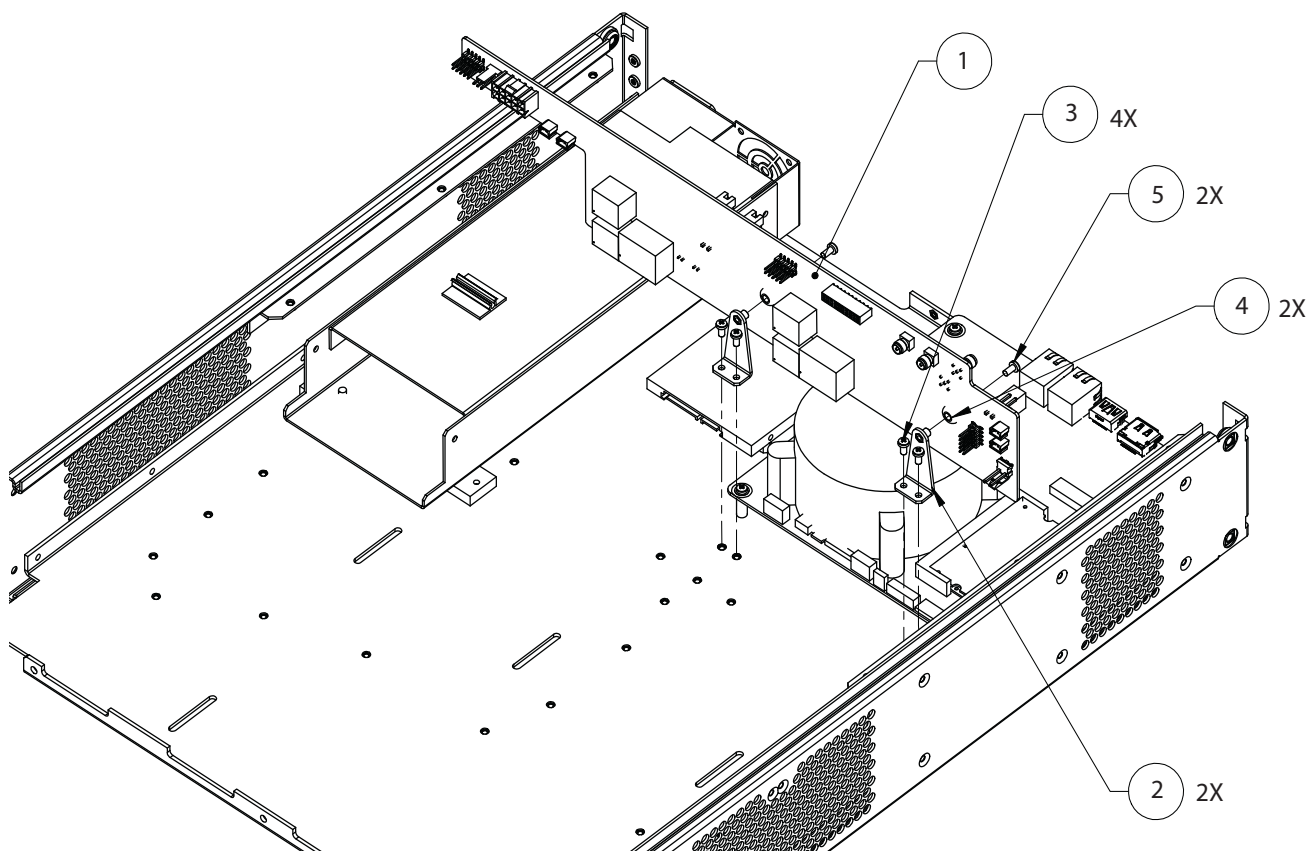
Use this procedure to replace the Back Plane PCB Assembly.

Replacement Part

- MS46322A Back Plane PCB Assembly – ND80994-RFB
- MS46322B Back Plane PCB Assembly – 3-ND87249-RFB

Reference Figure

- [Figure 6-14, “Back Plane PCB Assembly”](#)



- 1 – Back Plane PCB Assembly
- 2 – Mounting Bracket
- 3 – Bracket Mounting Screw
- 4 – Isolator
- 5 – PCB Mounting Screw

Figure 6-14. Back Plane PCB Assembly

Replacement Procedure

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the stiffener plate.
3. Disconnect the VNA Module 12V Power Supply Cable from P17.
4. Disconnect the PC ON/OFF/RST ribbon cable from J2.
5. Disconnect the PC USB Interface ribbon cable from J12.
6. Disconnect the IO Handler PCB cable from J7 (For units with Option 5 only).
7. Disconnect the cable harness from J1.
8. Disconnect the PC 19V cable harness from the P4.
9. Disconnect the rear panel fan power supply harness from J13.
10. Disconnect the front panel LED interface ribbon cables from J3 and J13.
11. Disconnect the Power Supply harness cables from J4 and P16.
12. Disconnect the left Fan Assembly power supply harnesses from P9 and P10.
13. Disconnect the right Fan Assembly power supply harnesses from P13 and P14.
14. Remove the four Phillips screws that secure the Back Plane PCB Assembly mounting brackets to the chassis. See [Figure 6-14 on page 6-20](#).
15. Remove the PCB mounting screws and separate the mounting brackets from the PCB assembly. Be sure not to lose the two isolators.
16. Install the mounting brackets and isolators onto the replacement Back Plane PCB Assembly. Do not tighten the PCB mounting screws.
17. Install the replacement Back Plane PCB Assembly to the chassis and secure it with the screws that were removed in [Step 15](#).
18. Tighten the PCB mounting screws.
19. Re-connect all the cables.
20. Install the stiffener plate.
21. Install the top cover.

6-9 IO Handler PCB Assembly

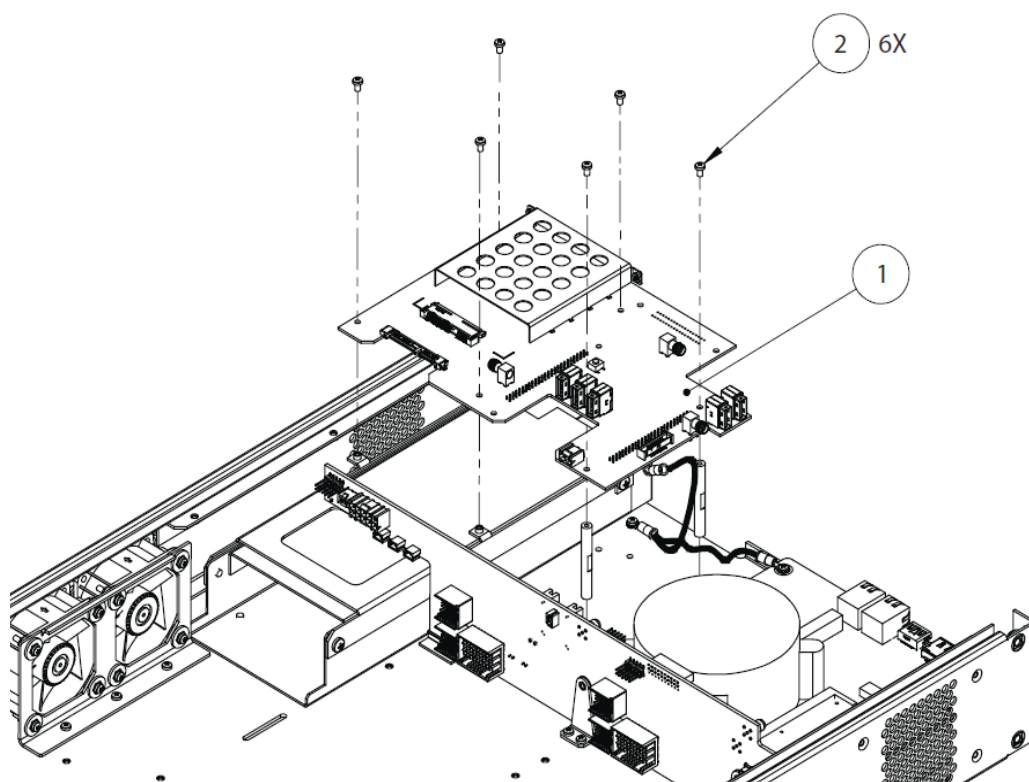
Use this procedure to replace the IO Handler PCB assembly. The IO Handler PCB assembly is being used in the MS46322A Revision 2 and the MS46322B instrument only.

Replacement Parts

- MS46322A IO Handler PCB Assembly – ND80995-RFB
- MS46322B IO Handler PCB Assembly – 3-ND80995-RFB

Reference Figures

Figure 6-15 shows the location of the IO Handler PCB assembly.



1. IO Handler PCB Assembly

2. Mounting Screw

Figure 6-15. IO Handler PCB Assembly

Replacement Procedure for IO Handler PCB Assembly

1. Remove the top cover as described in the “Common Disassembly Procedure” on page 5-3.
2. Remove the stiffener plate.
3. Remove the solid state drive.
4. Unplug the SATA cable and solid state drive power cable from the IO Handler PCB assembly.
5. Remove the six Phillips screws that secure the IO Handler PCB assembly to the chassis and then remove it from the chassis.
6. Install the replacement IO Handler PCB assembly and secure it with screws that were removed in [Step 5](#).
7. Re-connect the SATA cable and solid state drive power cable.
8. Install the solid state drive.
9. Install the stiffener plate and then the top cover.

6-10 Fan Assemblies

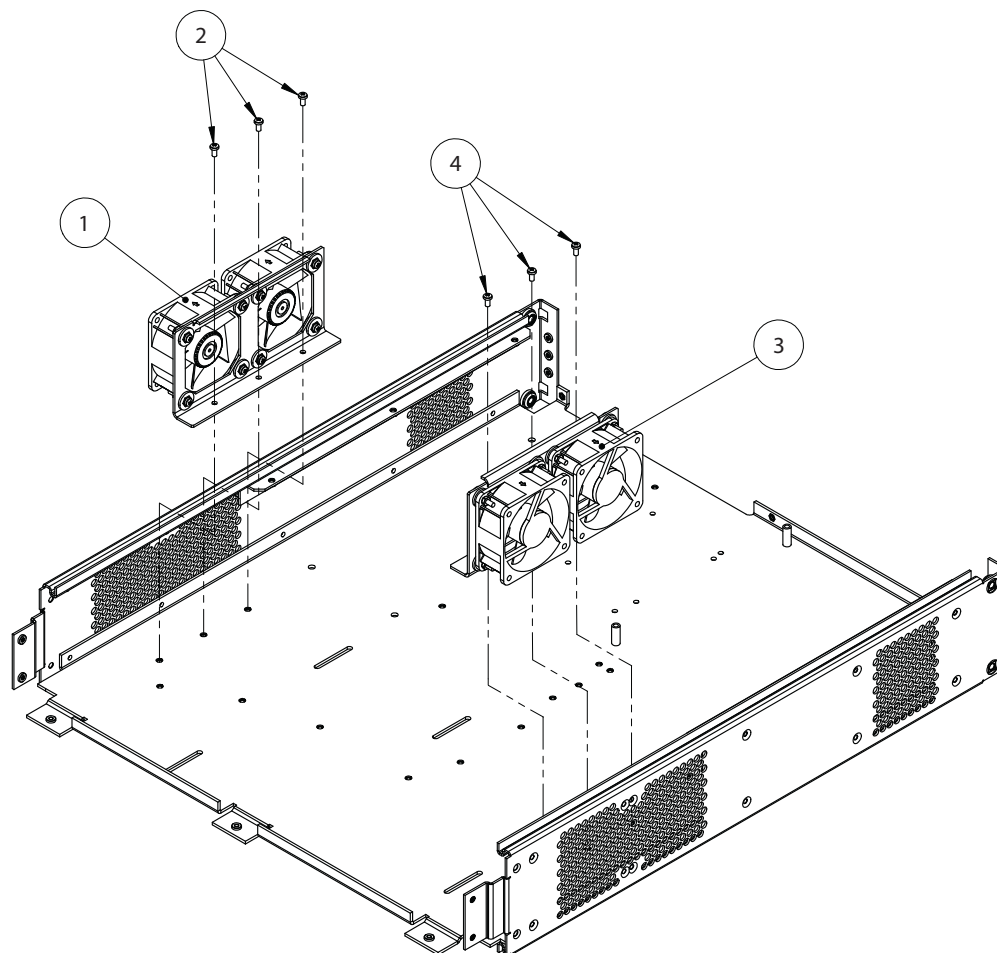
Use this procedure to replace the Fan Assemblies.

Replacement Parts

- MS46322A Fan Assembly, Right – ND80986
- MS46322A Fan Assembly, Left – ND80987
- MS46322A Fan Assembly, Rear – ND80989
- MS46322B Fan Assembly, Right – 3-ND80986
- MS46322B Fan Assembly, Left – 3-ND80987
- MS46322B Fan Assembly, Rear – 3-ND83585

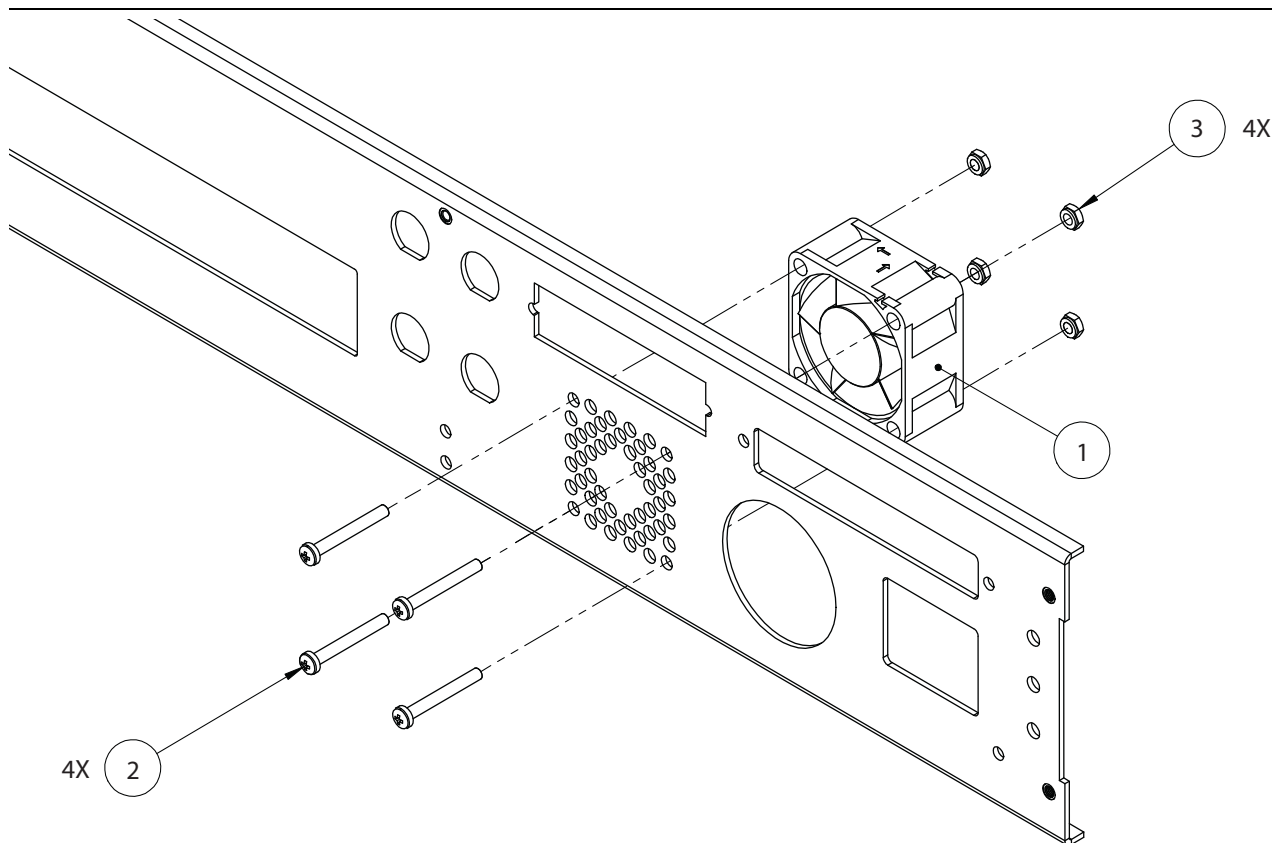
Reference Figures

- [Figure 6-16, “Left and Right Fan Assemblies” on page 6-23](#)
- [Figure 6-17, “Rear Fan Assembly” on page 6-24](#)



- 1 – Left Fan Assembly
- 2 – Mounting Screw
- 3 – Right Fan Assembly
- 4 – Mounting Screw

Figure 6-16. Left and Right Fan Assemblies



- 1 – Rear Fan Assembly
- 2 – Mounting Screw
- 3 – Hex Nut

Figure 6-17. Rear Fan Assembly

Replacement Procedure for Right Fan Assembly

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the stiffener plate.
3. Disconnect the fan assembly power cables from P13 and P14 of the Back Plane PCB Assembly.
4. Remove the three Phillips screws that secure the fan bracket to the chassis. See [Figure 6-16 on page 6-23](#).
5. Remove the Right Fan Assembly.
6. Install the replacement fan assembly and secure it with the screws that were removed in [Step 4](#).
7. Connect the fan assembly power cables to P13 and P14 of the Back Plane PCB Assembly.
8. Install the stiffener plate.
9. Install the top cover.

Replacement Procedure for Left Fan Assembly

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the stiffener plate.
3. Disconnect the fan assembly power cables from P9 and P10 of the Back Plane PCB Assembly.
4. Remove the three Phillips screws that secure the fan bracket to the chassis. See [Figure 6-16 on page 6-23](#).
5. Remove the Right Fan Assembly.
6. Install the replacement fan assembly and secure it with the screws that were removed in [Step 4](#).
7. Connect the fan assembly power cables to P9 and P10 of the Back Plane PCB Assembly.
8. Install the stiffener plate.
9. Install the top cover.

Replacement Procedure for Rear Fan Assembly

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the stiffener plate.
3. Disconnect the Fan Assembly power cable from P12 of the Back Plane PCB Assembly.
4. Remove the mounting screws and hex nuts that secure the fan assembly to the rear panel. See [Figure 6-17 on page 6-24](#).
5. Remove the fan assembly.
6. Install the replacement fan assembly to the rear panel. Note that the direction of the air flow is inward.
7. Secure the fan assembly with the screws and nuts that were removed from [Step 4](#). Be sure to install the Ground wire lug between the fan assembly and nut at the upper right corner of the fan assembly.
8. Connect the fan power cable to P12 of the Back Plane PCB Assembly.
9. Install the stiffener plate.
10. Install the top cover.

6-11 Power Supply Assembly

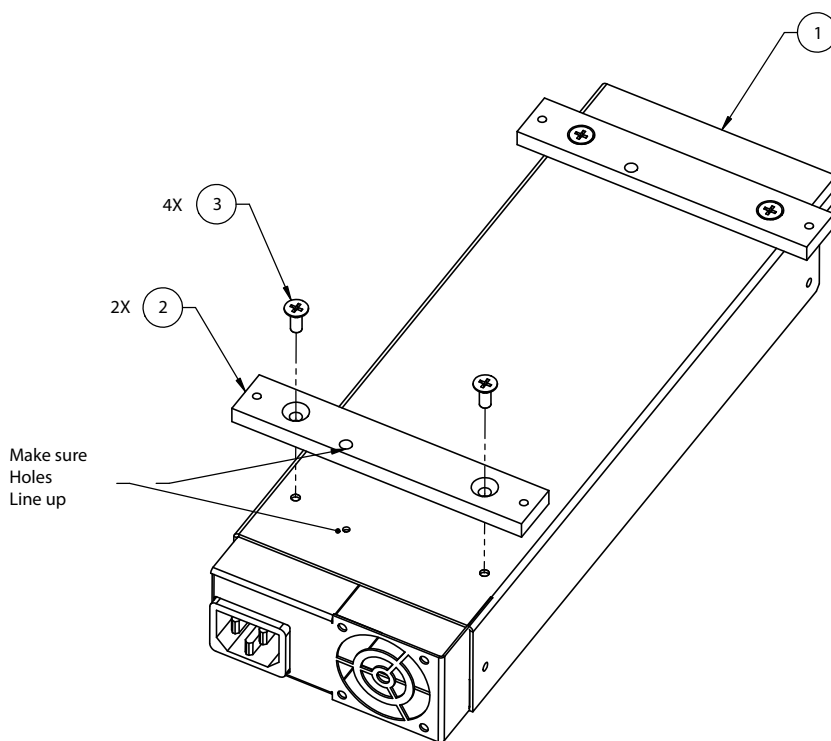
Use this procedure to replace the Power Supply Assembly.

Replacement Part

- Power Supply Assembly – 3-40-191

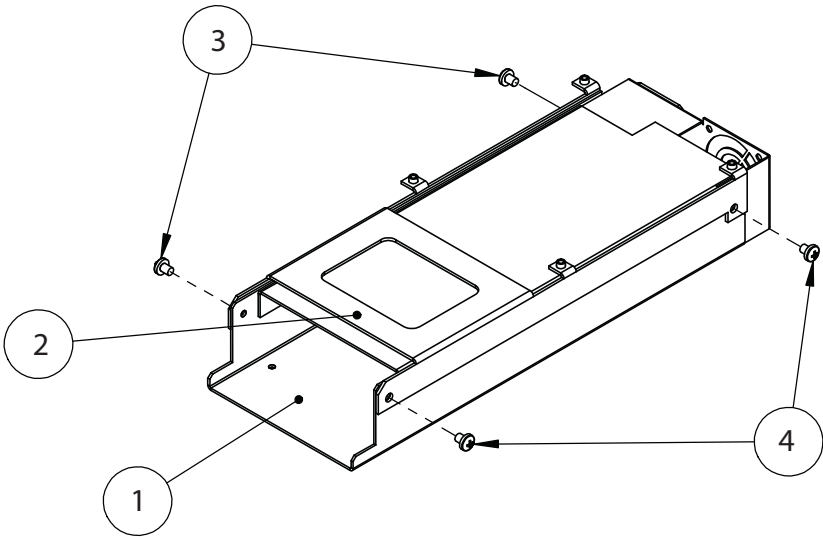
Reference Figures

- [Figure 6-18](#) shows how the power supply mounting bars are installed to the power supply.
- [Figure 6-19](#) shows a power supply with IO Handler PCB Mounting Bracket installed on Revision 2 instrument.
- [Figure 6-20](#) shows the power supply cable connections.



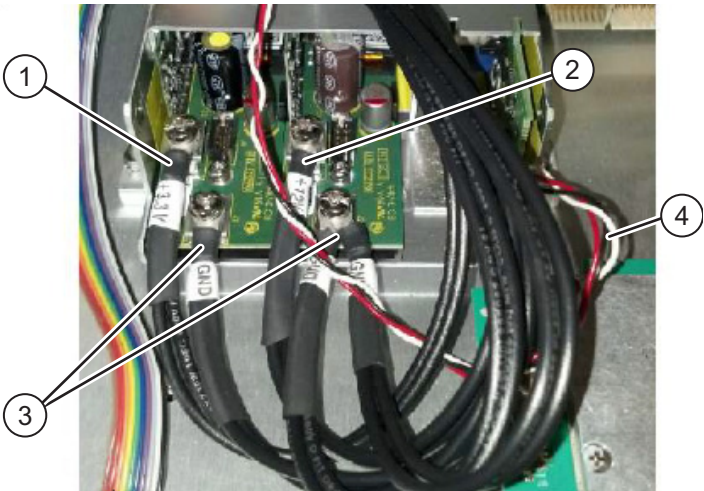
- 1 – Power Supply
- 2 – Mounting Bar
- 3 – Mounting screw

Figure 6-18. MS46322A Revision 1 Instrument Power Supply with Mounting Bars Installed



- 1 – Power Supply
- 2 – IO Handler PCB Mounting Plate
- 3 – Mounting screw

Figure 6-19. Power Supply with IO Handler PCB Mounting Plate installed, MS46322A Revision 2 Instrument and MS46322B



- | | |
|--------------------------------------|------------------------------------|
| 1 – 3.3 V Power Supply Cable Harness | 3 – Ground Connection Points |
| 2 – 12 V Power Supply Cable Harness | 4 – 5 V Power Supply Cable Harness |

Figure 6-20. Power Supply Cable Harness Connection

Replacement Procedure

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the Stiffener Plate.
3. For MS46322A Revision 2 instrument and MS46322B, do the following:
 - a. Remove the solid state drive. Refer to [Section 6-7 “Solid State Drive” on page 6-18](#) for removal procedure.
 - b. Remove the IO Handler PCB Assembly. Refer to [Section 6-9 “IO Handler PCB Assembly”](#) for removal procedure.
4. Remove the VNA Module Assembly. Refer to [Section 6-5 “VNA Module Assembly”](#) for removal procedure.
5. Remove the Back Plane PCB Assembly. Refer to [Section 6-8 “Back Plane PCB Assembly”](#) for removal procedure.
6. Refer to [Figure 6-20 on page 6-27](#). Use a Phillips screwdriver to loosen the terminal screws and then remove the 3.3V/12V Power Cable Harness and 5V Power Cable Harness from the Power Supply.
7. Flip over the instrument so the bottom cover is facing upward.
8. Remove the bottom cover.
9. Place the instrument on its left side.
10. Remove the five Phillips screws that secure the power supply to the chassis. Use one hand to hold the power supply in place to prevent it to drop unexpectedly.
11. Remove the power supply from the chassis.
12. For MS46322A Revision 1 instrument, remove the two Mounting Bars from the power supply. Install the two Mounting Bars to the replacement power supply. Refer to [Figure 6-18 on page 6-26](#).
13. For MS46322A Revision 2 instrument and MS46322B, remove the IO Handler PCB Mounting Bracket from the power supply. Install the IO Handler PCB Mounting Bracket to the replacement power supply. Refer to [Figure 6-18 on page 6-26](#).
14. Re-connect the 5V power supply cable harness that was removed in [Step 6](#).
15. Install the power supply to the chassis. Be sure to re-attach the Ground wire lug with a hex nut to the corner near the rear fan assembly.
16. Place the instrument on the working surface with the bottom of the instrument facing up.
17. Install the bottom cover.
18. Flip over the instrument so the top side is now facing upward.
19. Install the Back Plane PCB Assembly.
20. For Revision 2 Instrument, install the IO Handler PCB Assembly and then the solid state drive.
21. Power on the instrument.
22. Use a digital volt meter to measure the unloaded +3.3V and +12V output voltage.
23. Using a tuning screwdriver, adjust the voltages to +3.7V and +12.5V respectively.
24. Re-connect the 3.3V/12V cable to the power supply.
25. Install the stiffener plate.
26. Install the top cover.

6-12 Test Port Adapter

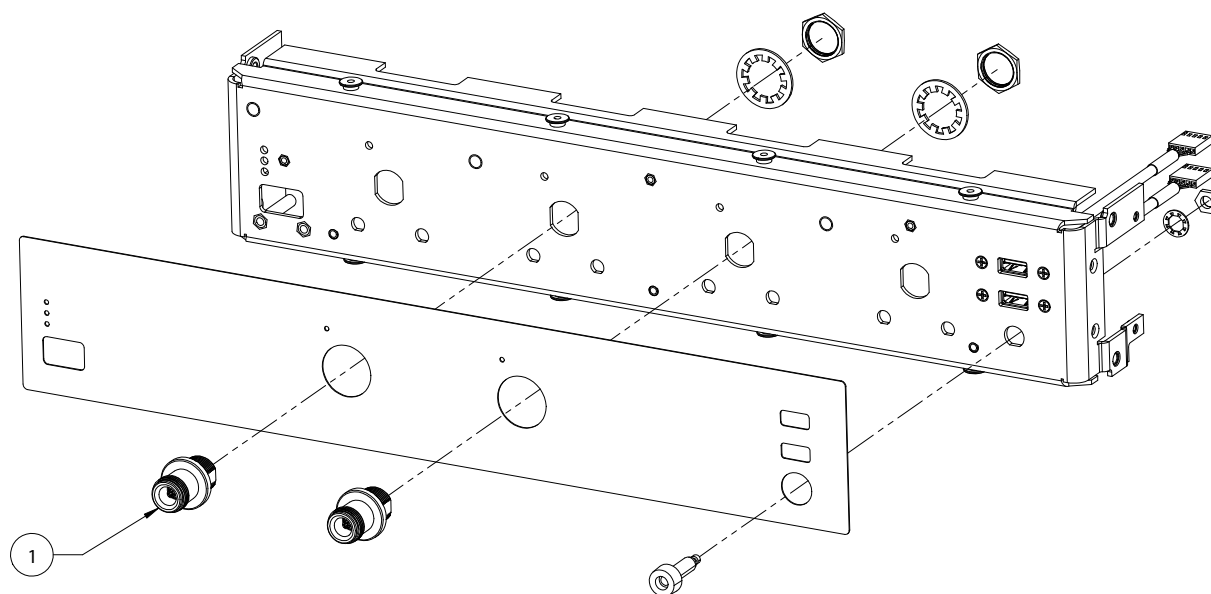
Use this procedure to replace the Front Panel Test Port Adapters.

Replacement Parts

- MS46322A/B N(f) Test Port Adapter – 3-513-122
- MS46322A Revision 1 Instrument K(m) Test Port Adapter – 3-75651
- MS46322A Revision 2 Instrument K(m) Test Port Adapter – 3-71353
- MS46322B K(m) Test Port Adapter for units with Option 20 or 40 – 3-71353
- MS46322B K(m) Test Port Adapter for units with Opt 43 – 3-84738

Reference Figures

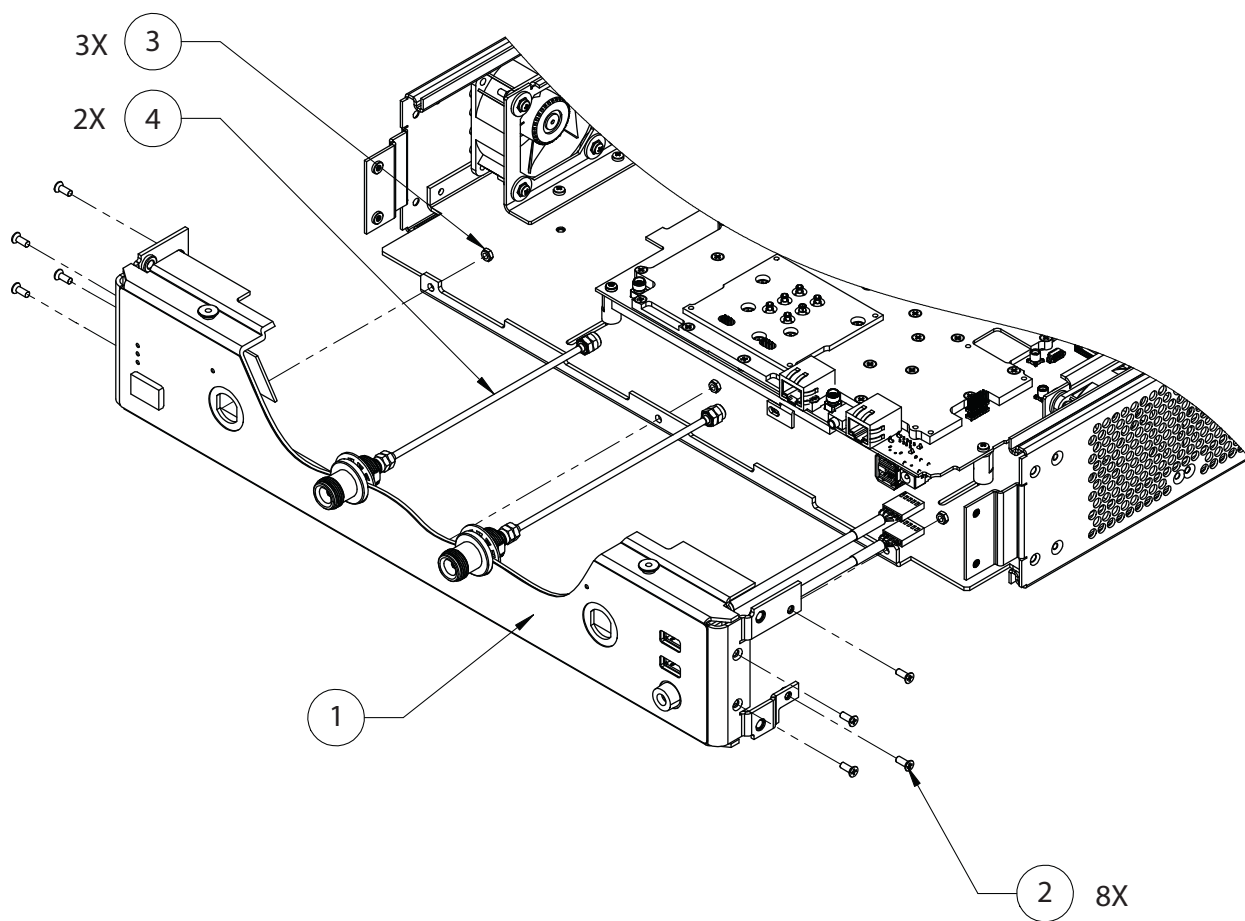
- [Figure 6-21, “Test Port Adapter Mounting” on page 6-29](#)
- [Figure 6-22, “N\(f\) Test Port Adapter \(For Instruments with Options 4 or 10\)” on page 6-30](#)
- [Figure 6-23, “K\(m\) Test Port Adapter \(For Instruments with Options 14, 20, 30, 40, or 43\)” on page 6-31](#)



1 – Test Port Adapter

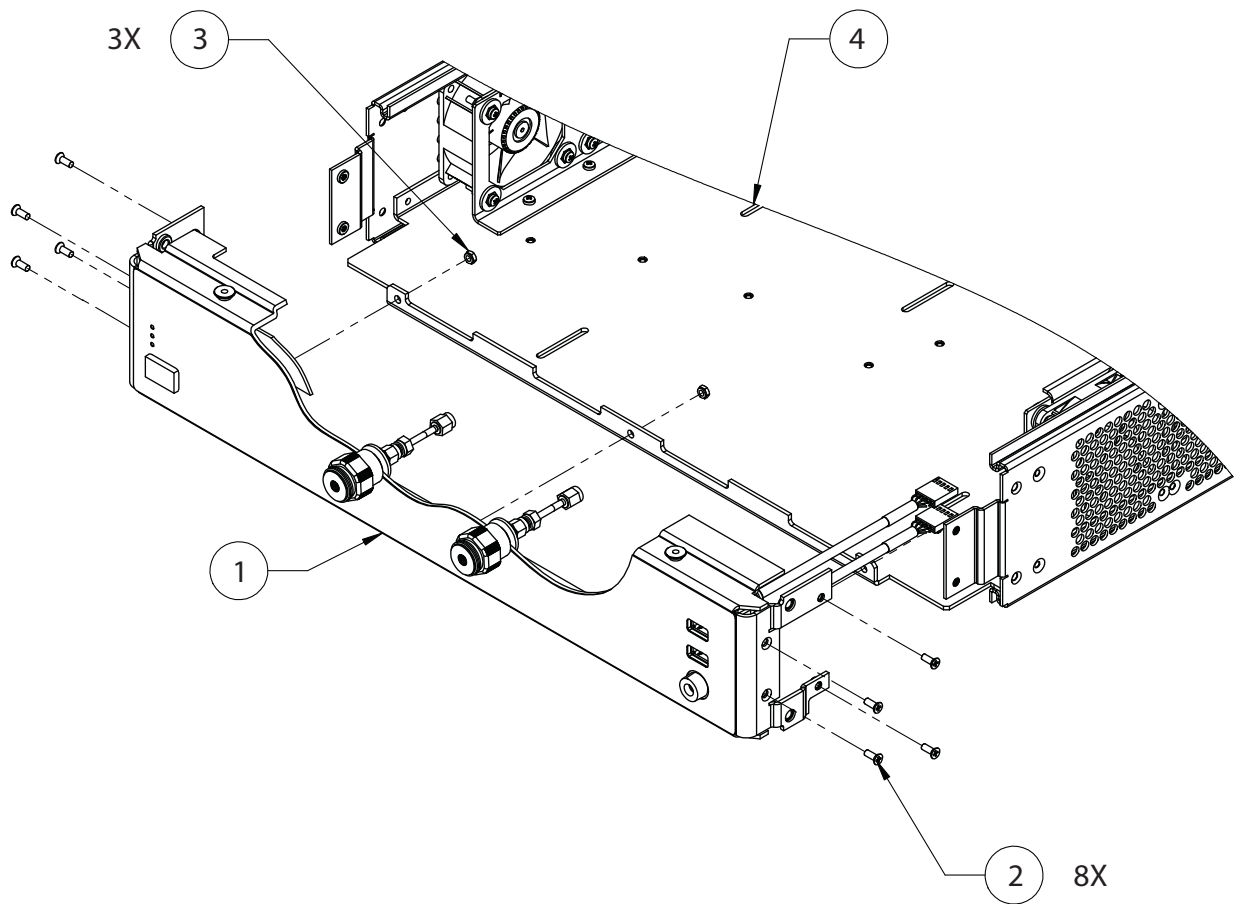
Note: Washer and Hex Nut are included in replacement Test Port Adapter package

Figure 6-21. Test Port Adapter Mounting



- 1 – Front Panel
- 2 – Mounting Screws (8)
- 3 – Nuts (3)
- 4 – Flexible Coaxial Cables (2)

Figure 6-22. N(f) Test Port Adapter (For Instruments with Options 4 or 10)



- 1 – Front Panel
- 2 – Mounting Screws (8)
- 3 – Nuts (3)
- 4 – Chassis

Figure 6-23. K(m) Test Port Adapter (For Instruments with Options 14, 20, 30, 40, or 43)

Replacement Procedure – N(f) Test Port Adapter

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Disconnect the flexible coaxial cable from the SMA(f) connector of the test port adapter. See [Figure 6-22 on page 6-30](#).
3. Use a ratchet wrench with 3/4 inch deep socket to remove the hex nut that secures the test port adapter to the front panel.
4. Remove the test port adapter from the front panel. See [Figure 6-21 on page 6-29](#).
5. Install the replacement test port adapter to the front panel. Install the washer and then the hex nut. Tighten the hex nut with fingers.
6. Use a ratchet wrench with the 3/4 inch deep socket to tighten the hex nut.
7. Re-connect the flexible coaxial cable to the SMA(f) connector of the test port adapter.
8. Install the top cover.

Replacement Procedure – K(m) Test Port Adapter

1. Remove the top cover as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Remove the High Frequency VNA Module Assembly as described in [“Replacement Procedure \(For Instruments with Options 14, 20, 30, 40, or 43\)” on page 6-13](#).
3. Disconnect the coaxial cables from the K connector of the test port adapter on the back side of the front panel. See [Figure 6-23 on page 6-31](#).
4. Use a ratchet wrench with 1/2 inch deep socket to remove the hex nut that secures the test port adapter to the front panel.
5. Remove the test port adapter from the front panel. See [Figure 6-21 on page 6-29](#).
6. Install the replacement test port adapter to the front panel. Install the washer and then the hex nut. Tighten the hex nut with fingers.
7. Use a ratchet wrench with the 1/2 inch deep socket to tighten the hex nut.
8. Re-connect the flexible coaxial cable to the K connector of the test port adapter.
9. Re-install the High Frequency VNA Module Assembly.
10. Install the top cover.

6-13 Front Panel LED PCB Assembly

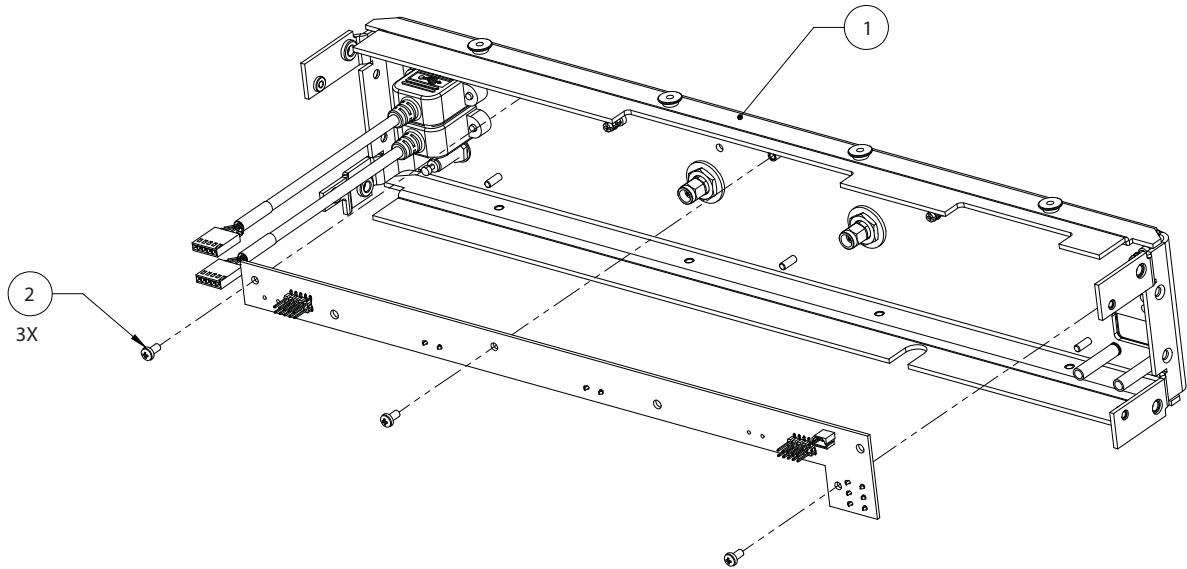
Use this procedure to replace the Front Panel LED PCB Assembly.

Replacement Part

- Front Panel LED PCB Assembly – ND81163

Reference Figure

- [Figure 6-24, “Front Panel LED PCB Assembly” on page 6-33](#)



1 – Front Panel

2 – Front Panel LED PCB Assembly Mounting Screws (3)

Figure 6-24. Front Panel LED PCB Assembly

Replacement Procedure – Instruments with N(f) Test Ports

1. Remove the top cover and handles as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Disconnect the flexible coaxial cables from the SMA(f) connector of the test port adapters. See [Figure 6-22 on page 6-30](#).
3. Disconnect the Front Panel USB interface cables from the CPU Module.
4. Disconnect the LED control ribbon cable from the left side of the Front Panel LED PCB Assembly.
5. Remove the eight (8) Phillips screws on both sides of the front panel.
6. Remove the three (3) nuts that secure the front panel to the bottom of the chassis.
7. Remove the Front Panel from the chassis.
8. Remove the three (3) screws that secure the Front Panel LED PCB Assembly to the chassis.
9. Install the replacement Front Panel LED PCB Assembly to the front panel and secure with the screws that were removed in [Step 8](#).
10. Re-install the Front Panel to the chassis.
11. Re-connect the flexible coaxial cables to the SMA(f) connector of the test port adapters.
12. Re-connect the Front Panel USB interface cables to the CPU Module.
13. Re-connect the LED control ribbon cable to the left side of the Front Panel LED PCB Assembly.
14. Install the handles.
15. Install the top cover.

Replacement Procedure – Instruments with K(m) Test Ports

1. Remove the top cover, bottom cover and handles as described in the [“Common Disassembly Procedure” on page 6-3](#).
2. Place the instrument on its side and loosen the five (5) screws that secure the standoffs to the chassis on the bottom so that the VNA Module Assembly can be sliding backward.
3. Place the instrument on its bottom.
4. Disconnect the semi-rigid coaxial cables from Port 1 and Port 2 Inputs of the VNA Module Assembly.
5. Carefully slide the VNA Module Assembly backward.
6. Disconnect the Front Panel USB interface cables from the CPU Module.
7. Disconnect the LED control ribbon cable from the left side of the Front Panel LED PCB Assembly.
8. Remove the eight (8) Phillips screws on both sides of the front panel.
9. Remove the three (3) nuts that secure the front panel to the bottom of the chassis.
10. Remove the Front Panel from the chassis.
11. Remove the three (3) screws that secure the Front Panel LED PCB Assembly to the chassis.
12. Install the replacement Front Panel LED PCB Assembly to the front panel and secure with the screws that were removed in [Step 11](#).
13. Re-install the Front Panel to the chassis.
14. Re-connect the coaxial cables to the VNA Module Assembly.
15. Place the instrument on its side and tighten the five (5) screws that secure the standoffs to the chassis on the bottom.
16. Place the instrument on its bottom.
17. Re-connect the Front Panel USB interface cables to the CPU Module.
18. Re-connect the LED control ribbon cable to the left side of the Front Panel LED PCB Assembly.

19. Install the handles.
20. Install the top cover and bottom cover.

Appendix A — Test Records

A-1 Introduction

This appendix provides test record that can be used to record the performance of the ShockLine MS46322A/B.

Make a copy of the following Test Record pages and document the measured values each time performance verification is performed. Continuing to document this process each performance verification session provides a detailed history of the instrument's performance.

The following test record forms are available:

- [“ShockLine MS46322A/B System Performance Test Record” on page A-2](#)
- [“ShockLine MS46322B Instrument Performance Test Record” on page A-3](#)

Instrument Information

Serial Number:	Firmware Revision:	Operator:
Options:		Date:

A-2 ShockLine MS46322A/B System Performance Test Record

System Performance Verification

This test is automated using the System Verification software that is included with 3663-x or 3668-x Verification Kits.

Note

Pass/Fail criteria is determined from EnR, $EnR \leq 1$ = PASS, $EnR > 1$ = FAIL
Where $EnR = [Ma-Mb/\sqrt{Ua^2+Ub^2}]$ is applied to the test data report which is generated by the software.

Test Data Report generated by System Verification software is attached []

Instrument Information

Serial Number:	Firmware Revision:	Operator:
Options:		Date:

A-3 ShockLine MS46322B Instrument Performance Test Record

Frequency Accuracy

Table A-1. Frequency Accuracy

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)	Specification ^a (Hz)	Pass/Fail
1		32		

a. Specification is ± 1 ppm (1 kHz at 1 GHz) at time of calibration (adjustment). Stability and Aging values must be added to determine the limit when the instrument is re-verified at its regular calibration intervals.

Output Power (Operational Test)

(Output Power = High)

Table A-2. High Output Power (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
1			0.38
10			0.38
45			0.38
100			0.48
1000			0.48
2000			0.48
3000			0.48
4000			0.48
5000			0.48
6000			0.48
7000			0.48
8000			0.48
8500			0.48
9000			0.48
10000			0.48
11000			0.51

Table A-2. High Output Power (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
12000			0.51
13000			0.51
14000			0.51
15000			0.51
16000			0.51
17000			0.51
18000			0.51
19000			0.51
20000			0.51
21000			0.66
22000			0.66
23000			0.66
24000			0.66
25000			0.66
26000			0.66
27000			0.66
28000			0.66
29000			0.66
30000			0.66
31000			0.66
32000			0.66
33000			0.66
34000			0.66
35000			0.66
36000			0.66
37000			0.66
38000			0.66
39000			0.66
40000			0.66

*(Output Power = Low)***Table A-3.** Low Output Power (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
1			0.38
10			0.38
45			0.38
100			0.48
1000			0.48
2000			0.48
3000			0.48
4000			0.48
5000			0.48
6000			0.48
7000			0.48
8000			0.48
8500			0.48
9000			0.48
10000			0.48
11000			0.51
12000			0.51
13000			0.51
14000			0.51
15000			0.51
16000			0.51
17000			0.51
18000			0.51
19000			0.51
20000			0.51
21000			0.66
22000			0.66
23000			0.66
24000			0.66
25000			0.66
26000			0.66
27000			0.66
28000			0.66
29000			0.66

Table A-3. Low Output Power (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
30000			0.66
31000			0.66
32000			0.66
33000			0.66
34000			0.66
35000			0.66
36000			0.66
37000			0.66
38000			0.66
39000			0.66
40000			0.66

System Dynamic Range*(High Power, 10 Hz IFBW, RMS)***Table A-4.** S12 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
1 MHz to 10 MHz		0.16	85	
> 10 MHz to 8 GHz		1.1	100	
> 8 to 14		0.44	95	
> 14 to 20		0.43	100	
> 20 to 30		0.43	100	
> 30 to 40		0.43	100	
> 40 to 43.5		1.1	97	

Table A-5. S21 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
1 MHz to 10 MHz		0.16	85	
> 10 MHz to 8 GHz		1.1	100	
> 8 to 14		0.44	95	
> 14 to 20		0.43	100	
> 20 to 30		0.43	100	
> 30 to 40		0.43	100	
> 40 to 43.5		1.1	97	

High Level Noise*(100 Hz IFBW, RMS)***Table A-6.** High Level Noise – S12 Magnitude (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)
1		0.00059
10		0.00059
50		0.0029
100		0.0029
501		0.0029
1000		0.0029
2000		0.0029
3000		0.0029
4001		0.0029
5000		0.0029
6000		0.0029
7000		0.0029
8000		0.0029
8500		0.0029
9000		0.0029
10000		0.0029
11000		0.0029
12000		0.0029
13000		0.0029
14000		0.0029
15000		0.0029
16000		0.0029
17000		0.0029
18000		0.0029
19000		0.0029
20000		0.0029
21000		0.0029
22000		0.0029
23000		0.0029
24000		0.0029
25000		0.0029
26000		0.0029
27000		0.0029
28000		0.0029
29000		0.0029
30000		0.0029

Table A-6. High Level Noise – S12 Magnitude (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)
31000		0.0029
32000		0.0029
33000		0.0029
34000		0.0029
35000		0.0029
36000		0.0029
37000		0.0029
38000		0.0029
39000		0.0029
40000		0.0029
41000		0.0043
42000		0.0043
43000		0.0043
43500		0.0043

Table A-7. High Level Noise – S12 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)
1		0.0051
10		0.0051
50		0.0018
100		0.0018
501		0.0018
1000		0.0018
2000		0.0018
3000		0.0018
4001		0.0018
5000		0.0018
6000		0.0018
7000		0.0018
8000		0.0018
8500		0.0018
9000		0.0018
10000		0.0018
11000		0.0018
12000		0.0018
13000		0.0018
14000		0.0018

Table A-7. High Level Noise – S12 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)
15000		0.0018
16000		0.0018
17000		0.0018
18000		0.0018
19000		0.0018
20000		0.0018
21000		0.0018
22000		0.0018
23000		0.0018
24000		0.0018
25000		0.0018
26000		0.0018
27000		0.0018
28000		0.0018
29000		0.0018
30000		0.0018
31000		0.0018
32000		0.0018
33000		0.0018
34000		0.0018
35000		0.0018
36000		0.0018
37000		0.0018
38000		0.0018
39000		0.0018
40000		0.0018
41000		0.0013
42000		0.0013
43000		0.0013
43500		0.0013

Table A-8. High Level Noise – S21 Magnitude (1 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)
1		0.00059
10		0.00059
50		0.0029
100		0.0029

Table A-8. High Level Noise – S21 Magnitude (2 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)
501		0.0029
1000		0.0029
2000		0.0029
3000		0.0029
4001		0.0029
5000		0.0029
6000		0.0029
7000		0.0029
8000		0.0029
8500		0.0029
9000		0.0029
10000		0.0029
11000		0.0029
12000		0.0029
13000		0.0029
14000		0.0029
15000		0.0029
16000		0.0029
17000		0.0029
18000		0.0029
19000		0.0029
20000		0.0029
21000		0.0029
22000		0.0029
23000		0.0029
24000		0.0029
25000		0.0029
26000		0.0029
27000		0.0029
28000		0.0029
29000		0.0029
30000		0.0029
31000		0.0029
32000		0.0029
33000		0.0029
34000		0.0029
35000		0.0029
36000		0.0029
37000		0.0029

Table A-8. High Level Noise – S21 Magnitude (3 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)
38000		0.0029
39000		0.0029
40000		0.0029
41000		0.0043
42000		0.0043
43000		0.0043
43500		0.0043

Table A-8

Table A-9. High Level Noise – S21 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)
1		0.0051
10		0.0051
50		0.0018
100		0.0018
501		0.0018
1000		0.0018
2000		0.0018
3000		0.0018
4001		0.0018
5000		0.0018
6000		0.0018
7000		0.0018
8000		0.0018
8500		0.0018
9000		0.0018
10000		0.0018
11000		0.0018
12000		0.0018
13000		0.0018
14000		0.0018
15000		0.0018
16000		0.0018
17000		0.0018
18000		0.0018
19000		0.0018
20000		0.0018
21000		0.0018

Table A-9. High Level Noise – S21 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)
22000		0.0018
23000		0.0018
24000		0.0018
25000		0.0018
26000		0.0018
27000		0.0018
28000		0.0018
29000		0.0018
30000		0.0018
31000		0.0018
32000		0.0018
33000		0.0018
34000		0.0018
35000		0.0018
36000		0.0018
37000		0.0018
38000		0.0018
39000		0.0018
40000		0.0018
41000		0.0013
42000		0.0013
43000		0.0013
43500		0.0013

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