

ShockLine™

MS4652xB Series

Vector Network Analyzer

MS46522B

- 50 kHz to 8.5 GHz (Option 10)
- 50 kHz to 20 GHz (Option 20)
- 50 kHz to 43.5 GHz (Option 40)
- 50 kHz to 43.5 GHz (Option 43)
- 55 GHz to 92 GHz (Option 82)
- 55 GHz to 92 GHz (Option 83)

MS46524B

- 50 kHz to 8.5 GHz (Option 10)
- 50 kHz to 20 GHz (Option 20)
- 50 kHz to 43.5 GHz (Option 40)
- 50 kHz to 43.5 GHz (Option 43)



MS46524B



MS46522B

Anritsu

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UPDATES

The latest service and sales contact information, and updated documents can be downloaded from the Anritsu Website at: <http://www.anritsu.com>

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Chapter 1 — General Information

1-1 Introduction

This manual provides service and maintenance information for the Anritsu ShockLine MS4652xB Series Vector Network Analyzer. The information includes product description, performance verification procedures, parts removal and replacement procedures, and troubleshooting information.

1-2 Description

The ShockLine MS4652xB Series Vector Network Analyzer is an instrument system that contains a built-in source, test set, and analyzer. It is a high performance, 3U high, 2-port or 4-port VNA available in broadband frequency ranges from 50 kHz to 43.5 GHz and a banded E-band option covering the 55 GHz to 92 GHz frequency range. It is capable of measuring s-parameters and time domain characteristics of passive RF devices.

Standard Accessories

Each instrument includes:

- Power Cord
- Instructions on where to download software and related literature

MS46522B Available Options

Table 1-1. MS46522B Available Options

Part Number	Description
MS46522B-001	Option 1, Rack Mount
MS46522B-002	Option 2, Time Domain
MS46522B-022	Option 22, Advanced Time Domain
MS46522B-024	Option 24, Universal Fixture Extraction
MS46522B-051	Option 51, Direct Access Loop (For units with Option 10 only)
MS46522B-061	Option 61, Bias Tees (For units with Option 10 only)
MS46522B-010	Option 10, Frequency Option, 50 kHz to 8.5 GHz, type N(f) test ports
MS46522B-020	Option 20, Frequency Option, 50 kHz to 20 GHz, type K(m) test ports
MS46522B-040	Option 40, Frequency Option, 50 kHz to 43.5 GHz, type K(m) test ports
MS46522B-043	Option 43, Frequency Option, 50 kHz to 43.5 GHz, type K(m) test ports
MS46522B-082	Option 82, Frequency Option, 55 GHz to 92 GHz, WR-12 test ports, 1 meter
MS46522B-083	Option 83, Frequency Option, 55 GHz to 92 GHz, WR-12 test ports, 5 meters

MS46524B Available Options

Table 1-2. MS46524B Available Options

Options	Description
MS46524B-001	Option 1, Rack Mount
MS46524B-002	Option 2, Time Domain
MS46524B-022	Option 22, Advanced Time Domain
MS46524B-024	Option 24, Universal Fixture Extraction
MS46524B-051	Option 51, Direct Access Loop (For units with Option 10 only)
MS46524B-061	Option 61, Bias Tees (For units with Option 10 only)
MS46524B-010	Option 10, Frequency Option, 50 kHz to 8.5 GHz, type N(f) test ports
MS46524B-020	Option 20, Frequency Option, 50 kHz to 20 GHz, type K(m) test ports
MS46524B-040	Option 40, Frequency Option, 50 kHz to 43.5 GHz, type K(m) test ports
MS46524B-043	Option 43, Frequency Option, 50 kHz to 43.5 GHz, type K(m) test ports

Identification Number

All Anritsu MS4652xB instruments are assigned a seven-digit ID number (Serial Number), such as “1638003”. 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 MS46522B, Option 2, Option 10, Serial Number 1638003.

1-3 Related Documents

Other documents are available for the MS4652xB at the Anritsu web site at: www.anritsu.com

- ShockLine MS46522B VNA Technical Data Sheet – part number 11410-00858
- ShockLine MS46524B VNA Technical Data Sheet – part number 11410-00860
- ShockLine MS4652xB VNA Operation Manual – part number 10410-00743
- ShockLine MS4652xB VNA User Interface Reference Manual – part number 10410-00744
- ShockLine MS4612xA/B, MS46131A, MS46322A/B, MS4652xB VNA Programming Manual – part number 10410-00746
- ShockLine Vector Network Analyzers Verification Kits and Performance Verification Software Quick Start Guide – part number 10410-00766

1-4 Basic Maintenance

Maintain Operating System Integrity

The Microsoft Windows Embedded operation system on the ShockLine MS4652xB 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 MS4652xB 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.
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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, “Performance Verification”](#).

Repair Service

In the event that the MS4652xB 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

Table 1-3 and Table 1-4 list test equipment that is recommended for use in testing and maintaining the ShockLine MS4652xB.

Table 1-3. Recommended Test Equipment for MS4652xB with Options 10, 20, 40, or 43 (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
Calibration Kit (For Opt. 10)	Frequency: DC to 18 GHz Connector: N Type	Anritsu Model OSLN50A-18 and OSLNF50A-18	P
Calibration Kit (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model TOSLK50A-40 and TOSLK50A-40	P
Calibration Kit (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K Type	Anritsu Model TOSLK50A-43.5 and TOSLK50A-43.5	P
Verification Kit (For Opt. 10)	Connector: N Type	Anritsu Model 3663-3 (Includes Verification Software)	P
Verification Kit (For Opt. 20 or 40)	Connector: K Type	Anritsu Model 3668-4 (Includes Verification Software)	P
Verification Kit (For Opt. 43)	Connector: K Type	Anritsu Model 3668-4 (Includes Verification Software)	P
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50 [Qty 2 for MS46524B]	P, A
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50 [Qty 2 for MS46524B]	P, A
Torque Wrench (For Opt. 10)	3/4 in. Open End Wrench 12 in·lbf (1.35 N·m)	Anritsu Model 01-200	P
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50B [Qty 2 for MS46524B]	P
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B [Qty 2 for MS46524B]	P
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C [Qty 2 for MS46524B]	P
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C [Qty 2 for MS46524B]	P
Torque Wrench (For Opt. 20, 40, or 43)	5/16 in. Open End Wrench 8 in·lbf (0.90 N·m)	Anritsu Model 01-201	P
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 [Qty 2 for MS46524B]	P, A
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 [Qty 2 for MS46524B]	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), GPIB Software: National Instruments VISA version 4.4.1 or later	Any	P

Table 1-3. Recommended Test Equipment for MS4652xB with Options 10, 20, 40, or 43 (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
GPIB Adapter		National Instruments Model GPIB-USB-HS	A
GPIB Cable	Length: 2m	Anritsu Part Number 2100-2-R	A
Frequency Counter	Frequency: 10 MHz to 20 GHz	Anritsu Model MF2412B or MF2412C with Option 3	P, A
Frequency Reference	Frequency: 10 MHz	Symmetricom Model RubiSource T&M	P, A
RF Coaxial Cable	Frequency: 10 MHz Impedance: 50 ohm Connector: BNC(m) to BNC(m)	Anritsu Part Number 2000-1627-R	P, A
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A	P, A
Power Sensor (For Opt. 10)	Frequency: 100 kHz to 18 GHz Connector Type: N(m)	Anritsu Model SC7400	P, A
Power Sensor (For Opt. 20, 40, or 43)	Frequency: 100 kHz to 40 GHz Connector Type: K(m)	Anritsu Model SC7413	P, A
Power Sensor (For Opt. 43)	Frequency: 70 kHz to 70 GHz Connector Type: V(m)	Anritsu Model SC7770	P
Adapter (For Opt. 43)	Connector: N(m) to V(f)	Pasternack Model PE9720	P
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: V(f) to K(f)	Anritsu Model 34VFKF50A	P
Fixed Attenuator (For Opt. 10)	Frequency: DC to 18 GHz Attenuation: 10 dB Connector Type: N(m) to N(f)	Aeroflex Weinschel Model 44-10	A
Fixed Attenuator (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Attenuation: 10 dB Connector Type: K(m) to K(f)	Anritsu Model 41KC-10	A
Fixed Attenuator (For Opt. 10)	Frequency: DC to 18 GHz Attenuation: 20 dB Connector Type: N(m) to N(f)	Aeroflex Weinschel Model 44-20 [Qty 2 for MS46524B]	P
Fixed Attenuator (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Attenuation: 20 dB Connector Type: K(m) to K(f)	Anritsu Model 43KC-20 [Qty 2 for MS46524B]	P
Termination (Load) (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(f) Type	Anritsu Model 28NF50-2	P
Termination (Load) (For Opt. 20, 40, or 43)	Frequency: DC to 48 GHz Connector: K(m) Type	Anritsu Model 28K50A	P
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in. Open End Wrench 8 in·lbf (0.9 N·m)	Anritsu Model 01-203	P
Step Attenuator	With traceable characterization data at 2 GHz	Anritsu Model SC7974	P
Step Attenuator Control Box		Anritsu Model SC3796	P

a.P = Performance Verification; A = Adjustment

Table 1-4. Recommended Test Equipment for MS46522B with Option 82 and Option 83

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes ^a
Calibration Kit	Frequency: 60 to 90 GHz Waveguide: WR12	Anritsu Model 3655E-1	P
Adapter	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B	A
Adapter	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50	P, A
Fixed Attenuator	Frequency: DC to 40 GHz Attenuation: 10 dB Connector Type: K(m) to K(f)	Anritsu Model 41KC-10	A
GPIB Adapter	Connector: USB Type A to GPIB	National Instruments Model GPIB-USB-HS	A
GPIB Cable	Length: 2m	Anritsu Part Number 2100-2-R [Qty 2]	A
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A	A
Power Sensor	Frequency: 10 MHz to 40 GHz Connector Type: K(m)	Anritsu Model MA2474D	A
Power Meter	Power Range: -70 to +20 dBm	Agilent Model 437B or E4418B, or Keysight Model N1913A with Option 200 (437B Code compatibility)	A
Power Sensor	Frequency: 50 to 75 GHz Power Range: -30 to +20 dBm Waveguide Type: WR15	Keysight Model V8486A	A
Power Sensor	Frequency: 75 to 110 GHz Power Range: -30 to +20 dBm Waveguide Type: WR10	Keysight Model W8486A	A
Low Pass Filter	Cutoff Frequency: 75 GHz Waveguide Type: WR12	Spacek Labs Part Number LPF-75-11	A
Waveguide Section	Waveguide Type: WR8 Length: 2 inch	Aerowave Part Number 08-1202Au	A
Adapter	Frequency: DC to 40 GHz Connector: K(m) to SMPM-T(m)	Huber-Suhner Part Number 29429-1T2 [Qty 2]	A
Directional Coupler	Frequency: 2 to 40 GHz Nominal Coupling: 13 ± 1 dB Connector: K(f)	Krytar Part Number 102040013K	A
RF Coaxial Cable	Frequency: DC to 40 GHz Length: 39.37 inch Connector: SMPM-T, (f) to (f)	Anritsu Part Number 3-806-310	A
GPIB Cable	Length: 2m	Anritsu Part Number 2100-2-R	A

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 MS4652XB. They can also be viewed in the ShockLine Application ShockLine Info box display (Select 9 ABOUT | 1. ShockLine Info).

The revision level of the instrument can be determined by reading the information on the Serial Number label found on the rear panel of the instrument. If there is no mention of revision on the label, it is a Revision 1 unit. Revision 2 units will state “Revision 2” and Revision 3 units will state “Revision 3”.

The tables below summarizes the available replaceable parts and assemblies

Table 1-5. MS4652xB Common Replaceable Parts and Assemblies

Part Number	Description
3-ND87256-RFB^a	CPU Assembly – For Revision 5 Instruments
3-ND87279	CPU Assembly Conversion Kit – For Revisions 1, 2, 3, and 4 Instruments to Revision 5 Instruments with serial number < 2234000
ND80984	Solid State Drive with Operating System Software – For Revision 1 and Revision 2 Instruments
3-ND83424	Solid State Drive with Operating System Software (Win 7) – For Revision 3 Instruments
3-ND85712	Solid State Drive with Operating System Software (Win 10) – For Revision 5 Instruments
3-ND82274-RFB	Back Plane PCB Assembly – For Revision 1 and Revision 2 Instruments
3-ND83815-RFB	Back Plane PCB Assembly – For Revision 3 and Revision 4 Instruments
3-ND87257-RFB	Back Plane PCB Assembly – For Revision 5 Instruments with serial number < 2234000
3-ND82275-RFB	Power Supply Assembly
3-ND82276	AC Input Module Harness Assembly
3-ND82277	Power Supply Cable Assembly, 48 V Bias
ND82278	Power Supply Cable Assembly, Logic – For Revision 1 and Revision 2 Instruments
3-ND83342	Power Supply Cable Assembly, Logic – For Revision 3 Instruments
3-ND82279	Fan Assembly, Right
3-ND82280	Fan Assembly, Left
3-ND82281	Front Panel USB Hub PCB Assembly
3-ND82282	Front Panel LED Interface PCB Assembly
3-ND82283	Front Panel Power Switch Harness Assembly

a. For users replacing the CPU assembly with Rev 1, 2, 3 or 4 instruments, a 3-ND87279 CPU Conversion Kit is required.

Table 1-6. MS46522B Unique Replaceable Parts and Assemblies (1 of 2)

Part Number	Description
ND82284-RFB	VNA Module Assembly – For Revision 1 Instrument with Option 10
3-ND82818-RFB	VNA Module Assembly – For Revision 2 Instrument with Option 10
3-ND84677-RFB	VNA Module Assembly – For Revision 4 Instrument with Option 10
3-ND82819-RFB	VNA Module Assembly – For Revision 2 Instrument with Option 10 or 51
3-ND82820-RFB	VNA Module Assembly – For Revision 2 Instrument with Option 10 or 61
3-ND82821-RFB	VNA Module Assembly – For Revision 2 Instrument with Option 10, 51, or 61
ND82285-RFB	VNA Module Assembly – For Revision 1 Instrument with Option 20
3-ND83430-RFB	VNA Module Assembly – For Revision 3 Instrument with Option 20
3-ND84678-RFB	VNA Module Assembly – For Revision 4 Instrument with Option 20
ND82286-RFB	VNA Module Assembly – For Revision 1 Instrument with Option 40
3-ND83431-RFB	VNA Module Assembly – For Revision 3 Instrument with Option 40
3-ND84679-RFB	VNA Module Assembly – For Revision 4 Instrument with Option 40
3-ND84749-RFB	VNA Module Assembly – For Instrument with Option 43
3-ND82553-RFB	VNA Module Assembly – For Instrument with Option 82 Revision 1
3-ND82554-RFB	Millimeter-wave Module Assembly, Left – For Instrument with Option 82 Revision 1 – Fixed RF Interface Cables included
3-ND82555-RFB	Millimeter-wave Module Assembly, Right – For Instrument with Option 82 Revision 1 – Fixed RF Interface Cables included
3-ND83639-RFB	VNA Module Assembly – For Instrument with Option 82 Revision 2 and later
3-ND83640-RFB	Millimeter-wave Module Assembly, Left – For Instrument with Option 82 Revision 2 and later – Fixed RF Interface Cables included
3-ND83641-RFB	Millimeter-wave Module Assembly, Right – For Instrument with Option 82 Revision 2 and later – Fixed RF Interface Cables included
3-ND83636-RFB	VNA Module Assembly – For Instrument with Option 83

Table 1-6. MS46522B Unique Replaceable Parts and Assemblies (2 of 2)

Part Number	Description
3-ND83637-RFB	Millimeter-wave Module Assembly, Left – For Instrument with Option 83 – Fixed RF Interface Cables included
3-ND83638-RFB	Millimeter-wave Module Assembly, Right – For Instrument with Option 83 – Fixed RF Interface Cables included
3-81905	MS46522B-082/083 Front Panel Overlay
3-513-122	N(f) Test Port Adapter – For Instrument with Option 10
3-806-361	SMA(m) to SMA(m) RF cable, linked Test Port Adapter to VNA Module Assembly – For Instrument with Option 10
3-75651	Ruggedized K(m) Test Port Adapter – For Instrument with Option 20 or 40
3-84738	Ruggedized K(m) Test Port Adapter – For Instrument with Option 43
3-806-358	K(m) to K(m) RF cable, linked Test Port Adapter to VNA Module Assembly – For Instrument with Option 20, 40, or 43
3-ND87889-RFB	Tether Harness Assembly 1 M – For Instruments with Option 82
3-ND87817-RFB	Tether Harness Assembly 5 M – For Instruments with Option 83

Table 1-7. MS46524B Unique Replaceable Parts and Assemblies (1 of 2)

Part Number	Description
ND82287-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 1 Instrument with Option 10
3-ND82822-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 2 Instrument with Option 10
3-ND84680-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 4 Instrument with Option 10
3-ND82823-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 2 Instrument with Option 10 or 51
3-ND82824-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 2 Instrument with Option 10 or 61
3-ND82825-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 2 Instrument with Option 10, 51 or 61
ND82288-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 1 Instrument with Option 10 only
3-ND82826-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 2 Instrument with Option 10
3-ND84681-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 4 Instrument with Option 10

Table 1-7. MS46524B Unique Replaceable Parts and Assemblies (2 of 2)

Part Number	Description
3-ND82827-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 2 Instrument with Option 10 or 51
3-ND82828-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 2 Instrument with Option 10 or 61
3-ND8282-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 2 Instrument with Option 10, 51 or 61
ND82289-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 1 Instrument with Option 20
ND82290-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 1 Instrument with Option 20
3-ND83432-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 3 Instrument with Option 20
3-ND83433-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 3 Instrument with Option 20
3-ND84682-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 4 Instrument with Option 20
3-ND84683-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 4 Instrument with Option 20
ND82291-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 1 Instrument with Option 40
ND82292-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 1 Instrument with Option 40
3-ND83434-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 3 Instrument with Option 40
3-ND83435-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 3 Instrument with Option 40
3-ND84682-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Revision 4 Instrument with Option 40
3-ND84683-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Revision 4 Instrument with Option 40
3-ND84750-RFB	VNA #1 Module Assembly, Port 1 and Port 2 – For Instrument with Option 43
3-ND84751-RFB	VNA #2 Module Assembly, Port 3 and Port 4 – For Instrument with Option 43
3-513-122	N(f) Test Port Adapter – For Instrument with Option 10
3-806-361	SMA(m) to SMA(m) RF cable, linked Test Port Adapter to VNA Module Assembly – For Instrument with Option 10
3-75651	Ruggedized K(m) Test Port Adapter – For Instrument with Option 20 or 40
3-84738	Ruggedized K(m) Test Port Adapter – For Instrument with Option 43
3-806-358	K(m) to K(m) RF cable, linked Test Port Adapter to VNA Module Assembly – For Instrument with Option 20, 40, or 43

Chapter 2 — Performance Verification

2-1 Introduction to Performance Verification

This chapter provides procedures to be used to verify the performance of ShockLine MS4652xB.

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.

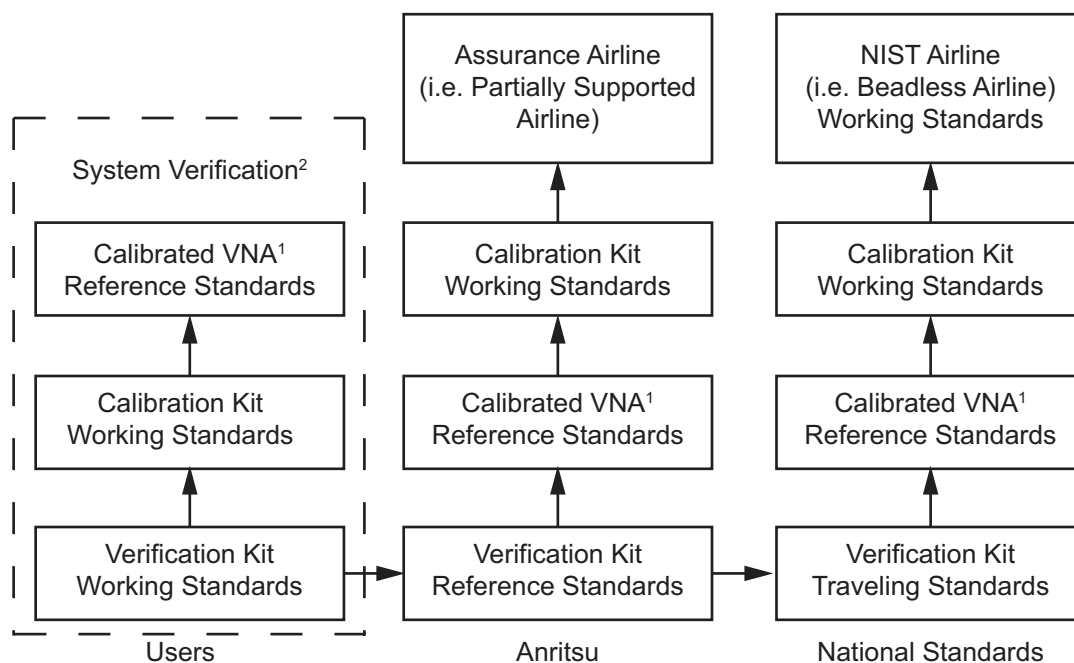
Third Tier of Uncertainty – Random Measurement Error

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



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

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:
 - 45 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 practice and maintaining environment conditions within specified limits during calibration and measurements are critical requirements for performing system performance verification which involve reliable high quality measurements with associated measurement uncertainties. Note that both of these factors affect the measurement uncertainty.

2-5 Performance Verification

The performance of MS4652xB VNA can be verified using either verification procedures below:

- System Verification Procedure in [Section 2-6](#)
 - The VNA, calibration kit, test cable, and any required adapter(s) are verified as a system
- Instrument Key Performance Parameter Verification procedure in [Section 2-7](#)
 - The VNA is verified as an independent instrument

Note For performance verification of MS46522B-082 and MS46522B-083, refer to [Section 2-14](#).

2-6 System Verification (MS46522B-082/083 Excluded)

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 ShockLine VNA System Verification Software – 3-2300-610, in conjunction with the appropriate Anritsu Calibration Kits and Verification Kits listed in the table below.

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

Equipment	Critical Specification	Recommended Manufacturer/Model
Calibration Kit (For Opt. 10)	Frequency: DC to 18 GHz Connector: N Type	Anritsu Model OSLN50A-18 and OSLNF50A-18
Calibration Kit (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model TOSLK50A-40 and TOSLKF50A-40
Calibration Kit (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K Type	Anritsu Model TOSLK50A-43.5 and TOSLKF50A-43.5
Verification Kit (For Opt. 10)	Connector: N Type	Anritsu Model 3663-3 (Includes Verification Software)
Verification Kit (For Opt. 20 or 40)	Connector: K Type	Anritsu Model 3668-4 (Includes Verification Software)
Verification Kit (For Opt. 43)	Connector: K Type	Anritsu Model 3668-4 (Includes Verification Software)
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50 [Qty 2 for MS46524B]
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50 [Qty 2 for MS46524B]
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50B [Qty 2 for MS46524B]
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B [Qty 2 for MS46524B]
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C [Qty 2 for MS46524B]
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C [Qty 2 for MS46524B]
Torque Wrench (For Opt. 10)	3/4 in. (0.75 in.) Open End 12 in·lbf (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 in·lbf (0.90 N·m)	Anritsu Model 01-201
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 [Qty 2 for MS46524B]
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 [Qty 2 for MS46524B]
Interface Cable	Ethernet: RJ45, cross-over, Cat.5E Ethernet: RJ45, Cat.5E	Anritsu Part Number 3-806-152 Anritsu Part Number 2000-1371-R

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

Equipment	Critical Specification	Recommended Manufacturer/Model
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 hard copy (printout) of the test reports which include the measured data, the measurement uncertainties, and the Pass/Fail status.

For MS46524B, the same verification standards are measured between Port 1 and Port 2; and then they are measured between Port 3 and Port 4.

Test Reports

The test data can be viewed and printed using the software built-in “View Data/Report” function.

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:

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

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.

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

The System Verification 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

1. Turn on the PC controller.
2. If required, install the MS4652XB 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.

Note

Refer to Section 5 of the ShockLine Series Vector Network Analyzers Verification Kits and Performance Verification Software Quick Start Guide – part number 10410-00766 for software installation instructions

3. Use a Cat5-E Ethernet cable to connect the ShockLine MS4652xB to a Local Area Network port that is close to the PC controller using DHCP server for obtaining an IP address. Alternatively, use a Cat5-E Ethernet Crossover cable to connect the ShockLine MS4652xB directly to the PC Controller Ethernet port using Static IP address such as 10.0.0.x.

Note	Refer to Section 4 and Section 5 of the ShockLine Series Vector Network Analyzers Verification Kits and Performance Verification Software Quick Start Guide – part number 10410-00766 for setup instructions
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4. Turn on the ShockLine MS4652xB and allow the instrument to warm up for 45 minutes.
5. Prepare the Thru Cable(s) as follows:
 - a. For ShockLine MS4652xB with Option 10:
Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 or 3670K50A-2 Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
 - b. For ShockLine MS4652xB with Option 20, 40, or 43:
Install the 33KKF50B or 33KKF50C Adapter to the male end of the 3670K50-2 or 3670K50A-2 Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
 - c. For ShockLine MS46524B, prepare a second Thru Cable as described in [Step a](#) or [Step b](#), depending on the frequency option that is installed on the instrument.
6. Install the Thru Cable to Port 2 of the instrument.
7. For ShockLine MS46524B, install the second Thru Cable to Port 4 of the instrument.
8. For ShockLine MS4652XB with Option 20, 40, or 43:
 - a. Install the 33KFKF50B or 33KFKF50C Adapter to Port 1.
 - b. For ShockLine MS46524B, install the second 33KFKF50B or 33KFKF50C Adapter to Port 3.
9. Run the ShockLine VNA Performance Verification software on the PC.
10. Insert the USB flash drive that is supplied with the 366x-3 or 3668-4 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.
11. Follow the instructions in Section 6 of the Quick Start Guide to add the calibration kits to the verification tools database.
12. On the VNA, select: Main Menu | System | Network Interface.
13. Read the DHCP assigned IP Address when connecting the instrument to a Local Area Network, or enter the Static IP address (e.g. 10.0.0.2) when connecting the instrument directly to the PC controller.
14. On the verification software graphic user interface (GUI) displayed on the PC controller, do the following:
 - a. Locate the **Select Interface** field and then select TCP/IP using the drop-down menu.
 - b. Enter the IP address from [Step 13](#) into the **Address** field of the verification software GUI.
15. Follow the instructions in Section 7 of the Quick Start Guide to start the performance verification testing.

Caution	Use an appropriate torque wrench to insure proper connection of calibration devices during calibration and during verification standards testing.
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16. Follow the directions on the computer to perform measurements of the four impedance transfer standards of the verification kit using Port 1 and Port 2.

17. For MS46524B, follow the directions to perform measurements of the four impedance transfer standards of the verification kit using Port 3 and Port 4.
18. After all tests have been completed, print the test results and attach the printouts to the test record in [Appendix A, “Test Records”](#)

If Verification Fails

If the verification fails, then check the quality, cleanliness, and installation methods for the calibration and verification components. These are the most common causes for verification failures. 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.

2-7 Instrument Key Parameter Performance Tests

The Instrument Key Parameter Performance tests verify the key performance parameter of the MS4652xB Vector Network Analyzer as an independent instrument.

The Instrument Key Performance tests consist of the following:

- [Output Power Accuracy](#)
- [Maximum Power](#)
- [System Dynamic Range](#)
- [High Level Noise](#)
- [Frequency Accuracy \(Operational Test\)](#)

PASS/FAIL Determination for Instrument Key Parameter Performance Tests

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

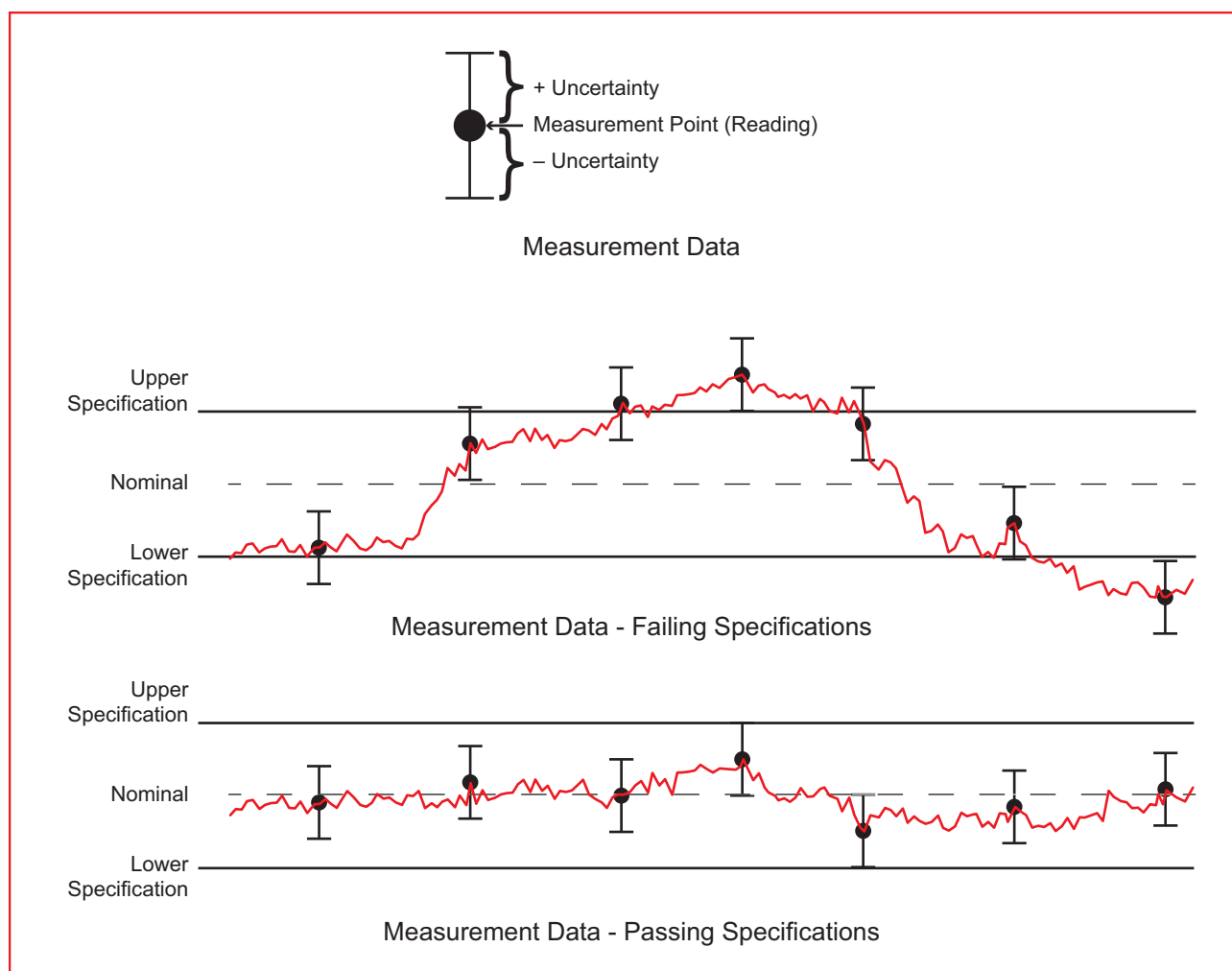


Figure 2-2. Pass/Fail Determination

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 error) based on the suggested equipment, the equipment setup, and the prescribed procedure. Most of the uncertainties are type-B per ISO/IEC Guide 98-3, Guide to the Expression of Uncertainty in Measurement (GUM).

2-8 Output Power Accuracy

The section provides the procedure to characterize the output power accuracy at each VNA port of the MS4652xB. For units with Option 10, 20, or 40 Rev 4 and below, this is an operational test.

Equipment Required

Equipment required for Output Power Accuracy characterization is listed in [Table 2-2](#).

Table 2-2. Equipment Required for Output Power Accuracy 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
Power Sensor (For Opt. 43)	Frequency: 70 kHz to 70 GHz Connector Type: V(m)	Anritsu Model SC7770
Adapter (For Opt. 20 or 40)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Adapter (For Opt. 43)	Connector: N(m) to V(f)	Pasternack Model PE9720
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B (Qty 2 for MS46524B)
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50B (Qty 2 for MS46524B)
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: V(f) to K(f)	Anritsu Model 34VFKF50A
Torque Wrench (For Opt. 10)	3/4 in. (0.75 in.) Open End 12 in·lbf (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 in·lbf (0.90 N·m)	Anritsu Model 01-201
RF Coaxial Cable (For Opt. 20 or 40)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2 (Qty 2 for MS46524B)
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(m) to K(f)	Anritsu Model 3670K50A-2 (Qty 2 for MS46524B)
Calibration Kit (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model TOSLK50-40 and TOSLK50A-40

Procedure

1. Power on the MS4652xB and ML2438A. Allow both instruments to warm up for 45 minutes.

Note

When testing units with Option 43, install SC7413 Power Sensor to channel A input of the power meter and install SC7770 Power Sensor to channel B input of the power meter.

2. Preset the VNA as follows:

- a. Select Preset button on the Icon Bar and then the OK button.

Note	After Preset, VNA port output power is set to 0 dBm.
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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 300 kHz)
 - e. Change # of Points to 801
4. Zero and calibrate the Power Sensor on the Power Meter.

0 dBm Power Accuracy

5. Connect the Power Sensor to VNA Port 1.
6. On the VNA, set the Start Frequency to the test frequency in [Table 2-3](#). (e.g. Set Start Frequency to 300 kHz 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.
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Table 2-3. Test Frequency List for Output Power Accuracy Characterization

Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
0.3	9000	22000	35000
1	10000	23000	36000
10	11000	24000	37000
100	12000	25000	38000
1000	13000	26000	39000
2000	14000	27000	40000
3000	15000	28000	41000
4000	16000	29000	42000
5000	17000	30000	43000
6000	18000	31000	43500
7000	19000	32000	–
8000	20000	33000	–
8500	21000	34000	–

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 the **System** key to display the power reading.

8. Record the power meter reading in the appropriate table:
 - [Table A-1, “0 dBm Output Power Accuracy” on page A-3](#) for MS46522B with Option 10, 20, or 40 Rev 4 and below
 - [Table A-10, “0 dBm Output Power Accuracy” on page A-14](#) for MS46522B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1
 - [Table A-33, “0 dBm Output Power Accuracy” on page A-36](#) for MS46524B with Option 10, 20, or 40 Rev 4 and below
 - [Table A-49, “0 dBm Output Power Accuracy” on page A-57](#) for MS46524B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1
9. Repeat [Step 6](#) through [Step 8](#) for the next frequency point in [Table 2-3](#) until it reaches the appropriate end frequency point of the VNA being tested (8500 MHz for Option 10 unit, 20000 MHz for Option 20 unit, 40000 MHz for Option 40 unit, or 43500 MHz for Option 43 unit).
10. Change the VNA display as follows:
 - a. Click on Tr1 on the top of the S11 trace on the screen.
 - b. 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](#).
13. For MS46524B, continue as follows:
 - a. Change Tr1 trace to display S33 response.
 - b. Connect the power sensor to VNA Port 3.
 - c. Repeat [Step 6](#) through [Step 9](#).
 - d. Change Tr1 trace to display S44 response.
 - e. Connect the power sensor to VNA Port 4.
 - f. Repeat [Step 6](#) through [Step 9](#).

2-9 Maximum Power

This section provides the procedure to characterize the Maximum Power Level at each VNA port of the MS4652xB. For units with Option 10, 20, or 40 Rev 4 and below, this is an operational test.

Equipment Required

Equipment required for Maximum Power characterization is listed in [Table 2-4](#).

Table 2-4. Equipment Required for Maximum Power Characterization

Equipment	Critical Specification	Recommended Manufacturer/Model
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50 (Qty 2 for MS46524B)
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50 (Qty 2 for MS46524B)
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50B (Qty 2 for MS46524B)
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B (Qty 2 for MS46524B)
Adapter (For Opt 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C (Qty 2 for MS46524B)
Adapter (For Opt 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C (Qty 2 for MS46524B)
Torque Wrench (For Opt. 10)	3/4 in. (0.75 in.) Open End 12 in·lbf (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 in·lbf (0.90 N·m)	Anritsu Model 01-201
Fixed Attenuator (For Opt. 10)	Frequency: DC to 18 GHz Attenuation: 20 dB Connector Type: N(m) to N(f)	Aeroflex Weinschel Model 44-20 (Qty 2 for MS46524B)
Fixed Attenuator (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Attenuation: 20 dB Connector Type: K(m) to K(f)	Anritsu Model 43KC-20 (Qty 2 for MS46524B)
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 (Qty 2 for MS46524B)
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(m) to K(f)	Anritsu Model 3670K50A-2 (Qty 2 for MS46524B)
Calibration Kit (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model TOSLK50-40 and TOSLKF50A-40
Step Attenuator	With traceable characterization data at 2 GHz	Anritsu Model SC7974
Step Attenuator Control Box		Anritsu Model SC3796

Procedure

1. Power on the MS4652xB and allow the instrument to warm up for 45 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(s) as follows:
 - b. For ShockLine MS4652XB with Option 10:
Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
 - c. For ShockLine MS4652XB with Option 20, 40, or 43:
Install the 33KKF50x Adapter to the male end of the 3670K50-2 or 3670K50A-2 (For Opt 43) Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
4. Install the 20 dB Fixed Attenuator to Port 1 and then install the Thru Cable between Attenuator and Port 2. For MS46524B, install the second Fixed Attenuator to Port 1 and then install the Thru Cable between Attenuator and Port 4.
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 2-5](#) into the setup table on the bottom of the VNA display.
 - d. Select **Add**
 - e. Enter the data in the next row of [Table 2-5](#) into the VNA.
 - f. Repeat [Step d](#) through [Step e](#) until F2 = 8500 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 2-5. VNA Segmented Sweep Setup for Maximum Power Test

F1	F2	# of Pts	IFBW	P1 or P3 Src Pwr	P2 or P4 Src Pwr	Avg
300 kHz	1 MHz	2	100 Hz	0 dBm	0 dBm	1
10 MHz	100 MHz	2	100 Hz	0 dBm	0 dBm	1
1000 MHz	8000 MHz	8	100 Hz	0 dBm	0 dBm	1
8100 MHz	8500 MHz	5	100 Hz	0 dBm	0 dBm	1
9000 MHz	40000 MHz	32	100 Hz	0 dBm	0 dBm	1
41000 MHz	42000 MHz	2	100 Hz	0 dBm	0 dBm	1
43000 MHz	43500 MHz	2	100 Hz	0 dBm	0 dBm	1

6. For MS46522B, set up the VNA display as follows:
 - a. Select **Trace** and then set **# of Traces** to 2
 - b. Click on Tr1 on the top of the S12 trace on the screen, select **Response** and then select **User-defined**

- c. Set Driver Port to Port 2, set Numerator to B1, and set Denominator to 1
 - d. Select Display and then change Trace Format of Tr1 to Log Mag
 - e. Select View Trace, select Store Data to Memory, and then select Data, Memory Math
 - f. Click on Tr2 on the top of the S21 trace on the screen, select Response and then select User-defined
 - g. Set Driver Port to Port 1, set Numerator to B2, and set Denominator to 1
 - h. Select Display and then change Trace Format of Tr2 to Log Mag
 - i. Select View Trace, select Store Data to Memory, and then select Data, Memory Math
7. For MS46524B, set up the VNA display as follows:
- a. Select Trace and then set # of Traces to 4
 - b. Click on Tr1 on the top of the S12 trace on the screen, select Response and then select User-defined
 - c. Set Driver Port to Port 2, set Numerator to B1, and set Denominator to 1
 - d. Select Display and then change Trace Format of Tr1 to Log Mag
 - e. Select View Trace, select Store Data to Memory, and then select Data, Memory Math
 - f. Click on Tr2 on the top of the S21 trace on the screen, select Response and then select User-defined
 - g. Set Driver Port to Port 1, set Numerator to B2, and set Denominator to 1
 - h. Select Display and then change Trace Format of Tr2 to Log Mag
 - i. Select View Trace, select Store Data to Memory, and then select Data, Memory Math
 - j. Click on Tr3 on the top of the S12 trace on the screen, select Response and then select User-defined
 - k. Set Driver Port to Port 4, set Numerator to B3, and set Denominator to 1
 - l. Select Display and then change Trace Format of Tr3 to Log Mag
 - m. Select View Trace, select Store Data to Memory, and then select Data, Memory Math
 - n. Click on Tr4 on the top of the S21 trace on the screen, select Response and then select User-defined
 - o. Set Driver Port to Port 1, set Numerator to B2, and set Denominator to 1
 - p. Select Display and then change Trace Format of Tr4 to Log Mag
 - q. Select View Trace, select Store Data to Memory, and then select Data, Memory Math
8. Select Freq-based Seg. Sweep Setup
9. Change all Port power settings to 30 dBm.
10. Select Sweep, select Hold Functions and then select Single Sweep & Hold
11. Select File and then Save Data
12. Change the Type of File to Active Channel TXT File (*.txt)
13. Change the file name to MaxPwr1.txt and then click the Save button. Note the location of the data file being saved to.

Note

Trace1 = Port 2 Max Power, Trace 2 = Port 1 Max Power, Trace 3 = Port 4 Max Power, Trace 4 = Port 3 Max Power

- 14. Copy the saved data file off the MS4652xB onto a USB flash drive for transferring to a Personal Computer.
- 15. On a separate Windows Personal Computer, open the MaxPwr1.txt file with Windows Notepad program.

16. Transfer the Notepad data from the PC to the appropriate table:

- [Table A-2, “Maximum Power” on page A-4](#) for MS46522B with Option 10, 20, or 40 Rev 4 and below
- [Table A-11, “Maximum Power” on page A-16](#) for MS46522B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1
- [Table A-34, “Maximum Power” on page A-38](#) for MS46524B with Option 10, 20 or 40 Rev 4 and below
- [Table A-50, “Maximum Power” on page A-58](#) for MS46524B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1

17. Follow the Receiver Linearity Uncertainty determination procedure to calculate the uncertainty contributed by the VNA Receivers.

18. Note the worst case Deviation (%) value and enter it to all the cells of the C column in [Table 2-6, “Uncertainty Contributors”](#).

19. Calculate the composite uncertainty using the following formula:

$$D = \text{SQRT}((A/(\text{SQRT}(2)))^2 + (B/(\text{SQRT}(3)))^2 + (C/(\text{SQRT}(2)))^2)$$

20. Enter the calculated D values from [Table 2-6](#) into [Table 2-7, “Maximum Power Measurement Uncertainty Calculation”](#).

21. Calculate the maximum power measurement uncertainty using the following formula:

$$H = 10 \times \text{LOG}((2 \times \text{SQRT}(D/100)^2 + E^2) + 1) + F$$

22. Enter the calculated measurement uncertainty values to the measurement uncertainty column of the appropriate table:

- [Table A-2, “Maximum Power” on page A-4](#) for MS46522B with Option 10, 20, or 40 Rev 4 and below
- [Table A-11, “Maximum Power” on page A-16](#) for MS46522B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1
- [Table A-34, “Maximum Power” on page A-38](#) for MS46524B with Option 10, 20, or 40 Rev 4 and below
- [Table A-50, “Maximum Power” on page A-58](#) for MS46524B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1

Table 2-6. Uncertainty Contributors

Frequency	Sensor/DUT Mismatch Uncertainty, A	Power Measurement Uncertainty (excluding mismatch), B	Receiver Linearity Uncertainty, C	Calculated Composite Uncertainty, D
0.3 MHz to 6 GHz	0.57%	0.34%	%	%
6 GHz to 8 GHz	0.57%	0.34%	%	%
8 GHz to 8.5 GHz	0.57%	0.34%	%	%
8.5 GHz to 20 GHz	0.81%	0.34%	%	%
20 GHz to 40 GHz	1.5%	0.44%	%	%
40 GHz to 43.5 GHz	1.6%	0.45%	%	%

Table 2-7. Maximum Power Measurement Uncertainty Calculation

Frequency	Calculated Composite Uncertainty, D	Repeatability Uncertainty, E	Adapter Loss (dB), F	Calculated Maximum Power Measurement Uncertainty, G
0.3 MHz to 8.5 GHz	%	0.0084	0.003	dB
8.5 GHz to 20 GHz	%	0.012	0.003	dB
20 GHz to 25 GHz	%	0.013	0.003	dB
25 GHz to 40 GHz	%	0.014	0.007	dB
40 GHz to 43.5 GHz	%	0.014	0.007	dB

2-10 System Dynamic Range

This section provides the procedure to measure the Noise Floor performance of the MS4652xB and calculate the System Dynamic Range.

Equipment Required

Equipment required for System Dynamic Range test is listed in [Table 2-8](#).

Table 2-8. 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 (Qty 2 for MS46524B)
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50 (Qty 2 for MS46524B)
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B (Qty 2 for MS46524B)
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C (Qty 2 for MS46524B)
Torque Wrench (For Opt. 10)	3/4 in. (0.75 in.) Open End 12 in·lbf (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 in·lbf (0.90 N·m)	Anritsu Model 01-201
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 (Qty 2 for MS46524B)
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(m) to K(f)	Anritsu Model 3670K50A-2 (Qty 2 for MS46524B)
Calibration Kit (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) Type	Anritsu Model OSLN50A-18
Calibration Kit (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K(f) Type	Anritsu Model TOSLKF50A-40
Termination (Load) (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(f) Type	Anritsu Model 28NF50-2
Termination (Load) (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K(m) Type	Anritsu Model 28K50A
Fixed Attenuator (For Opt. 10)	Frequency: DC to 18 GHz Attenuation: 20 dB Connector Type: N(m) to N(f)	Aeroflex Weinschel Model 44-20 (Qty 2 for MS46524B)
Fixed Attenuator (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Attenuation: 20 dB Connector Type: K(m) to K(f)	Anritsu Model 43KC-20 (Qty 2 for MS46524B)
Calibration Kit (For Opt. 20, 40, or 43)	Frequency: DC to 40 GHz Connector: K Type	Anritsu Model TOSLK50-40 and TOSLKF50A-40
Step Attenuator	With traceable characterization data at 2 GHz	Anritsu Model SC7974
Step Attenuator Control Box		Anritsu Model SC3796

Procedure

1. Power on the MS4652xB and allow the instrument to warm up for 45 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(s) as follows:
 - b. For ShockLine MS4652XB with Option 10:
Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
 - c. For ShockLine MS4652XB with Option 20, 40, or 43:
Install the 33KKF50x Adapter to the male end of the 3670K50-2 or 3670K50A-2 (For Opt 43) Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
4. Install the Thru Cable to Port 2. For MS46524B, also install the second Thru Cable to Port 4.
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 2-9](#) into the setup table on the bottom of the VNA display.
 - d. Select **Add**
 - e. Enter the data in the next row of [Table 2-9](#) into the VNA.
 - f. Repeat [Step d](#) through [Step e](#) until F2 = 8500 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 2-9. VNA Segmented Sweep Setup for System Dynamic Range Test

F1	F2	# of Pts	IFBW	P1 or P3 Src Pwr	P2 or P4 Src Pwr	Avg
300 kHz	1 MHz	20	10 Hz	-20 dBm	-20 dBm	1
1.001 MHz	50 MHz	80	10 Hz	-20 dBm	-20 dBm	1
50.001 MHz	2000 MHz	49	10 Hz	-20 dBm	-20 dBm	1
2000.001 MHz	4000 MHz	44	10 Hz	-20 dBm	-20 dBm	1
4000.001 MHz	6000 MHz	46	10 Hz	-20 dBm	-20 dBm	1
6000.001 MHz	8000 MHz	44	10 Hz	-20 dBm	-20 dBm	1
8000.001 MHz	8500 MHz	11	10 Hz	-20 dBm	-20 dBm	1
8500.001 MHz	20000 MHz	264	10 Hz	-20 dBm	-20 dBm	1
20000.001 MHz	25000 MHz	114	10 Hz	-20 dBm	-20 dBm	1
25000.001 MHz	40000 MHz	342	10 Hz	-20 dBm	-20 dBm	1

6. For MS46522B, 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. For MS46524B, perform a Transmission Response calibration as follows:

- a. Select Calibration
- b. Select Calibrate and then Manual Cal
- c. Select Transmission Freq. Response
- d. Select Modify Cal Setup
- e. Select Edit Cal Params
- f. On the setup dialog, place 2 check marks in the 2 checkboxes above Thru3-4 Info to activate the Thru calibration between Port 3 and Port 4 and then click the OK button to continue
- g. Select Back
- h. Select Thru/Recip
- i. Connect the Thru Cable from Port 2 to Port 1 and connect the Thru Cable from Port 4 to Port 3
- j. Select Thru 1-2 and then allow the VNA to complete the measurements
- k. Select Thru 3-4 and then allow the VNA to complete the measurements
- l. Click on the OK button on the displayed dialog
- m. Disconnect the Thru Cable from Port 1 and the Thru Cable from Port 3
- n. Select Isolation (Optional)
- o. Install Loads to both Port 3 and Port 4 (at the end of the Thru Cable)
- p. Select Isolation 3-4 and then allow the VNA to complete the measurements
- q. Install Loads to both Port 1 and Port 2 (at the end of the Thru Cable)
- r. Select Isolation 1-2 and then allow the VNA to complete the measurements
- s. Select Back
- t. Select Done
- u. This completes the Transmission Response calibration
- v. Leave the Loads connected between Port 1 and Port 2

8. For MS46522B, 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**.
9. For MS46524B, set up the VNA display as follows:
 - a. Select **Trace** and then set **# of Traces** to 4.
 - 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**.
 - e. Click on Tr3 on the top of the S31 trace on the screen. Then, set **Trace Format** to **Linear Mag** and set **Response** to **S34**.
 - f. Click on Tr4 on the top of the S41 trace on the screen. Then, set **Trace Format** to **Linear Mag** and set **Response** to **S43**.
10. Select **Sweep**, select **Hold Functions** and then select **Single Sweep & Hold**.
11. Select **File** and then **Save Data**.
12. Change the **Type of File** to **Active Channel TXT File (*.txt)**.
13. Change the file name to **SDR12#1.txt** and then click the **Save** button. Note the location of the data file being saved to.
14. Repeat [Step 10](#) through [Step 13](#) seven (7) more times. When saving the data, increment the number at the end of the file name by one (e.g. **SDR12#2.txt**, **SDR12#3.txt** and etc.).
15. For MS46524B, move the loads to Port 3 and Port 4 and then repeat [Step 10](#) through [Step 13](#) eight (8) more times. Change the file name to **SDR34#1.txt**

Note

If four (4) loads are available to terminate all four VNA ports at the same time, then [Step 15](#) can be skipped, as the **SDR12#n.txt** files would have valid data for S34 and S43.

16. Select **Calibration** button on the Icon bar and then select **Cal Status** to turn calibration OFF.
17. Select **Sweep**, select **Hold Functions** and then select **Sweep**.
18. Select **Back**.
19. Select **Freq-based Seg. Sweep Setup**.
20. Change all Port power settings to 0 dBm.
21. Remove all Loads from the MS4652xB.
22. Install the 20 dB Fixed Attenuator between Port 1 and Port 2 Thru Cable. For MS46524B, also install the second 20 dB Fixed Attenuator between Port 3 and Port 4 Thru Cable.
23. Click on Tr1 on the top of the S12 trace on the screen, select **Response** and then select **User-defined**.
24. Set **Driver Port** to **Port 2**, set **Numerator** to **B1**, and set **Denominator** to 1.
25. Select **Display** and then change **Trace Format** of Tr1 to **Log Mag**.
26. Select **View Trace**, select **Store Data to Memory**, and then select **Data, Memory Math**.
27. Click on Tr2 on the top of the S21 trace on the screen, select **Response** and then select **User-defined**.
28. Set **Driver Port** to **Port 1**, set **Numerator** to **B2**, and set **Denominator** to 1.
29. Select **Display** and then change **Trace Format** of Tr2 to **Log Mag**.
30. Select **View Trace**, select **Store Data to Memory**, and then select **Data, Memory Math**

31. For MS46524B, continue to set up the VNA display as follows:
 - a. Click on Tr3 on the top of the S34 trace on the screen, select **Response** and then select **User-defined**
 - b. Set **Driver Port** to **Port 4**, set **Numerator** to **B3**, and set **Denominator** to **1**
 - c. Select **Display** and change **Trace Format** of Tr3 to **Log Mag**
 - d. Select **View Trace**, select **Store Data to Memory**, and then select **Data, Memory Math**
 - e. Click on Tr4 on the top of the S43 trace on the screen, select **Response** and then select **User-defined**
 - f. Set **Driver Port** to **Port 3**, set **Numerator** to **B4**, and set **Denominator** to **1**
 - g. Select **Display** and change **Trace Format** of Tr3 to **Log Mag**
 - h. Select **View Trace**, select **Store Data to Memory**, and then select **Data, Memory Math**
32. Select **Freq-based Seg. Sweep Setup**
33. Change all Port power settings to **30 dBm**.
34. Select **Sweep**, select **Hold Functions** and then select **Single Sweep & Hold**
35. Select **File** and then **Save Data**
36. Change the **Type of File** to **Active Channel TXT File (*.txt)**
37. Change the file name to **MaxPwr2.txt** and then click the **Save** button. Note the location of the data file being saved to.

Note

Trace1 = Port 2 Max Power, Trace 2 = Port 1 Max Power, Trace 3 = Port 4 Max Power, Trace 4 = Port 3 Max Power

38. Copy the saved data files off the MS4652xB onto a USB flash drive for transferring to a Personal Computer.
39. On a separate Windows Personal Computer, import the saved data from the **SDR12#n.txt** and **MaxPwr.txt** files into Microsoft Excel so the System Dynamic Range can be calculated.
40. There are many ways one can set up Microsoft Excel for calculating the System Dynamic Range in Deg 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, Noise Floor, Max Power, SDR
 - Column A – Freq (Imported from the **SDR12#n.txt** files)
 - Column B through Column I – Data1 through Data8 (Imported from the **SDR12#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 – Maximum Power values (Imported from the **MaxPwr2.txt** file)
 - Column N – Calculated System Dynamic Range values
 - b. Import the frequency data from the **SDR12#n.txt** file.
 - c. Set up Cell J2 to calculate the rms value in Linear Mag by entering the following formula into the cell:

$$=SQRT(SUMSQ(B2:I2)/8)$$
 - 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 the Noise Floor in dBm by entering the following formula into the cell:

$$= -20 - K2$$

- 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 into the cell:

$$= M2 - L2$$

- j. Copy the formula to the next cell on Column N until it reaches the last frequency point.

- k. Rename 'Sheet 1' to 'SDR S12' by right-clicking on the 'Sheet 1' tab, selecting 'Rename' and typing in the new name.

- l. Copy 'SDR S12' sheet by right-clicking on the 'SDR S12' tab, selecting 'Move or Copy...', selecting '(move to end)', checking 'Create a copy' checkbox and then clicking OK.

- m. Rename the new sheet as 'S21 Magnitude'.

- n. For MS46524B, use the 'Move or Copy...' of Excel to create two more new sheets for the remaining SDR measurements. Rename the sheets to indicate which measurement is being computed on the worksheet (e.g. SDR S34, and SDR S43.).

- o. Import the S12 and Port 2 Max Power data, and S21 and Port 1 Max Power data to appropriate Excel worksheet for System Dynamic Range calculation.

- p. For MS46524B, import the S34 and Port 4 Max Power data, and S43 and Port 3 Max Power data to the appropriate Excel worksheet for System Dynamic Range calculation.

41. Record the worst case calculated SDR value of each frequency band in the appropriate tables:

- [Table A-3, "S12 System Dynamic Range" on page A-6](#) and [Table A-4, "S21 System Dynamic Range" on page A-6](#) for MS46522B with Option 10, 20, or 40 Rev 4 and below
- [Table A-12, "S12 System Dynamic Range with Serial Numbers < 2324xxx" on page A-18](#) and [Table A-13, "S21 System Dynamic Range with Serial Numbers < 2324xxx" on page A-18](#) for MS46522B with Option 10 Rev 5, Option 20 Rev 5, or Option 43 Rev 1
- [Table A-35, "S12 System Dynamic Range" on page A-40](#) through [Table A-38, "S34 System Dynamic Range" on page A-41](#) for MS46524B with Option 10, 20, or 40 Rev 4 and below
- [Table A-51, "S12 System Dynamic Range with Serial Numbers < 2324xxx" on page A-61](#) through [Table A-54, "S34 System Dynamic Range with Serial Numbers < 2324xxx" on page A-62](#) for MS46524B with Option 10 Rev 5, Option 20 Rev 5, or Option 43 Rev 1

42. Follow the Receiver Linearity Uncertainty determination procedure to calculate the uncertainty contributed by the VNA Receivers.

43. Note the 80 dB Deviation (%) value and enter it to all the cells of the D column in [Table 2-10, "Uncertainty Contributors"](#).

44. Calculate the composite uncertainty using the following formula:

$$F = (\text{SQRT}(A^2 + B^2 + C^2 + D^2)/100)/(\text{SQRT}(3))$$

45. Enter the calculated F values from [Table 2-10](#) into [Table 2-11, "Maximum Power Measurement Uncertainty Calculation"](#).

46. Calculate the system dynamic range measurement uncertainty using the following formula:

$$H = 20 \times \text{LOG}((2 \times \text{SQRT}(F^2 + (1 - 10^{(G/20)})^2)) + 1)$$

47. Enter the calculated measurement uncertainty values to the measurement uncertainty column of the appropriate tables:

- [Table A-3, “S12 System Dynamic Range” on page A-6](#) and [Table A-4, “S21 System Dynamic Range” on page A-6](#) for MS46522B with Option 10, 20, or 40 Rev 4 and below
- [Table A-12, “S12 System Dynamic Range with Serial Numbers < 2324xxx” on page A-18](#) and [Table A-13, “S21 System Dynamic Range with Serial Numbers < 2324xxx” on page A-18](#) for MS46522B with Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1
- [Table A-35, “S12 System Dynamic Range” on page A-40](#) through [Table A-38, “S34 System Dynamic Range” on page A-41](#) for MS46524B with Option 10, 20, or 40 Rev 4 and below
- [Table A-51, “S12 System Dynamic Range with Serial Numbers < 2324xxx” on page A-61](#) through [Table A-54, “S34 System Dynamic Range with Serial Numbers < 2324xxx” on page A-62](#) for MS46524B Option 10 Rev 5, Option 20 Rev 5 or Option 43 Rev 1

Table 2-10. Uncertainty Contributors

Frequency	VNA Source Default Power Level Uncertainty, A	VNA Source Power Level Uncertainty (-20 dBm), B	Termination Noise Uncertainty, C	ADC Linearity Uncertainty, D	Receiver Linearity Uncertainty, E	Calculated Composite Uncertainty, F
0.3 MHz to 1 MHz	4.7%	6.3%	0.0000040%	0.00058%	%	%
1 MHz to 50 MHz	4.7%	6.3%	0.000040%	0.00058%	%	%
50 MHz to 2 GHz	4.7%	6.3%	0.40%	0.00058%	%	%
2 GHz to 4 GHz	4.7%	6.3%	0.20%	0.00058%	%	%
4 GHz to 6 GHz	4.7%	6.3%	0.040%	0.00058%	%	%
6 GHz to 8 GHz	4.7%	6.3%	0.0063%	0.00058%	%	%
8 GHz to 8.5 GHz	4.7%	6.3%	0.0040%	0.00058%	%	%
8.5 GHz to 20 GHz	6.3%	6.3%	0.0020%	0.00058%	%	%
20 GHz to 25 GHz	11%	11%	0.0020%	0.00058%	%	%
25 GHz to 40 GHz	11%	11%	0.0040%	0.00058%	%	%
40 GHz to 43.5 GHz	11%	11%	0.0040%	0.00058%	%	%

Table 2-11. Maximum Power Measurement Uncertainty Calculation

Frequency	Calculated Composite Uncertainty, F	Repeatability Uncertainty (dB), G	Calculated Maximum Power Measurement Uncertainty, H
0.3 MHz to 1 MHz	%	0.018	dB
1 MHz to 50 MHz	%	0.012	dB
50 MHz to 2 GHz	%	0.39	dB
2 GHz to 4 GHz	%	0.26	dB
4 GHz to 6 GHz	%	0.14	dB
6 GHz to 8 GHz	%	0.12	dB
8 GHz to 8.5 GHz	%	0.24	dB
8.5 GHz to 20 GHz	%	0.20	dB
20 GHz to 25 GHz	%	0.13	dB
25 GHz to 40 GHz	%	0.18	dB
40 GHz to 43.5 GHz	%	0.18	dB

2-11 High Level Noise

This test verifies the High Level Noise performance of the MS4652xB.

Equipment Required

Equipment required for High Level Noise test is listed in [Table 2-12](#).

Table 2-12. 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 (Qty 2 for MS46524B)
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50 (Qty 2 for MS46524B)
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50B (Qty 2 for MS46524B)
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B (Qty 2 for MS46524B)
Adapter (For Opt 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C (Qty 2 for MS46524B)
Adapter (For Opt 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C (Qty 2 for MS46524B)
Torque Wrench (For Opt. 10)	3/4 in. (0.75 in.) Open End 12 in·lbf (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 in·lbf (0.90 N·m)	Anritsu Model 01-201
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 (Qty 2 for MS46524B)
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 (Qty 2 for MS46524B)

Procedure

- Power on the MS4652xB and allow the instrument to warm up for 45 minutes.
- Preset the VNA as follows:
 - Select **Preset** button on the Icon Bar and then the **OK** button.
- Prepare the Thru Cable(s) as follows:
 - For ShockLine MS4652XB with Option 10:
Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
 - For ShockLine MS4652XB with Option 20, 40, or 43:
Install the 33KKF50B or 33KFKF50C (For Option 43) Adapter to the male end of the 3670K50-2 or 3670K50A-2 (For Option 43) Thru Cable. Use torque wrench to tighten the K connectors to insure that the connections do not work themselves loose during the test.
- Install the Thru Cable to Port 2. For MS46524B, also install the second Thru Cable to Port 4.

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 2-13](#) into the setup table on the bottom of the VNA display.
- d. Select Add
- e. Enter the data in the next row of [Table 2-13](#) into the VNA.
- f. Repeat [Step d](#) through [Step e](#) until F2 = 8500 MHz for Option 10 unit, F2 = 20000 MHz for Option 20 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 2-13. VNA Segmented Sweep Setup for High Level Noise Test

F1	F2	# of Pts	IFBW	P1 or P3 Src Pwr	P2 or P4 Src Pwr	Avg
300 kHz	900 kHz	7	100 Hz	0 dBm	0 dBm	1
1 MHz	10 MHz	10	100 Hz	0 dBm	0 dBm	1
15 MHz	100 MHz	10	100 Hz	0 dBm	0 dBm	1
250 MHz	501 MHz	2	100 Hz	0 dBm	0 dBm	1
701 MHz	1000 MHz	2	100 Hz	0 dBm	0 dBm	1
1101 MHz	1501 MHz	5	100 Hz	0 dBm	0 dBm	1
1550 MHz	2450 MHz	19	100 Hz	0 dBm	0 dBm	1
2499.99 MHz	2500.01 MHz	2	100 Hz	0 dBm	0 dBm	1
2600 MHz	3900 MHz	14	100 Hz	0 dBm	0 dBm	1
3975 MHz	4001 MHz	2	100 Hz	0 dBm	0 dBm	1
4100 MHz	8500 MHz	45	100 Hz	0 dBm	0 dBm	1
4100 MHz (for Opt. 20, 40, or 43)	8000.01 MHz	40	100 Hz	0 dBm	0 dBm	1
8100 MHz (for Opt. 20, 40, or 43)	8500 MHz	5	100 Hz	0 dBm	0 dBm	1
8600 MHz	20000 MHz	115	100 Hz	0 dBm	0 dBm	1
21000 MHz	40000 MHz	191	100 Hz	0 dBm	0 dBm	1
41000 MHz	43500 MHz	51	100 Hz	0 dBm	0 dBm	1

6. For MS46522B, 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. For MS46524B, perform a Transmission Response calibration as follows:
- a. Select Calibration.
 - b. Select Calibrate and then Manual Cal.
 - c. Select Transmission Freq. Response.
 - d. Select Modify Cal Setup.
 - e. Select Edit Cal Params.
 - f. On the setup dialog, place 2 check marks in the 2 checkboxes above Thru3-4 Info to activate the Thru calibration between Port 3 and Port 4 and then click the OK button to continue.
 - g. Select Back.
 - h. Select Thru/Recip.
 - i. Connect the Thru Cable from Port 2 to Port 1 and connect the Thru Cable from Port 4 to Port 3.
 - j. Select Thru 1-2 and then allow the VNA to complete the measurements.
 - k. Select Thru 3-4 and then allow the VNA to complete the measurements.
 - l. Click on the OK button on the displayed dialog.
 - m. Select Done.
 - n. This completes the Transmission Response calibration.
 - o. Leave the Thru Cable connected between Port 1 and Port 2 and leave the Thru Cable connected between Port 3 and Port 4.
8. For MS46522B, 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.
9. For MS46524B, set up the VNA display as follows:
- a. Select Trace and then set # of Traces to 4.
 - 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.
 - e. Click on Tr3 on the top of the S31 trace on the screen. Then, set Trace Format to Linear Mag And Phase and set Response to S34.
 - f. Click on Tr4 on the top of the S41 trace on the screen. Then, set Trace Format to Linear Mag And Phase and set Response to S43.
10. Select Sweep and then Hold Functions. Select Single Sweep & Hold.
11. Select File and then Save Data.
12. Change the Type of File to Active Channel TXT File (*.txt).

13. Change the file name to HLN#1 and then click the **Save** button. Note the location where the data file is saved to.
14. Repeat [Step 10](#) through [Step 13](#) nineteen (19) 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.).
15. Copy the nineteen (19) saved data files off the MS4652xB onto a USB flash drive for transferring to a Personal Computer.
16. 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.
17. 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 Data20, rms Linear Mag, rms Log Mag (or rms Deg)
 - Column A – Freq (Imported from the HLN#n files)
 - Column B through Column U – Data1 through Data20 (Imported from the HLN#n files)
 - b. Set up Cell V2 to calculate the rms value in Linear Mag by entering the following formula into the cell:

$$= \text{STDEV.P}(B2:U2)$$

- c. Copy the formula to the next cell on Column V until it reaches the last frequency point.
- d. For magnitude measurements only,
 - i. Set up Cell W2 to calculate the rms value in Log Mag by entering the following formula into the cell:

$$= 20 * \text{LOG}(V2+1, 10)$$

- ii. Copy the formula to the next cell on Column W 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 'Create a copy' checkbox and then clicking OK.
 - g. Rename the new sheet as 'S21 Magnitude'.
 - h. Use the 'Move or Copy...' of 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. S21 Phase, and so on.).
 - i. Import the S21, S34 and S43 data to the appropriate worksheet for rms value calculation as required.
18. Record the calculated rms value of each frequency point listed in the appropriate tables:
- [Table A-5, "High Level Noise – S21 Magnitude" on page A-7](#) through [Table A-8, "High Level Noise – S12 Phase" on page A-12](#) for MS46522B with Option 10, 20, or 40 Rev 4 and below
 - [Table A-16, "High Level Noise – S21 Magnitude with Serial Numbers < 2404xxx" on page A-20](#) through [Table A-19, "High Level Noise – S12 Phase with Serial Numbers < 2404xxx" on page A-24](#) for MS46522B with Option 10 Rev 5, Option 20 Rev 5, or Option 43 Rev 1
 - [Table A-39, "High Level Noise – S21 Magnitude" on page A-42](#) through [Table A-46, "High Level Noise – S34 Phase" on page A-54](#) for MS46524B with Option 10, 20, or 40 Rev 4 and below
 - [Table A-59, "High Level Noise – S21 Magnitude with Serial Number < 2404xxx \(Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201\)" on page A-65](#) through [Table A-66, "High Level Noise – S34 Phase with Serial Number < 2404xxx \(Excluding 2341204, 2345204,](#)

[2346201, 2349203, 2351202, 2403201](#))” on page A-75 for MS46524B with Option 10 Rev 5, Option 20 Rev 5, or Option 43 Rev 1

2-12 Frequency Accuracy (Operational Test)

This test checks the internal time base of the MS4652xB.

Equipment Required

Equipment required for Frequency Accuracy check is listed in [Table 2-14](#).

Table 2-14. Equipment Required for Frequency Accuracy Check

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
 - a. Set the **Resolution** to 0.1 Hz
 - b. set the **Sample rate** to 11 ms.
5. Power on the MS4652xB and allow the instrument to warm up for 45 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 300 kHz)
 - g. Change **# of Points** to 801

- 2-33

2-13 Receiver Linearity Uncertainty Determination Procedure

1. Warm up the VNA for at least an hour.
2. Install 33KFKF50B to VNA Port 1.
3. Install the 33KKF50B to the male port of 3670K50-2 Thru Cable.
4. Set up the VNA as follows:
 - a. Select Preset button on the Icon Bar and then the OK button.
 - b. Select Frequency and then set the Start to 2 GHz.
 - c. Turn CW Mode to ON.
 - d. Change # of Points to 101.
 - e. Select the Home icon at the lower right corner.
 - f. Select Averaging and then set IFBW to 10 Hz.
 - g. Set Number of Average to 1024 and select Averaging to turn it On.
 - h. Select Back icon.
5. Perform a 12-Term 2-Port Calibration as follows:
 - a. Select Calibration.
 - b. Select Calibrate and then Manual Cal.
 - c. Select 2-Port Cal.
 - d. Select Modify Cal Setup and then Edit Cal Params.
 - e. Change Test Port 1 DUT Connector to K (m) connector and Test Port 2 DUT Connector to K (f) connector. Click on the OK button to close the dialog box.
 - f. Select Back icon.
 - g. Select Port 1 Reflective Devices.
 - h. Connect the Open of TOSLK50A-40 to the female end of the adapter at VNA Port 1.
 - i. Select Open to measure the calibration standard. A check mark will appear on the Open button when the measurement is complete.
 - j. Disconnect the Open and then connect the Short of TOSLK50A-40 to VNA Port 1.
 - k. Select Short to measure the calibration standard.
 - l. Disconnect the Short and then connect the Load of TOSLK50A-40 to VNA Port 1.
 - m. Select Load to measure the calibration standard.
 - n. Select Back icon.
 - o. Select Port 2 Reflective Devices.
 - p. Connect the Open of TOSLK50A-40 to the male end of the adapter on the Thru Cable connected to VNA Port 2.
 - q. Select Open to measure the calibration standard. A check mark will appear on the Open button when the measurement is complete.
 - r. Disconnect the Open and then connect the Short of TOSLK50A-40 to the cable connected to VNA Port 2.
 - s. Select Short to measure the calibration standard.
 - t. Disconnect the Short and then connect the Load of TOSLK50A-40 to the cable connected to VNA Port 2.
 - u. Select Load to measure the calibration standard.

- v. Select Back icon.
 - w. Select Isolation (Optional).
 - x. Select Isolation 1-2 to measure both Load standards. After measurement is complete, disconnect both loads and connect the open end of the Thru Cable at VNA Port 2 to Port 1. Select Back icon.
 - y. Select Thru/Recip and then Thru 1-2 to start the thru measurement. After the measurement is complete, select Back icon and then select Done to complete the calibration.
6. Setup the VNA display as follows:
- a. Select Trace.
 - b. Select Trace Max to expand the S11 Smith Chart graph to fill the screen.
 - c. Select Trace Next twice so S21 Data is displayed on screen.
 - d. Select Display.
 - e. Select Trace Format and then select Log Mag.
 - f. Select Marker.
 - g. Select Mkr1 [OFF] to turn Marker 1 On.
7. On the SC3796 Step Attenuator Control Box, set all four toggle switches to 0 dB.
8. Install the ribbon cable connector plug of the SC7974 Step Attenuator to the DIP socket of the SC3796 Step Attenuator Control Box.

Warning

The white dots and/or beveled connector corners designate Pin 1 on the ribbon cable connector plug of the step attenuator and the DIP socket of SC3796 Step Attenuator Control Box. The Pin 1 dot or beveled corner MUST be aligned together to prevent damage to the step attenuator.

9. On the VNA, disconnect the Thru Cable from Port 1 and then install the SC7974 Step Attenuator between Port 1 and Port 2 Thru Cable.
10. Record the marker M1 value on the display to 0 dB row on Table x, "Measured S21 Values and Calculated Step Attenuator Attenuation Values.
11. Set the first toggle switch on the most right of the SC3796 Step Attenuator Control Box to 10 dB position to set the step attenuator to 10 dB attenuation.
12. Record the M1 value on the display to 10 dB row on [Table 2-15, "Measured S21 Values and Calculated Step Attenuator Attenuation Values.](#)
13. Set the toggle switch from 10 dB back to 0 dB position.
14. Toggle the second switch from the right to 20 dB position to set the step attenuator to 20 dB attenuation.
15. Record the M1 value on the display to 20 dB row on [Table 2-15.](#)
16. Toggle the first switch to 10 dB position to set the step attenuator to 30 dB attenuation.
17. Record the M1 value on the display to 30 dB row on [Table 2-15.](#)
18. Set both switches (10 dB and 20 dB) back to 0 dB position.
19. Toggle the third switch from the right to 40 dB position to set the step attenuator to 40 dB attenuation.
20. Record the M1 value on the display to 40 dB row on [Table 2-15.](#)
21. Toggle the first switch to 10 dB position to set the step attenuator to 50 dB attenuation.
22. Record the M1 value on the display to 50 dB row on [Table 2-15.](#)
23. Set the first switch from 10 dB back to 0 dB position.
24. Toggle the second switch to 20 dB position to set the step attenuator to 60 dB attenuation.
25. Record the M1 value on the display to 60 dB row on [Table 2-15.](#)

26. Toggle the first switch to 10 dB position to set the step attenuator to 70 dB attenuation.
27. Record the M1 value on the display to 70 dB row on [Table 2-15](#).
28. Set both the first and second switches (10 dB and 20 dB) back to 0 dB position.
29. Toggle the last switch to 40 dB position to set the step attenuator to 80 dB attenuation.
30. Record the M1 value on the display to 80 dB row on [Table 2-15](#).
31. Set all switches on the SC3796 Step Attenuator Control Box back to 0 dB position.
32. Repeat [Step 10](#) to [Step 31](#) nine more times. Record the M1 value to the next available column on [Table 2-15](#).
33. Calculate the attenuation values for the 10, 20, 30, 40, 50, 60, 70, and 80 attenuation step of the step attenuator using the following formula:

$$\text{Attenuation(XdB)} = \text{MeasuredValue(XdB)} - \text{MeasuredValue(0dB)}$$

where X = Attenuation step (e.g. 10 dB, 20 dB, and etc.)

34. Calculate the mean values by summing the 10 calculated values in the previous steps and then divide the sum by 10 for each attenuation step of the step attenuator using the following formula:

$$\text{Attenuation(Xdb)}_{\text{mean}} = \frac{[\text{Atten(Xdb)}_{\text{pass1}} + \text{Atten(Xdb)}_{\text{pass2}} + \dots + \text{Atten(Xdb)}_{\text{pass10}}]}{10}$$

35. Record the calculated mean values in [Table 2-15](#).
36. Open the characterization data file (using a text editor program such as Windows Notepad) that is supplied with the SC7974 Step Attenuator on a personal computer and copy the eight characterization values to [Table 2-16](#), "Attenuation Deviation Calculation".

Note

The data for each attenuation step is found on the same line as the nominal value. For example, the line read "-10 = -10.02, 0.25". Then copy "-10.02" to the Characterized Value column on Table y.

37. Transfer the mean values from [Table 2-15](#) to [Table 2-16](#).
38. Calculate the absolute deviation of each attenuation step using the following formula:

$$\text{Deviation} = |\text{MeasuredMeanValue} - \text{CharacterizedValue}|$$

39. Convert the Log values in previous step into Linear values using the following formula:

$$\text{ReceiverLinearityUncertainty(\%)} = (10^{(\text{Deviation}/20)} - 1) \times 100$$

40. Enter the calculated values in [Table 2-16](#).

Table 2-15. Measured S21 Values and Calculated Step Attenuator Attenuation Values

Step Attenuator Setting	Pass #1	Pass #2	Pass #3	Pass #4	Pass #5	Pass #6	Pass #7	Pass #8	Pass #9	Pass #10	
	Measured S21 Values										
0 db											
10 db											
20 db											
30 db											
40 db											
50 db											
60 db											
70 db											
80 db											
	Calculated Step Attenuator Attenuation Values										Mean Value
0 db											
10 db											
20 db											
30 db											
40 db											
50 db											
60 db											
70 db											
80 db											

Table 2-16. Attenuation Deviation Calculation

Attenuation Nominal Value	Characterized Value	Measured Mean Value	Deviation (db) Mean-Characterized	Deviation (%)
-10dB				
-20dB				
-30dB				
-40dB				
-50dB				
-60dB				
-70dB				
-80dB				

2-14 Performance Verification For MS46522B-082 and MS46522B-083

This section describes the test to verify that the MS46522B-082/083 VNA meets its factory specifications.

The following parameter is the only specification that is warranted for MS46522B-082/83:

- System Dynamic Range

Required Equipment

- Anritsu 3655E WR12 Waveguide Calibration Kit

Best Practices for Waveguide Connections

- The flange flat surface around the device waveguide aperture should be free of debris, nicks and scratches. Use appropriate size protective cap to cover the waveguide flange(s) when not in use.
- Waveguide thru section and shim waveguide channels should be free of debris. Clean pressurized air is permissible to clean the channel. DO NOT use cold spray as the resultant condensation may affect the channel surface.
- DO NOT attempt to clean out the channel of any other waveguide device besides a thru section or shim.
- Use only captivated (partially threaded) screws for waveguide connections. The threads should contact ONE flange only when fully tightened. The unthreaded length is critical when inserting shims.
- Carefully observe the threads of waveguide screws before use, especially the starting threads, for nicks and burrs.
- There are two standard hex head sizes for waveguide captivated screws; one is more common than the other – 3/32" or 0.093".
- Essential tools are a hex head driver for the waveguide screws with a ball joint end and a short right angle hex head wrench. There is no standard torque specification for waveguide screws in this application.
- When mating two waveguide devices, use care that the fixed index pins do not scratch the flat surface of the opposite flange.
- If the Test Ports are precision type flanges, ALWAYS use the removable precision index pins from the calibration kit at every step of the calibration. Note if one end of the pin is beveled, that end projects out of the flange, to facilitate mating. Also note that the precision flange index pin length and the depth of the bore in the flange are not standardized, so mixing parts from different manufacturers may result in a (short) pin being "lost" in a (deep) bore!
- Always use four screws when connecting waveguide devices. It is permissible to use two back side and two front side but both screws on each side must be 180 degrees apart.
- Use extreme care when starting the threading of waveguide screws, especially with aluminum material. Ensure the screw is perpendicular to the flange—this is made difficult when the ball head driver is used and mechanical interferences dictates that it is set at an angle. If the screw starts to bind, STOP and back it out. Discard this particular screw and start with another.
- When mating waveguide devices, the four screws should first be threaded down just until they stop and then backed slightly. Observe closely the two mating surfaces of the waveguide flanges. This is particularly important if the flange are not of the precision type. Make sure that the flange mating surfaces are parallel to each other now and while the screws are subsequently tightened. Move one or both flanges to set the parallel surfaces. If the flanges are not mated properly (cocked), a small gap will be observed at the outside rim of the mating surface circumference.
- The four waveguide screws should be torqued as follows:
 - First, all four screws should be tightened until they just stop (minimum torque) with the mating surfaces parallel as mentioned in the previous bullet point.
 - Any one screw is then tightened to "half" torque.
 - The 180 degrees opposite screw to the first one is tightened to half torque.
 - Next, one of the two remaining screws is tightened to half torque.

- The last screw (it should be 180 degrees opposite to the one just torqued) is then tightened to half torque.
- Repeat starting with the first screw and tighten all screws to “full” torque.
- Offset Short Shims have some considerations:
 - If the Test Port flange is not of the precision type, there will be no precision index pins to force the Shim into the correct alignment – it could be 90 degrees circularly off, invalidating the calibration. Verify the waveguide rectangular apertures match.
 - The thickness of the Shim and its Flush Short backing necessitate a longer waveguide captivated screw than for a standard flange. Note that the threaded portion of this screw only threads into the Test Port flange. There must be a minimum of three threads into the Test Port flange when the screw is tightened down – less may damage the flange threads.
 - The Flush Short surface should be free of debris, nicks or scratches, especially in the waveguide aperture mating area.
 - The calibration routine will require two Offset Shims of different thicknesses. Ensure that the correct thickness Offset Shim is attached when called out, or else the calibration will be invalid.
 - Offset Shims are sometimes used in LRL calibrations. In this case, of course, they are inserted between both Test Ports. The captivated screw length required for this application will be different.
- When a captivated screw must be removed (backed out) from a flange (such as when a mating part already has a screw on its end) and it is inserted past its threaded portion loose in the non-threaded section, similar attention must be taken as to when starting the screw. It is important that the screw be perpendicular to the flange as the threads start to catch. This is more difficult when backing out as there is no way to control the required perpendicularity with the hex driver. You may be able to take advantage of the knurls on the head of the captivated screw and start by pressing the free threaded end of the screw back with a finger until it stops at the beginning of the threads and start the reverse threading with your fingers. Once the threads are started, the driver can be used. If the threads start binding, STOP, forward, and carefully start over.
- All steps of the calibration process ideally should be completed in the minimum possible elapsed time to minimize uncorrectable errors due to system drift. To help accomplish this, waveguide screws should be applied to all one port calibration devices (terminations, sliding loads and one-piece offset shorts) prior to starting a calibration. The assumption here is that device mating will utilize all four screws from the calibration device side.

Procedure

1. Power on the MS46522B and allow the instrument to warm up for 45 minutes.
2. Install short waveguide straight sections from 3655E Calibration Kit to both Port 1 millimeter-wave module and Port 2 millimeter-wave module.
3. 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 2-17](#) into the setup table on the bottom of the VNA display.
 - d. Select Add
 - e. Enter the data in the next row of [Table 2-17](#) into the VNA.
 - f. Repeat [Step d](#) through [Step e](#) until all the data have been entered.
 - g. Select Back
 - h. Select Sweep type and then Segmented Sweep (Freq-based)
 - i. Select Back

- j. This completes the Segmented Sweep setup.

Table 2-17. VNA Segmented Sweep Setup

F1	F2	# of Pts	IFBW	P1 Src Pwr	P2 Src Pwr	Avg
55000 MHz	60000 MHz	200	10 Hz	30	30	1
60000.001 MHz	89000 MHz	601	10 Hz	30	30	1
89000.001 MHz	92000 MHz	200	10 Hz	30	30	1

4. Perform a 2-port Transmission Response calibration (included Isolation) as follows:

- a. Select Calibration
- b. Select Calibrate and then Manual Cal
- c. Select Transmission Freq. Response
- d. Select Modify Cal Setup
- e. Select Cal Method and then Offset Short (SSLT)
- f. Select Line Type and then Waveguide
- g. Select Edit Cal Params
- h. Select WR12 Waveguide Kit on the setup dialog and click the OK button to continue
- i. Select Back
- j. Select Thru/Recip
- k. Connect the Port 1 module to the Port 2 module
- l. Select Thru 1-2 and then allow the VNA to complete the measurements
- m. Click on the OK button on the displayed dialog
- n. Disconnect the Port 1 module from the Port 2 module
- o. Select Back
- p. Select Isolation (Optional)
- q. Install the Loads from the calibration kit to both Port 1 module and Port 2 module
- r. Select Isolation 1-2 and then allow the VNA to complete the measurements
- s. Select Back
- t. Select Done
- u. This completes the 2-port Transmission Response calibration

5. Set up the VNA display as follows:

- a. Select Trace and then set # of Traces to 2
- b. Select Response and then S21. Verify that Tr1 is displaying S21 response.
- c. Select Display and set Trace Format to Linear Mag
- d. Click on Tr2 on the top of the S12 trace on the screen and then set Trace Format to Linear Mag

6. Select Main and then 4.Averaging. Set Smoothing to 1.5 % of sweep and then set Trace Smoothing to ON.

7. Select Single Sweep & Hold

8. Select File and then Save Data

9. Change the Type of File to Active Channel TXT File (*.txt)

10. Change the file name to SDR#1 and then click the Save button. Note the location of the data file being saved to.

11. Repeat [Step 7](#) through [Step 10](#) seven more times. When saving the data, increment the number at the end of the file name by one (e.g. SDR#2, SDR#3 and etc.).
12. Copy the eight saved data files off the MS46522B onto a USB flash drive for transferring to a Personal Computer.
13. On a separate Windows Personal Computer, import the saved data from the SDR#n files into Microsoft Excel so the rms values can be calculated.
14. 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 sheet as follows -

- Row 1 is the header – Freq, Data1 through Data8, rms Linear Mag, rms Log Mag
- Column A – Freq
- Column B through Column I – Data1 through Data8 of the first Frequency point

- b. Set up Cell J2 to calculate the rms value in Linear Mag by entering the following formula into the cell:

`=SQRT(SUMSQ(B2:I2)/8`

- c. Copy the formula to the next 668 cells on Column J.

- d. Set up Cell K2 to calculate the rms value in Log Mag by entering the following formula into the cell:

`=20*LOG(J2,10)`

- e. Copy the formula to the next 668 cells on Column K.

- f. Rename 'Sheet 1' to 'S12 Magnitude' by right-clicking on the 'Sheet 1' tab, selecting 'Rename' and typing in the new name.

- g. Copy 'S12 Magnitude' sheet by right-clicking on the 'S12 Magnitude' tab, selecting 'Move or Copy...', selecting '(move to end)', checking 'Create a copy' checkbox and then clicking OK.

- h. Rename the new sheet as 'S21 Magnitude'.

- i. Import the magnitude data to the appropriate worksheet for rms value calculation.

15. Record the worst case value of each frequency band into the appropriate table:

- [Table A-25, "S21 System Dynamic Range of MS46522B-082 REV 1" on page A-33](#)
- [Table A-26, "S12 System Dynamic Range of MS46522B-082 REV 1" on page A-33](#)
- [Table A-29, "S21 System Dynamic Range of MS46522B-082 REV 2, REV 3, and REV 5 with Serial Numbers < 2324xxx" on page A-34](#)
- [Table A-30, "S12 System Dynamic Range of MS46522B-082 REV 2 or REV 3 with Serial Numbers < 2324xxx" on page A-34](#)
- [Table A-31, "S21 System Dynamic Range of MS46522B-083" on page A-35](#)
- [Table A-32, "S12 System Dynamic Range of MS46522B-083" on page A-35](#)

Chapter 3 — Adjustment

3-1 Introduction

This chapter contains procedures that are used to restore and optimize the operation of the MS4652xB Vector Network Analyzer.

- [“Adjustment Menu Access” on page 3-1](#)
- [“Recommended Adjustment Procedures” on page 3-4](#)
- [“10 MHz Time Base Adjustment” on page 3-5](#)
- [“LO Leveling Adjustment \(Exclude Units with Option 82/83\)” on page 3-6](#)
- [“LO Leveling Adjustment \(For MS46522B with Option 82\)” on page 3-8](#)
- [“LO Leveling Adjustment \(For MS46522B with Option 83\)” on page 3-10](#)
- [“ALC Adjustment \(Exclude Units with Option 82/83\)” on page 3-15](#)
- [“ALC Adjustment \(For MS46522B with Option 82/83\)” on page 3-19](#)
- [“MS46522B Factory RF Calibration \(Excluding Units with Option 82/83\)” on page 3-23](#)
- [“MS46524B Factory RF Calibration” on page 3-26](#)
- [“Thru Line Length Determination” on page 3-29](#)

3-2 Adjustment Menu Access

The hardware adjustment functions are accessed by selecting the **Diagnostics** button under the **SYSTEM** menu. The **DIAGNOSTICS** menu is password-protected to prevent a casual VNA user from changing the correction coefficients inadvertently.

Procedure

To access the **DIAGNOSTICS** menu, do the following:

1. Plug in the PC keyboard, PC Mouse and PC Monitor to the rear panel of the VNA.
2. Power on the VNA and wait until the ShockLine application is running.
3. 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 below in [Figure 3-1](#).

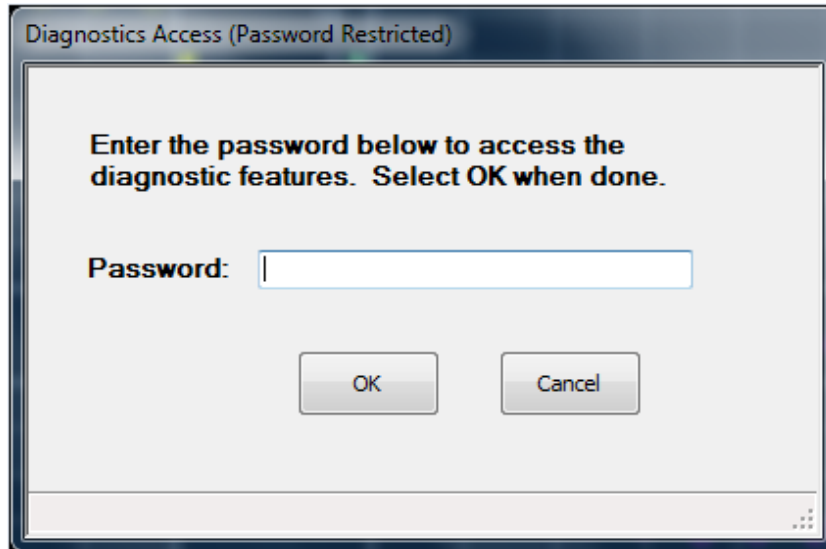


Figure 3-1. DIAGNOSTICS ACCESS Dialog Box

6. Enter the password ModVna in the Password field and click OK.
7. The DIAGNOSTICS menu appears as shown below in [Figure 3-2](#).

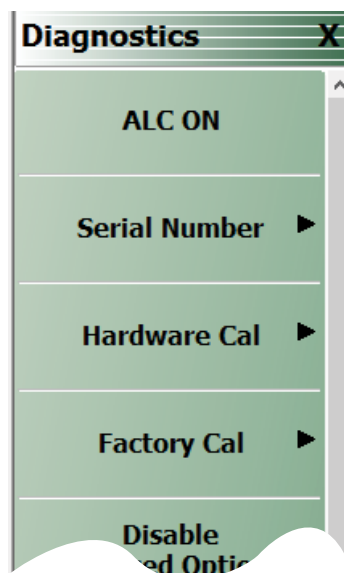


Figure 3-2. DIAGNOSTICS Menu

8. Select Hardware Cal button to access the HARDWARE CAL menu as shown in [Figure 3-3](#).

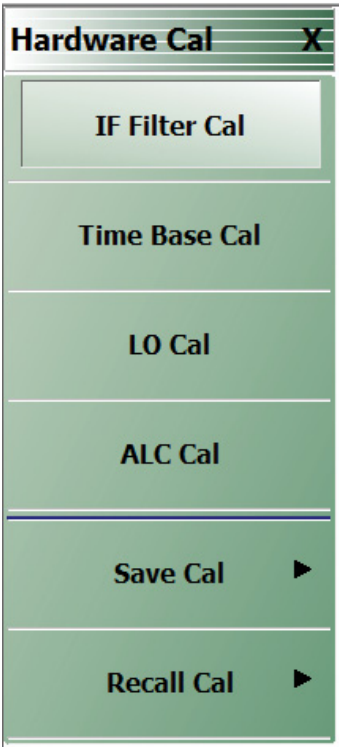


Figure 3-3. HARDWARE CAL Menu

3-3 Recommended Adjustment Procedures

Table 3-1 lists the adjustments that should be performed following the replacement of many MS4652XB sub-assemblies or RF components.

Table 3-1. Required Replacement Assembly Adjustments

Sub-assembly or RF Component Replaced	Perform the Following Adjustment(s)	Procedure Sections
CPU Assembly	Not Required	
Solid State Drive (SSD)	LO Leveling Adjustment - For MS46522B with Option 82 only - Only if the original cal data files cannot be retrieved from the original SSD	Section 3-6
	ALC Adjustment - For MS46522B with Option 82 only - Only if the original cal data files cannot be retrieved from the original SSD	Section 3-9
Back Plane PCB Assembly	10 MHz Time Base Adjustment, if Optimization is desired.	Section 3-4
Front Panel PCB Assemblies	Not Required	
Test Port Adapter		Section 3-8
	Factory RF Calibration	Section 3-10 or Section 3-11
Coaxial Cable between Test Port Adapter and VNA Module Assembly	ALC Adjustment, if output power level optimization is desired.	Section 3-8
	Factory RF Calibration	Section 3-10 or Section 3-11
VNA Module Assembly (non Option 82)		Section 3-8
	Factory RF Calibration	Section 3-10 or Section 3-11
VNA Module Assembly (Option 82)	LO Leveling Adjustment	Section 3-6
	ALC Adjustment	Section 3-9
Millimeter-wave Module (Option 82)		Section 3-6
	ALC Adjustment	Section 3-9
Power Supply	Not Required	

3-4 10 MHz Time Base Adjustment

This section provides the procedure to restore or optimize the operation of MS4652xB related to the frequency accuracy of VNA Test Port stimulus signal.

Note	Performing 10 MHz Time Base adjustment procedure is normally not required after the Back Plane assembly has been replaced. Each replacement Back Plane is fully pre-calibrated / pre-adjusted prior to shipping from the factory.
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Equipment Required

- Symmetricom Model RubiSource T&M 10 MHz Reference Standard or equivalent
- Anritsu Model MF2412C Frequency Counter or equivalent
- Anritsu Model 15NNF50C-1.0 RF Coaxial Cable (For MS4652XB with Option 10)
- Anritsu Model 3670K50-2 RF Coaxial Cable (For MS4652XB with Option 20 or 40)
- Anritsu part number 2000-1627-R BNC(m) to BNC(m) 50 Ohm Coaxial Cable

Procedure

1. Power on the 10 MHz Reference Standard.
2. Power on the VNA and Frequency Counter. Allow both instruments to warm up for at least 45 minutes.
3. Connect the BNC(m) to BNC(m) Coaxial cable between the 10 MHz Reference Standard output and the Reference 10 MHz Input connector on the rear panel of Frequency Counter.
4. Connect the RF Coaxial Cable between the VNA Port 1 and Frequency Counter Input.
5. Access the HARDWARE CAL Menu. Refer to [“Adjustment Menu Access” on page 3-1](#).
6. Select the Time Base Cal button and then following the instruction on the TIME BASE CALIBRATION dialog box to adjust the DAC Number until the frequency displayed on the frequency counter is within the required range.
7. Press the Close button when the calibration is complete.

3-5 LO Leveling Adjustment (Exclude Units with Option 82/83)

This section provides the procedure to optimize the LO drive for the operation of MS4652xB VNA receivers.

Note

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

Equipment Required

- Anritsu Model ML2438A Power Meter
- Anritsu Model MA2474D Power Sensor
- Anritsu Model 34NKF50 N(m) to K(f) Adapter
- Anritsu Model 41KC-10 10 dB Fixed Attenuator
- Anritsu Model 33KFKF50B K(f) to K(f) Adapter
- National Instruments Model GPIB-USB-HS USB to GPIB Adapter

Procedure

1. Place the instrument upside down on a work bench. Remove the eight (8) screws that secure the front panel bezel and then remove the bezel from the chassis.
2. Place the instrument in its normal stand up position. Remove the three (3) screws that secure the front panel to the chassis.
3. Carefully slide the front panel off the chassis but do not disconnect any cables between the front panel and the instrument.
4. Disconnect the flexible coaxial cable from J12 of the VNA Module Assembly.
5. Power on the MS4652XB.
6. Connect National Instrument USB to GPIB adapter between the USB port of the MS4652XB and the GPIB port of the power meter.
7. Install the power sensor to the power meter, power on the power meter.
8. Allow both the MS4652XB and power meter to warm up for 45 minutes.
9. Install the 34NKF50 Adapter to the Calibrator port of the Power Meter.
10. Zero and calibrate the Power Sensor.
11. Install the 10 dB Fixed Attenuator to the input of the power sensor.
12. Install the 33KFKF50B adapter to the open end of the 10 dB Fixed Attenuator.
13. On the power meter, select **Sensor** soft key, **More** soft key and then **Offset** soft key.
14. Press **Type** soft key until **Offset TYPE** is **Fixed** as shown on the display.
15. Select **Value** soft key.
16. Use the numeric keypad to enter 10.
17. Select **Enter** soft key to accept the value.
18. Press the **Sensor** key.
19. Insert the USB end of the USB to GPIB Adapter to an open USB port on the rear panel of the MS4652XB and wait for the Operating System software of the VNA to load the required driver for operation.
20. When the ready message appears on the VNA, connect the GPIB end of the USB to GPIB Adapter to the GPIB port of the power meter.

21. Connect the power sensor to the open end of the flexible coaxial cable that was disconnected from J12 of the VNA Module Assembly.
22. Access the Hardware Cal Menu. Refer to [“Adjustment Menu Access”](#) on page 3-1.
23. Select the LO Cal button on the Hardware Cal Menu.
24. Select Start Cal button to begin the calibration.
25. When the calibration is complete, disconnect the power sensor from the flexible coaxial cable and then re-connect the cable to J12 of the VNA Module Assembly. Torque the cable connection to 8 in·lbf.
26. Re-install the front panel and bezel.

3-6 LO Leveling Adjustment (For MS46522B with Option 82)

This section provides the procedure to optimize LO drive for the millimeter-wave modules after replacing the VNA Module Assembly, Port 1 Millimeter-wave Module and Port 2 Millimeter-wave Module, Port 1 1M cable tether, or Port 2 1M cable tethers.

Note The LO Cal is required on the port(s) where a millimeter-wave module or cable tether is replaced.

Equipment Required

- Anritsu Model ML2438A Power Meter
- Anritsu Model MA2474D Power Sensor
- Anritsu Model 34NKF50 N(m) to K(f) Adapter
- Anritsu Part Number 3-806-310 SMPM-T(f) to SMPM-T(f) RF Coaxial Cable
- Krytar Part Number 102040013K Directional Coupler
- Huber-Suhner Part Number 29429-1T2 SMPM-T(m) to 2.92mm(m) Adapter (Qty 2)
- National Instruments Model GPIB-USB-HS USB to GPIB Adapter

Procedure

1. Remove the top module panel plate from the instrument chassis. See Item 3 on [Figure 6-5 on page 6-5](#).
2. Remove the VNA Module Assembly from the instrument chassis.
3. In case of installing a replacement VNA Module Assembly, connect the RF coaxial cables and the control cables from both Millimeter-wave Module Cable Harnesses to their respective connectors on the VNA Module Assembly, except the LO cable of the Port 1 or Port 2 Millimeter-wave Modules. See [Figure 6-13 on page 6-12](#).
4. In case of installing a replacement millimeter-wave module, connect the RF coaxial cables and the control cables from the Millimeter-wave Module Cable Harnesses to their respective connectors on the VNA Module Assembly, except the LO cable.

Port 1 LO Cal

- Only needed if VNA Exchange Board was replaced or Port 1 Millimeter-wave Module and/or Port 1 Cable Tethers were replaced.
 - Jump to [Step 24](#) if only Port 2 LO Cal is needed.
5. Install one end of 3-806-310 cable to the Port 1 LO connector on the VNA Module Assembly.
 6. Install the VNA Module Assembly to the instrument chassis.
 7. Install the Huber-Suhner adapters to the RF In port and RF Out port of the Krytar Directional Coupler.
 8. Connect the open end of 3-806-310 to the RF In port of the Directional Coupler.
 9. Connect the open end of the LO cable of the Port 1 Millimeter-wave Module to the RF Out port of the Directional Coupler.
 10. Connect National Instrument USB to GPIB adapter between the USB port of the MS46522B and the GPIB port of the power meter.
 11. Power on the Power Meter and the MS46522B and allow both instruments to warm up at least 45 minutes.
 12. Install the 34NKF50 Adapter to the Calibrator port of the Power Meter.
 13. Zero and calibrate the Power Sensor.
 14. Connect the Power Sensor to the Coupling port of the Directional Coupler.
 15. Access the HARDWARE CAL MENU. Refer to [“Adjustment Menu Access” on page 3-1](#)

16. Select the Port 1 LO Cal button and the PORT1 LO CAL dialog box as shown in [Figure 3-4 on page 3-9](#) appears.

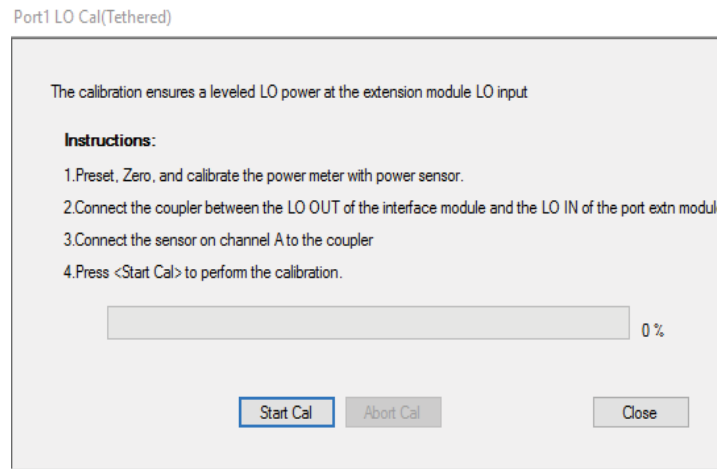


Figure 3-4. Port 1 LO Cal (Tethered) Dialog Box

17. Select the **Start Cal** button to begin the calibration (adjustment).
18. When the calibration is complete, select the **Close** button.
19. Power off the MS46522B.
20. Carefully remove the VNA Module Assembly from the instrument chassis.
21. Disconnect the 3-806-310 cable from the Port 1 LO connector of VNA Module Assembly.
22. Disconnect the LO cable from the Directional Coupler and re-connect it to the Port 1 LO connector of the VNA Module Assembly.
23. Continue to [Step 24](#) if Port 2 LO Cal is required. Install the VNA Module Assembly back to the instrument chassis.

Note

Note: If Port 2 LO Cal is not needed, go to [Section 3-9 “ALC Adjustment \(For MS46522B with Option 82/83\)” on page 3-19](#) to complete Max Power and ALC Cal adjustments on Port 1.

Port 2 LO Cal

- Only needed if VNA Exchange Board was replaced or Port 2 Millimeter-wave Module and/or Port 2 cable tethers were replaced.
24. Disconnect the LO cable of the Port 2 Millimeter-wave Module from the Port 2 LO connector of the VNA Module Assembly.
25. Connect the 3-806-310 cable from the Directional Coupler to the Port 2 LO connector of the VNA Module Assembly.
26. Connect the LO cable of the Port 2 Millimeter-wave Module to the RF Out port of the Directional Coupler.
27. Install the VNA Module Assembly to the instrument chassis.
28. Power on the MS46522B and allow it to warm up for 45 minutes.
29. Zero and calibrate the Power Sensor.
30. Connect the Power Sensor to the Coupling port of the Directional Coupler.
31. Select the Port 2 LO Cal button and then the **Start Cal** button to begin the calibration (adjustment).
32. When the calibration is complete, select the **Close** button.

33. Power off the MS46522B.
34. Carefully remove the VNA Module Assembly from the instrument chassis.
35. Disconnect the 3-806-310 cable from the Port 2 LO connector of VNA Module Assembly.
36. Disconnect the LO cable from the Directional Coupler and re-connect it to the Port 2 LO connector of the VNA Module Assembly.
37. Install the VNA Module Assembly back to the instrument chassis.

Note

If LO Cal was only performed for Port 2, then go to [Section 3-9 “ALC Adjustment \(For MS46522B with Option 82/83\)” on page 3-19](#) and complete Max Power and ALC Cal adjustments on Port 2 only. If LO Cal was performed on both ports, then complete Max Power and ALC Cal adjustments on both ports.

3-7 LO Leveling Adjustment (For MS46522B with Option 83)

This section provides the procedure to optimize LO drive for the millimeter-wave modules after replacing the VNA Module Assembly, Port 1 Millimeter-wave Module, Port 2 Millimeter-wave Module, Port 1 5 M cable tether or Port 2 5 M cable tethers.

Note

The LO Cal is required on the port(s) where a millimeter-wave module or cable tether is replaced.

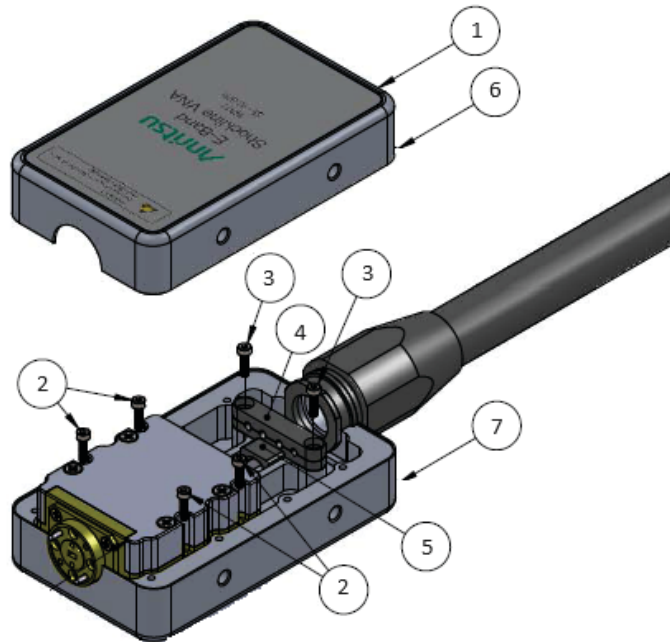
Equipment Required

- Anritsu Model ML2438A Power Meter
- Anritsu Model MA2474D Power Sensor
- Anritsu Model 34NKF50 N(m) to K(f) Adapter
- Anritsu Part Number 3-806-310 SMPM-T(f) to SMPM-T(f) RF Coaxial Cable
- Krytar Part Number 102040013K Directional Coupler
- Huber-Suhner Part Number 29429-1T2 SMPM-T(m) to 2.92mm(m) Adapter (Qty 2)
- National Instruments Model GPIB-USB-HS USB to GPIB Adapter

Preparing the Millimeter-wave Module

Note The millimeter-wave module heads are highly susceptible to ESD damage. An ESD-safe work area and proper ESK handling procedures that conform to ANSI/ESD S20.20-1999 or ANSI/ESD S20.20-2007 is mandatory to avoid ESD damage when handling.

1. Remove overlay sticker from millimeter wave module ([Figure 3-5](#)).



1. Overlay sticker
2. 6 mm Socket Head Cap Screw x 4
3. 8 mm Socket Head Cap Screw x 2
4. Cable Clamp, Top
5. Cable Clamp, Bottom
6. Tether Module Case, Top
7. Tether Module Case, Bottom

Figure 3-5. Millimeter-wave Module Head

2. Remove the eight screws attaching the Tether Module Top Case to the Bottom Case ([Figure 3-6](#)).

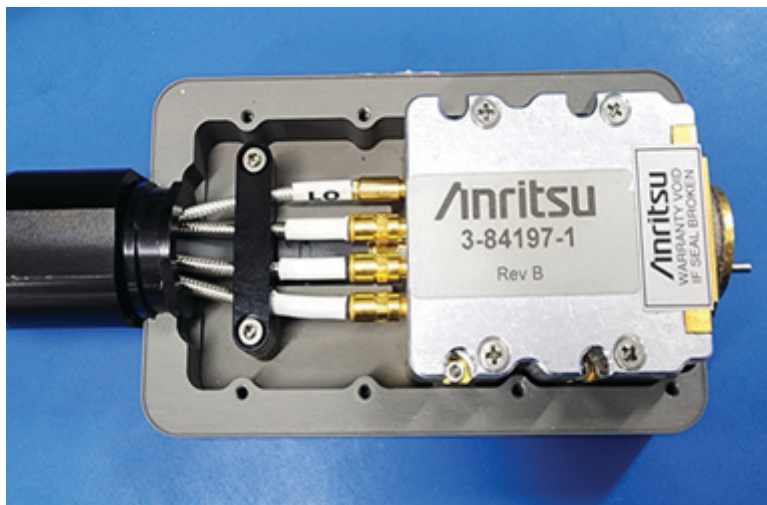


Figure 3-6. Millimeter-wave Module Head with Top Case Removed

3. Remove the two Socket Head Cap Screws attaching the Top Cable Clamp.
4. Remove the four Socket Head Cap Screws securing the module head to the Tether Module Bottom Case.
5. Millimeter-wave module is now ready for LO Cal adjustment ([Figure 3-7](#)).

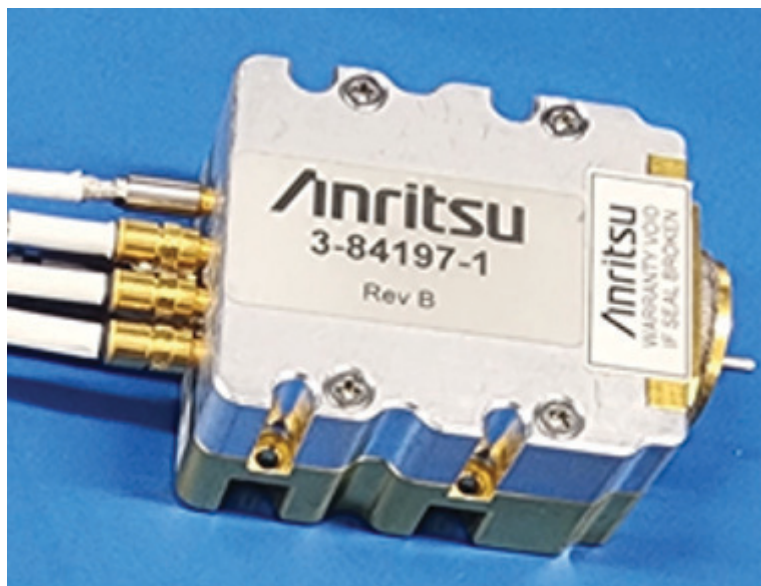


Figure 3-7. Millimeter-wave Module Head with Top and Bottom Case Removed

Procedure

Port 1 LO Cal

- Only needed if VNA Exchange Board was replaced or Port 1 Millimeter-wave Module and/or Port 1 Cable Tethers were replaced.
- Jump to [Step 22](#) if only Port 2 LO Cal is needed.

1. Remove Port 1 Millimeter-wave module head from the casing. Reference [“Preparing the Millimeter-wave Module”](#) instructions.
2. Disconnect LO cable from Port 1 Millimeter-wave Module head.
3. In case of installing a replacement Tether Harness Assembly (cables only, not the millimeter-wave module), connect the RF coaxial cables and the control cables from both Millimeter-wave Module Cable Harness to their respective connectors on the millimeter-wave module head, except the LO cable.
4. In case of installing a replacement millimeter-wave module, connect the RF coaxial cables and the control cables from the Millimeter-wave Module Cable Harness to their respective connectors on the millimeter-wave module head, except the LO cable.
5. Install one end of 3-806-310 cable to the Port 1 LO connector on the millimeter-wave module head.
6. Install the Huber-Suhner adapters to the RF IN port and RF Out port of the Krytar Directional Coupler.
7. Connect the open end of 3-806-310 to the RF OUT port of the Directional Coupler.
8. Connect the open end of the LO cable of the Port 1 Millimeter-wave Module to the RF IN port of the Directional Coupler. Refer to [Figure 3-8 on page 3-14](#).
9. Connect National Instrument USB to GPIB adapter between the USB port of the MS46522B and the GPIB port of the power meter.
10. Power on the Power Meter and the MS46522B and allow both instruments to warm up at least 45 minutes.
11. Install the 34NKF50 Adapter to the Calibrator port of the Power Meter.
12. Zero and calibrate the Power Sensor.
13. Connect the Power Sensor to the Coupling port of the Directional Coupler.
14. Access the HARDWARE CAL MENU. Refer to [“Adjustment Menu Access” on page 3-1](#).
15. Select the Port 1 LO Cal button and the PORT1 LO CAL dialog box as shown in [Figure 3-4 on page 3-9](#) appears.
16. Select the Start Cal button to begin the calibration (adjustment).
17. When the calibration is complete, select the Close button.
18. Power off the MS46522B.
19. Disconnect the 3-806-310 cable from the Port 1 LO connector on the millimeter-wave module head.
20. Disconnect the LO cable from the Directional Coupler and re-connect it to the Port 1 LO connector on the millimeter-wave module head.
21. Skip to [Step 22](#) if Port 2 LO Cal is required.

Note

Leave millimeter-wave module head out of casing until after Max Power and ALC Cals are performed. If Port 2 LO Cal is not needed, go to [Section 3-9 “ALC Adjustment \(For MS46522B with Option 82/83\)” on page 3-19](#) to complete Max Power and ALC Cal adjustments on Port 1.

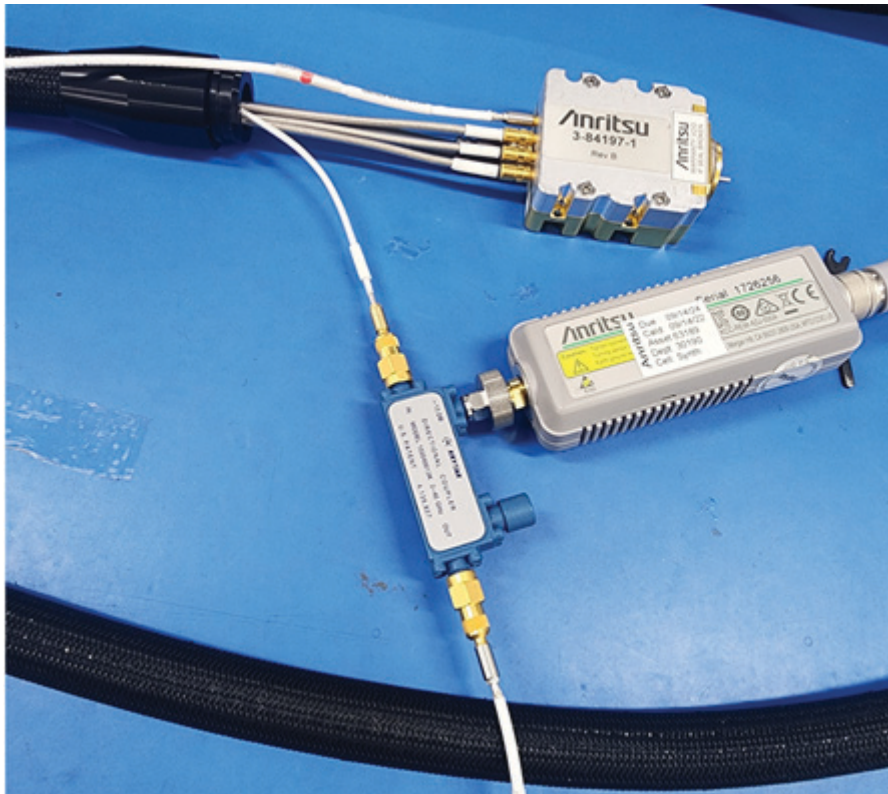


Figure 3-8. MS46522B-083 LO Cal Setup

Port 2 LO Cal

- Only needed if VNA Exchange Board was replaced or Port 2 Millimeter-wave Module and/or Port 2 cable tethers were replaced.
22. Remove Port 2 millimeter-wave module head from the casing. Reference [“Preparing the Millimeter-wave Module”](#) instructions.
 23. Disconnect LO cable from Port 2 Millimeter-wave Module Head.
 24. In case of installing a replacement Tether Harness Assembly (cables only, not the millimeter-wave module), connect the RF coaxial cables and the control cables from both Millimeter-wave Module Cable Harness to their respective connectors on the Millimeter-wave Module Head, except the LO cable.
 25. In case of installing a replacement millimeter-wave module, connect the RF coaxial cables and the control cables from the Millimeter-wave Module Cable Harness to their respective connectors on the Millimeter-wave Module Head, except the LO cable.
 26. Install one end of 3-806-310 cable to the Port 2 LO connector on the Millimeter-wave Module Head.
 27. Install the Huber-Suhner adapters to the RF IN port and RF Out port of the Krytar Directional Coupler.
 28. Connect the open end of 3-806-310 to the RF OUT port of the Directional Coupler.
 29. Connect the open end of the LO cable of the Port 2 Millimeter-wave Module to the RF IN port of the Directional Coupler. Refer to [Figure 3-8 on page 3-14](#).
 30. Connect National Instrument USB to GPIB adapter between the USB port of the MS46522B and the GPIB port of the power meter.
 31. Power on the Power Meter and the MS46522B and allow both instruments to warm up at least 45 minutes.
 32. Install the 34NKF50 Adapter to the Calibrator port of the Power Meter.
 33. Zero and calibrate the Power Sensor.

34. Connect the Power Sensor to the Coupling port of the Directional Coupler.
35. Access the HARDWARE CAL MENU. Refer to [“Adjustment Menu Access” on page 3-1](#)
36. Select the Port 2 LO Cal button and the PORT2 LO CAL dialog box as shown in [Figure 3-4 on page 3-9](#) appears.
37. Select the Start Cal button to begin the calibration (adjustment).
38. When the calibration is complete, select the Close button.
39. Power off the MS46522B.
40. Disconnect the 3-806-310 cable from the Port 2 LO connector on the Millimeter-wave Module Head.
41. Disconnect the LO cable from the Directional Coupler and re-connect it to the Port 2 LO connector on the Millimeter-wave Module Head.

Note	Leave Millimeter-wave Module Head out of casing until after Max Power and ALC Cals are performed. If LO Cal was only performed for Port 2, then go to Section 3-9 “ALC Adjustment (For MS46522B with Option 82/83)” on page 3-19 and complete Max Power and ALC Cal adjustments on Port 2 only. If LO Cal was performed on both ports, then complete Max Power and ALC Cal adjustments on both ports.
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3-8 ALC Adjustment (Exclude Units with Option 82/83)

This section provides the procedure to restore or optimize the operation of MS4652xB related to the RF leveling at the VNA Test Ports.

Note	Performing ALC 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

- Anritsu Model ML2438A Power Meter
- Anritsu Model SC7400 Power Sensor, for MS4652XB with Option 10
- Anritsu Model SC7413 Power Sensor, for MS4652XB with Option 20, 40, or 43
- Aeroflex Weinschel Model 44-10 10 dB Fixed Attenuator, for MS4652XB with Option 10
- Anritsu Model 41KC-10 10 dB Fixed Attenuator, for MS4652XB with Option 20, 40, or 43
- National Instruments Model GPIB-USB-HS USB to GPIB Adapter

Procedure

1. Install the power sensor to the power meter and then power on the power meter.
2. Power on the MS4652XB VNA.
3. Allows both instruments to warm up for at least 45 minutes.
4. Zero and calibrate the power sensor.
5. Install the 10 dB Fixed Attenuator to the input of the power sensor.
6. On the power meter, select **Sensor** soft key, **More** soft key and then **Offset** soft key.
7. Press **Type** soft key until **Offset TYPE** is **Fixed** as shown on the display.
8. Select **Value** soft key.
9. Use the numeric keypad to enter 10.

10. Select Enter soft key to accept the value.
11. Press the Sensor key.
12. Insert the USB end of the USB to GPIB Adapter to an open USB port on the rear panel of the MS4652XB and wait for the Operating System software of the VNA to load the required driver for operation.
13. When the ready message appears on the VNA, connect the GPIB end of the USB to GPIB Adapter to the GPIB port of the power meter.
14. Access the HARDWARE CAL menu. Refer to [“Adjustment Menu Access”](#) on page 3-1.
15. Select the ALC Cal button on the HARDWARE CAL menu.

Port 1 ALC Cal

16. Select the Port 1 ALC Cal button and the PORT1 ALC CAL dialog box shown in [Figure 3-9](#) appears.

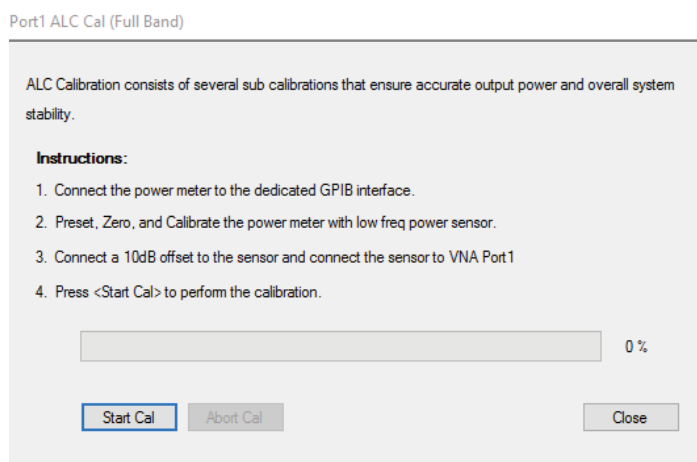


Figure 3-9. Port1 ALC Cal Dialog Box

17. Connect the power sensor with the 10 dB Fixed Attenuator attached to VNA Port 1.
18. Select the Start Cal button to begin the calibration (adjustment).
19. When calibration is complete, select the Close button.

Port 1 MS Factory Cal (ShockLine Application V2017.6.1 and later only)

20. Select the Port 1 MS Factory Cal button and then select the Start Cal button.
21. When calibration is complete, select the Close button and disconnect the power sensor from VNA Port 1.

Port 2 ALC Cal

22. Select the Port 2 ALC Cal button and the PORT2 ALC CAL dialog box shown in [Figure 3-10](#) appears.

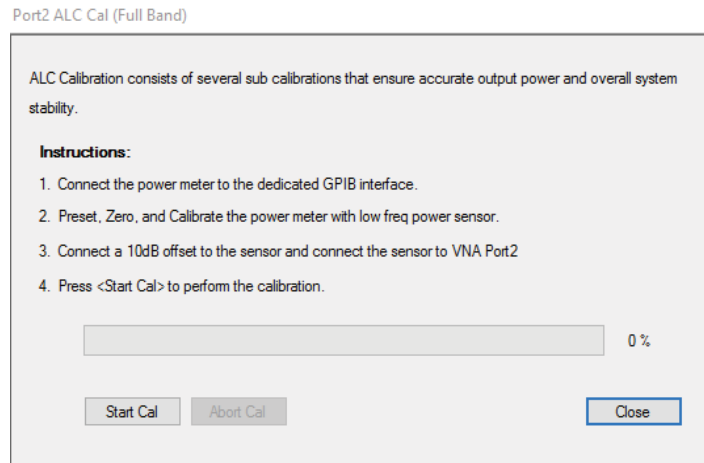


Figure 3-10. Port 2 ALC Cal Dialog Box

23. Connect the power sensor with the 10 dB Fixed Attenuator attached to VNA Port 2.

24. Select the Start Cal button to begin the calibration.

25. When calibration is complete, select the Close button.

Port 2 MS Factory Cal (ShockLine Application V2017.6.1 and later only)

26. Select the Port 2 MS Factory Cal button and then select the Start Cal button.

27. When calibration is complete, select the Close button and disconnect the power sensor from VNA Port 2.

Port 3 ALC Cal (For MS46524B Only)

28. Select the Port 3 ALC Cal button and the Port3 ALC Cal dialog box shown in [Figure 3-11](#) appears.

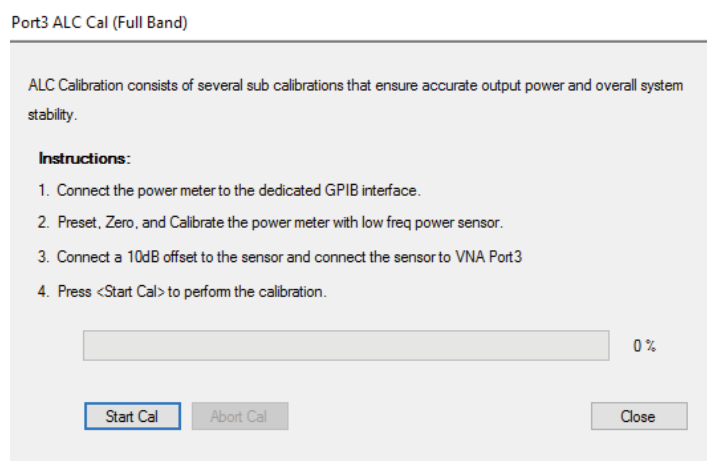


Figure 3-11. Port3 ALC Cal Dialog Box

29. Connect the power sensor with the 10 dB Fixed Attenuator attached to VNA Port 3.

30. Select the Start Cal button to begin the calibration (adjustment).

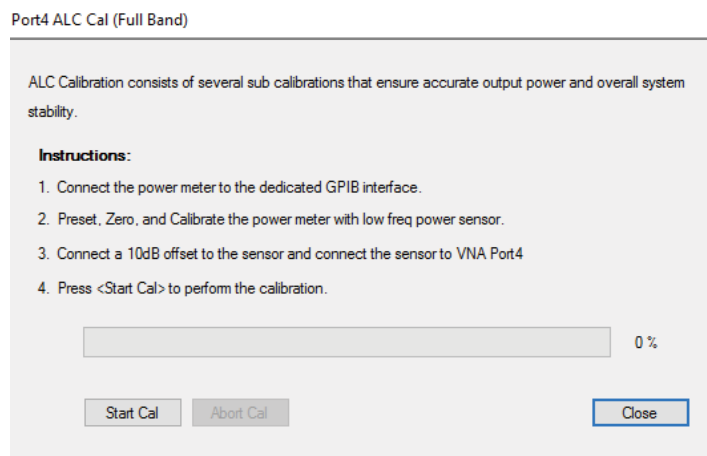
31. When calibration is complete, select the Close button.

Port 3 MS Factory Cal (ShockLine Application V2017.6.1 and later only)

32. Select the Port 3 MS Factory Cal button and then select the Start Cal button.
33. When calibration is complete, select the Close button and disconnect the power sensor from VNA Port 3.

Port 4 ALC Cal (For MS46524B Only)

34. Select the Port 4 ALC Cal button and the PORT4 ALC CAL dialog box shown in [Figure 3-12](#) appears.

**Figure 3-12.** Port 4 ALC Cal Dialog Box

35. Connect the power sensor with the 10 dB Fixed Attenuator attached to VNA Port 4.
36. Select the Start Cal button to begin the calibration.
37. When the calibration is complete, select the Close button.

Port 4 MS Factory Cal (ShockLine Application V2017.6.1 and later only)

38. Select the Port 4 MS Factory Cal button and then select the Start Cal button.
39. When calibration is complete, select the Close button and disconnect the power sensor from VNA Port 4.

3-9 ALC Adjustment (For MS46522B with Option 82/83)

This section provides the procedure to restore or optimize the operation of MS46522B with Option 82 related to the RF leveling at the millimeter-wave modules.

Equipment Required

- Agilent Model 437B with analog level display or Keysight N1913A with Opt 200 Power Meter
- Keysight Model V8486A WR15 Power Sensor
- Keysight Model W8486A WR10 Power Sensor
- Spacek Labs Model LPF-75-11 WR12 Low Pass Filter
- Aerowave Model 08-1212Au WR8 Waveguide Section
- National Instruments Model GPIB-USB-HS USB to GPIB Adapter

Procedure

1. Install the Spacek Lab Low Pass Filter to the V8486A Power Sensor.
2. Install the Aerowave WR8 Waveguide Section to the W8486A Power Sensor.
3. Install the V8486A power sensor to the power meter and then power on the power meter.
4. On the Agilent Model 437B Power Meter, enter the calibration factors of the V8486A into Sensor table as follows:
 - a. Press the **SPECIAL** key (**SHIFT + PRESET/LOCAL**).
 - b. Press the up or down arrow key repeatedly until the display reads 1 SENSR DATA.
 - c. Press the **ENTER** key. The power meter will display SENSOR 0, with the 0 blinking.
 - d. Use the up or down arrow key to select the sensor table to be modified. Press the **ENTER** key to select.
 - e. Modify the Sensor ID label and press the **ENTER** key to accept.
 - f. Use the up arrow key to change the N to Y. Press the **ENTER** key to accept.
 - g. Press the **ENTER** key again to display the frequency/calibration factor data. Use the arrow keys to modify the display data to enter the calibration factor of the power sensor to the power meter.
 - h. Press the **ENTER** key to accept the data entries.
 - i. When all calibration factors are entered, enter 0.000 GHz and the press the **ENTER** key to exit.
5. Repeat [Step 4](#) for the W8486A power sensor.

Note

It is not necessary to replace the V8486A power sensor with W8486A when entering the calibration factors. For Keysight N1913A power meter, refer to the *Keysight N1913A/N1914A User's Guide* for Editing/Generating Sensor Calibration Table and how to use the sensor calibration table.

6. Power on the MS46522B VNA.
7. Allows both instruments to warm up for at least 45 minutes.
8. Insert the USB end of the USB to GPIB Adapter to an open USB port on the rear panel of the MS46522B and wait for the Operating System software of the VNA to load the required driver for operation.
9. When the ready message appears on the VNA, connect the GPIB end of the USB to GPIB Adapter to the GPIB port of the power meter.
10. On the power meter, select the V8486A sensor table as follows:
 - a. Press the **SENSOR** key.
 - b. Use the up or down arrow key to select the sensor table for the V8486A.

c. Press the **ENTER** key to accept.

11. Zero and calibrate the V8486A power sensor.
12. Access the HARDWARE CAL menu. Refer to [“Adjustment Menu Access”](#) on page 3-1.
13. Select the ALC Cal button on the HARDWARE CAL Menu.

Port 1 Max Power Cal (ShockLine Application V2017.9.1 and later only)

14. Replace the W8486A power sensor with V8486A on the power meter.
15. On the power meter, select the sensor table for V8486A.
16. Zero and calibrate the power sensor.
17. Select the Port 1 Max Power Cal button and then select the Start Cal button.
18. When the dialog prompts for changing the power sensor, disconnect the V8486A along with the Low Pass Filter from the test port of the Port 1 Millimeter-wave Module.
19. Replace the V8486A power sensor with the W8486A power sensor on the power meter.
20. On the power meter, select the sensor table for W8486A.
21. Zero and calibration the power sensor.
22. Install the W8486A power sensor with the WR8 Waveguide section to the test port of the Port 1 Millimeter-wave Module.
23. Select the Start Cal button to continue the calibration.
24. When calibration is complete, select the Close button.
25. Disconnect the W8486A power sensor with the WR8 Waveguide section from the millimeter-wave module.

Port 1 ALC Calibration

26. Install the V8486A power sensor with the Low Pass Filter to the test port of the Port 1 Millimeter-wave Module.
27. Select the Port 1 ALC Cal button and the PORT1 ALC CAL dialog box as shown below in [Figure 3-13](#) appears.

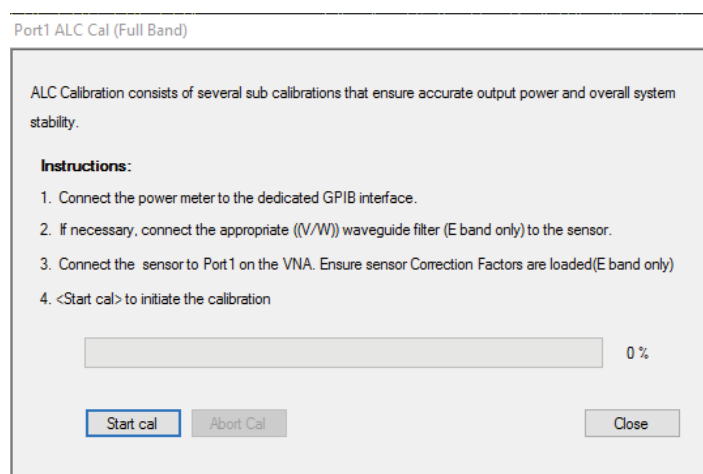


Figure 3-13. Port1 ALC Cal Dialog Box

28. Select the Start Cal button to begin the calibration.

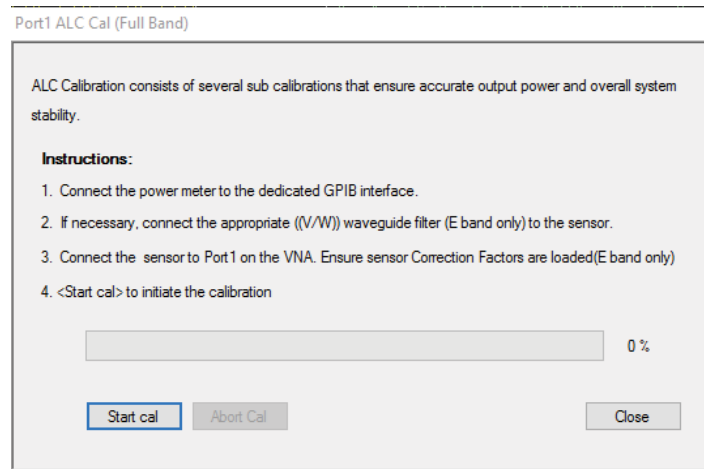
29. When the dialog prompts for changing the power sensor, disconnect the V8486A along with the Low Pass Filter from the test port of the Port 1 Millimeter-wave Module.
30. Replace the V8486A power sensor with the W8486A power sensor on the power meter.
31. On the power meter, select the sensor table for W8486A.
32. Zero and calibration the power sensor.
33. Install the W8486A power sensor with the WR8 Waveguide section to the test port of the Port 1 Millimeter-wave Module.
34. Select the **Start Cal** button to continue the calibration.
35. When calibration is complete, select the **Close** button.
36. Disconnect the W8486A power sensor with the WR8 Waveguide section from the millimeter-wave module.

Port 2 Max Power Cal (ShockLine Application V2017.9.1 and later only)

37. Replace the W8486A power sensor with V8486A on the power meter.
38. On the power meter, select the sensor table for V8486A.
39. Zero and calibrate the power sensor.
40. Select the **Port 2 Max Power Cal** button and then select the **Start Cal** button.
41. When the dialog prompts for changing the power sensor, disconnect the V8486A along with the Low Pass Filter from the test port of the Port 2 Millimeter-wave Module.
42. Replace the V8486A power sensor with the W8486A power sensor on the power meter.
43. On the power meter, select the sensor table for W8486A.
44. Zero and calibration the power sensor.
45. Install the W8486A power sensor with the WR8 Waveguide section to the test port of the Port 2 Millimeter-wave Module.
46. Select the **Start Cal** button to continue the calibration.
47. When the calibration is complete, select the **Close** button.
48. Disconnect the W8486A power sensor with the WR8 Waveguide section from the millimeter-wave module.

Port 2 ALC Calibration

49. Replace the W8486A power sensor with V8486A on the power meter, if required.
50. Install the V8486A power sensor with the Low Pass Filter to the test port of the Port 2 Millimeter-wave Module.
51. Select the Port 2 ALC Cal button and the PORT2 ALC CAL dialog box as shown below in [Figure 3-13](#) appears.

**Figure 3-14.** Port2 ALC Cal Dialog Box

52. Select the Start Cal button to begin the calibration.
53. When the dialog prompts for changing the power sensor, disconnect the V8486A along with the Low Pass Filter from the test port of the Port 2 Millimeter-wave Module.
54. Replace the V8486A power sensor with the W8486A power sensor on the power meter.
55. On the power meter, select the sensor table for W8486A.
56. Zero and calibration the power sensor.
57. Install the W8486A power sensor with the WR8 Waveguide section to the test port of the Port 2 Millimeter-wave Module.
58. Select the Start Cal button to continue the calibration.
59. When the calibration is complete, select the Close button.
60. Disconnect the W8486A power sensor with the WR8 Waveguide section from the millimeter-wave module.

3-10 MS46522B Factory RF Calibration (Excluding Units with Option 82/83)

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 an User Measurement Calibration.

This section provides the procedure to perform Factory RF Calibration on MS46522B, excluding instruments with Option 82.

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. For Instruments with N(f) test ports:
 - a. Install 34NK50 adapter to the K(f) end of the 3670K50-2 cable.
 - b. Install 34NKF50 adapter to the K(m) end of the 3670K50-2 cable.
 - c. Use torque wrench to tighten the connections between the cable and adapters.
3. For Instruments with K(m) test ports:
 - a. Install 33KFKF50B adapter to the K(F) end of the 3670K50-2 cable.
 - b. Use torque wrench to tighten the connections between the cable and adapter.
4. If the total length of the thru line cable plus adapter(s) is not known, perform the Length Determination Procedure in Section [“Thru Line Length Determination”](#) on page 3-29.
5. Preset the VNA and then select the **System** button on the right-side menu.
6. Select the **Diagnostics** button.
7. The **DIAGNOSTICS ACCESS** dialog box appears providing an entry field to enter the diagnostics access password as shown in [Figure 3-1](#).
8. Enter the password **ModVna** in the Password field and click **OK** button.

9. Select Factory Cal button to display the FACTORY CAL menu (Figure 3-15).

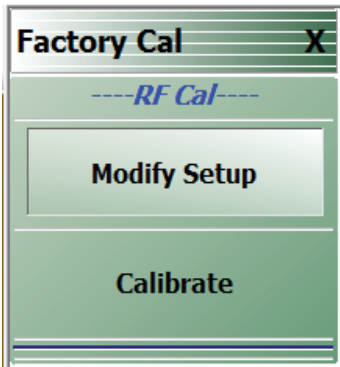


Figure 3-15. FACTORY CAL Menu

10. Select the Modify Setup button to display the FACTORY RF CAL SETUP dialog box.

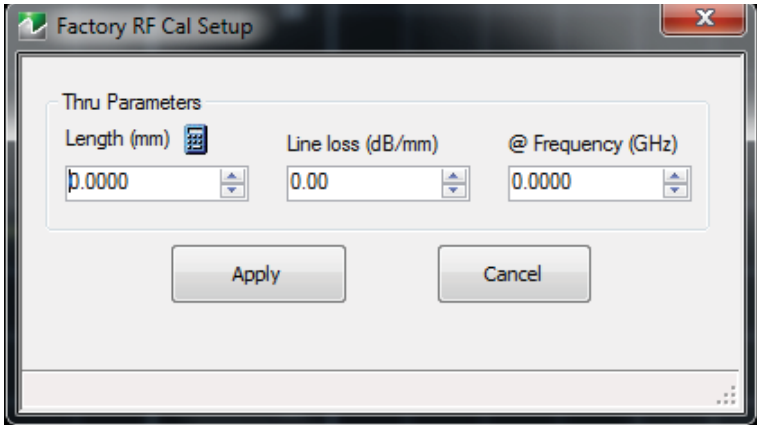


Figure 3-16. FACTORY RF CAL SETUP Dialog

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

Table 3-2. 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

12. Select the Calibrate button to display the FACTORY RF CAL dialog box ([Figure 3-17](#)).

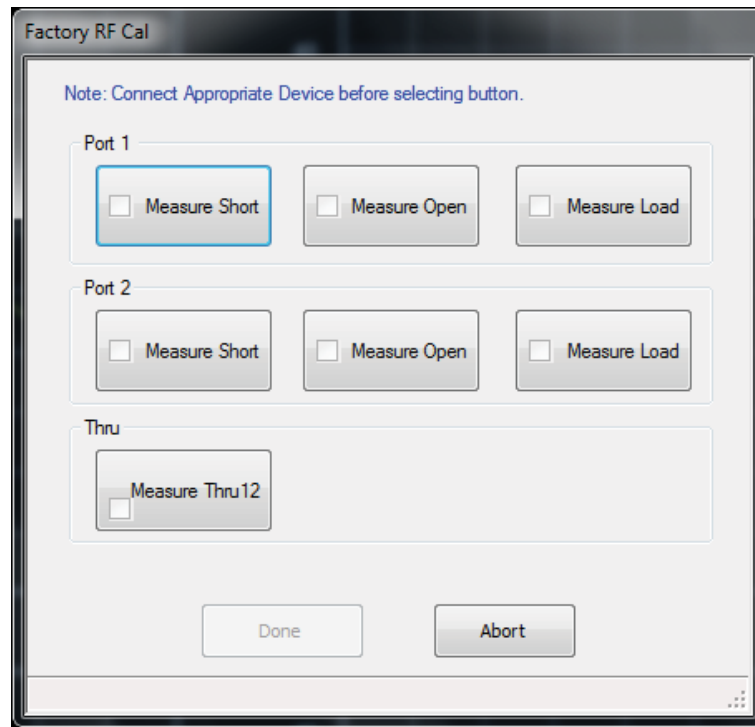


Figure 3-17. MS46522B Factory RF Cal Dialog

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

3-11 MS46524B Factory RF Calibration

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 an User Measurement Calibration.

This section provides the procedure to perform Factory RF Calibration on MS46524B.

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. For Instruments with N(f) test ports:
 - a. Install 34NK50 adapter to the K(f) end of the 3670K50-2 cable.
 - b. Install 34NKF50 adapter to the K(m) end of the 3670K50-2 cable.
 - c. Use torque wrench to tighten the connections between the cable and adapters.
3. For Instruments with K(m) test ports:
 - a. Install 33KFKF50B adapter to the K(F) end of the 3670K50-2 cable.
 - b. Use torque wrench to tighten the connections between the cable and adapter.
4. If the total length of the thru line cable plug adapter(s) is not known, perform the Length Determination Procedure in Section [“Thru Line Length Determination” on page 3-29](#).
5. Preset the VNA and then select the **System** button on the right-side menu.
6. Select the **Diagnostics** button.
7. The **Diagnostics Access** dialog box appears providing an entry field to enter the diagnostics access password as shown in [Figure 3-1](#).
8. Enter the password **ModVna** in the Password field and click **OK** button.

9. Select Factory Cal button to display the FACTORY CAL menu (Figure 3-18).



Figure 3-18. MS46524B Factory Cal Menu

10. Select the Modify Setup button to display the FACTORY RF CAL SETUP dialog box.

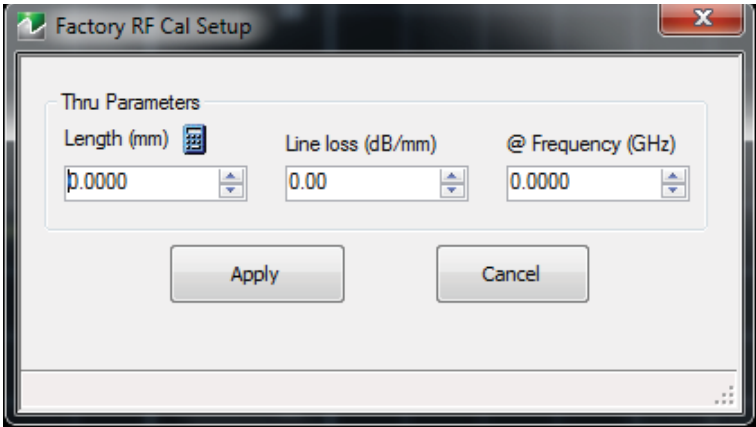


Figure 3-19. Factory RF Cal Setup Dialog

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

Table 3-3. 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

12. Select the Calibrate button to display the FACTORY RF CAL dialog box (Figure 3-20).

Note: Connect Appropriate Device before selecting button.

Port 1

☐ Measure Short ☐ Measure Open ☐ Measure Load

Port 2

☐ Measure Short ☐ Measure Open ☐ Measure Load

Port 3

☐ Measure Short ☐ Measure Open ☐ Measure Load

Port 4

☐ Measure Short ☐ Measure Open ☐ Measure Load

Thru

☐ Measure Thru12 ☐ Measure Thru13 ☐ Measure Thru14

☐ Measure Thru23 ☐ Measure Thru24 ☐ Measure Thru34

Done Abort

Figure 3-20. MS46524B FACTORY RF CAL Dialog

13. Connect each calibration standard from the calibration kit in sequence to the appropriate port. Click the appropriate button when ready.
14. When all seven (18) calibration standards have been measured, click the Done button to complete the procedure.

3-12 Thru Line Length Determination

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 OSLN50A-18 Connector Calibration Tee
- For Instruments with K(m) test ports:
 - Anritsu Model TOSLK50A-40 K Connector Calibration Tee

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. Select the **Calibrate** button and then the **Manual Cal** button.
6. Select the **1-Port Cal** button and then **Edit Cal Params** button.
7. 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)**
8. Click the **OK** button when done, then click on the **Back** icon to return to the previous men.
9. Select the **Port 1 Reflective Devices** button.
10. 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.
11. Disconnect the **Open**, connect the **Short** calibration standard to **VNA Port 1**, and then select the **Short** button to start the measurement.
12. Disconnect the **Short**, connect the **Load** calibration standard to **VNA Port 1**, and then select the **Load** button to start the measurement.
13. Disconnect the **Load** from **VNA Port 1** and click the **Done** button.
14. Connect a short to one end of the Thru Cable (DUT).
15. Connect the open end of the Thru Cable to **VNA Port 1**.
16. Select the **Measurement** button, then click the **Reference Plane** button, and then click the **Auto** button.
17. 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 – 17.83 mm
 - b. For K connector thru cable – 5.01 mm
18. Enter 0 to the **Distance** button to reset the value.

Chapter 4 — Troubleshooting

4-1 Introduction

This chapter provides information about troubleshooting tests that can be used to check the MS4652xB 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 MS4652xB 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.

4-2 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 MS4652XB 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.

4-3 Troubleshooting Test – Power Supply DC Check

This procedure verifies that the expected DC voltages are present on the Back Plane PCB Assembly of the MS4652XB VNA.

Equipment Required

- Digital Multimeter

Reference Figures

- [Figure 4-1](#) shows the locations of various connectors on the front side of the Back Plane PCB assembly for Revision 1 and Revision 2 instruments.
- [Figure 4-2](#) shows the locations of various connectors on the back side of the Back Plane PCB Assembly for Revision 1 and Revision 2 instruments.

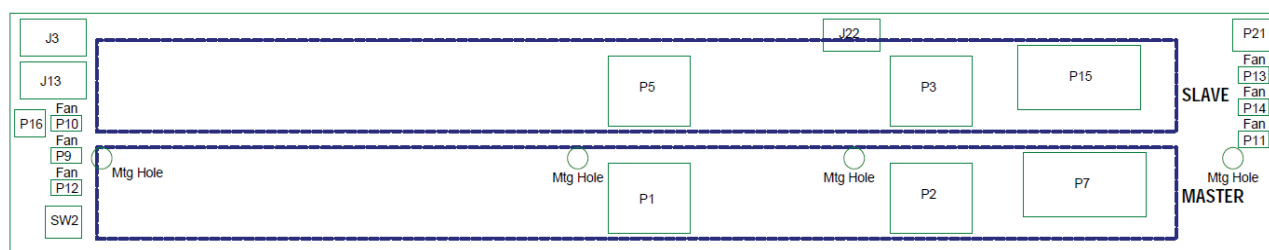


Figure 4-1. Locations of various connectors on the front side of the Back Plane PCB Assembly Revisions 1 and 2

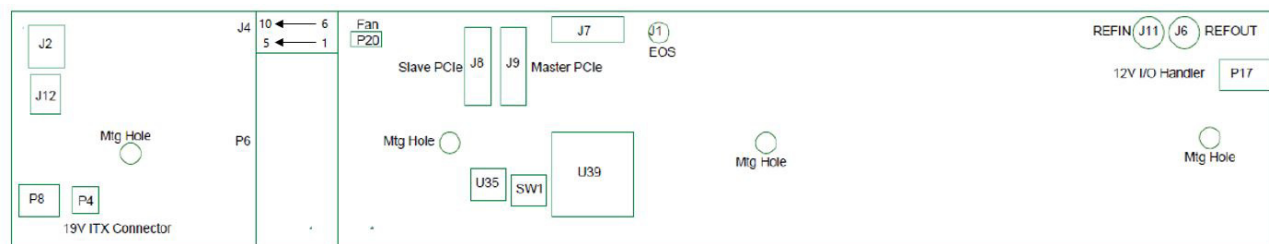


Figure 4-2. Locations of various connectors on the back side of the Back Plane PCB Assembly Revisions 1 and 2

- [Figure 4-3](#) shows the locations of various connectors on the front side of the Back Plane PCB assembly for Revision 3 and higher instruments.
- [Figure 4-4](#) shows the locations of various connectors on the back side of the Back Plane PCB Assembly for Revision 3 and higher instruments.

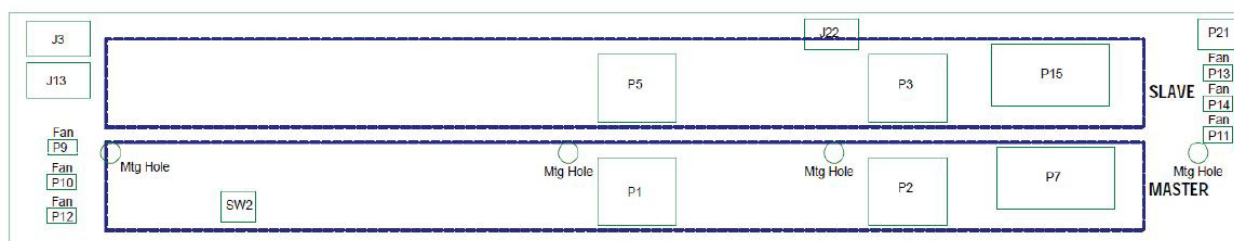


Figure 4-3. Locations of various connectors on the front side of the Back Plane PCB Assembly Revision 3+

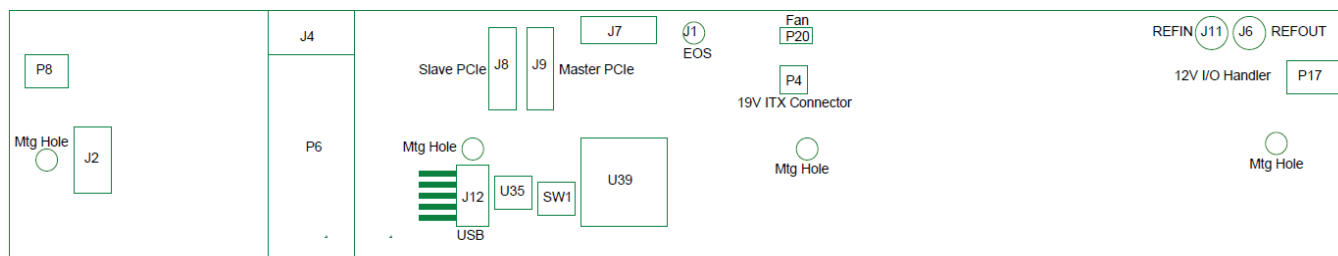


Figure 4-4. Locations of various connectors on the back side of the Back Plane PCB Assembly Revision 3+

Procedure

1. Power off the MS4652XB and unplug the AC power cord, mouse, keyboard and external monitor.
2. Remove the chassis cover. Refer to [Section 5-8](#).
3. Re-connect the AC power cord, mouse, keyboard and external monitor.
4. Power on the MS4652XB.
5. Use the digital multimeter to measure the DC voltage between J4 Pin 2 and J4 Pin 10.

Note Place the probes on the solder side of the J4 connector of the Back Plane PCB Assembly.

6. Verify if the voltage is at the expected value as stated in [Table 4-1 on page 4-4](#).
7. If the -48 V is not present, replace the power supply.
8. Power off the MS4652XB.
9. Unplug the 19V PC Bias cable from P4.
10. Unplug the USB Hub Bias cable from P21.
11. Power on the MS4652XB.
12. Use the digital multimeter to measure the DC voltage between P4 Pin 2 and P4 Pin 1.

Caution Avoid any contact of the meter probe to the instrument chassis during measurements. Doing so could damage the Back Plane PCB Assembly due to the presence of high DC voltage at the connector.

13. Verify if the voltage is at the expected value as stated in [Table 4-1](#).
14. Measure the DC voltage between P21 Pin 2 and P21 Pin 1.

Caution Avoid any contact of the meter probe to the instrument chassis during measurements. Doing so could damage the Back Plane PCB Assembly due to the presence of high DC voltage at the connector.

15. Verify if the voltage is at the expected value as stated in [Table 4-1](#).
16. If the voltage presented at P4 and P21 are not correct, replace the Back Plane PCB Assembly.
17. If all measured voltages are at the expected value, power off the MS4652XB and then reconnect the bias cables.

Table 4-1. Expected DC Bias Voltages

Test Point	Common	Expected Voltage
Back Plane PCB Assy J4 Pin 2	Back Plane PCB Assy J4 Pin 10	– 48 V
Back Plane PCB Assy P4 J1	Back Plane PCB Assy P4 J2	+19 V
Back Plane PCB Assy P21 pin 2	Back Plane PCB Assy P21 pin 1	– 48 V

4-4 Troubleshooting Test – MS46522B Non-Ratio Power Level Check

The Non-Ratio Power Level Check verifies if the VNA Module Assembly is faulty in the MS46522B. In case of MS46522B with Option 82, it helps verify if the VNA Module Assembly and Millimeter-wave Modules are 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(m) Adapter
- For instruments with K(m) test ports:
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 33KFKF50B K(f) to K(f) Adapter

Procedure

1. For Instruments with N(f) test ports:
 - a. Install 34NK50 adapter to the K(f) end of the 3670K50-2 cable.
 - b. Install 34NKF50 adapter to the K(m) end of the 3670K50-2 cable.
 - c. Use torque wrench to tighten the connections between the cable and adapters.
2. For Instruments with K(m) test ports:
 - a. Install 33KFKF50B adapter to the K(F) end of the 3670K50-2 cable.
 - b. Use torque wrench to tighten the connections between the cable and adapter.
3. Power on the MS46522B and preset the instrument.
4. Connect the Thru Cable between test port 1 and test port 2. For MS46522B with Option 82, install WR12 straight sections to both Millimeter-wave modules and then connect the modules together.
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 the mouse to move the Reference Line to one graticule below top scale.
9. Repeat [Step 5](#) through [Step 8](#) for Trace 2, setting Numerator to B2, Denominator to 1, and Driver Port to Port 1.
10. Repeat [Step 5](#) through [Step 8](#) for Trace 3, setting Numerator to B1, Denominator to 1, and Driver Port to Port 2.
11. Repeat [Step 5](#) through [Step 8](#) 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 (for example, very low power level).

4-5 Troubleshooting Test – MS46524B Non-Ratio Power Level Check

The Non-Ratio Power Level Check verifies if the VNA Module Assembly is faulty in the MS46524B.

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(m) Adapter
- For instruments with K(m) test ports:
 - Anritsu Model 3670K50-2 Thru Cable
 - Anritsu Model 33KFKF50B K(f) to K(f) Adapter

Procedure

1. For Instruments with N(f) test ports:
 - a. Install 34NK50 adapter to the K(f) end of the 3670K50-2 cable.
 - b. Install 34NKF50 adapter to the K(m) end of the 3670K50-2 cable.
 - c. Use torque wrench to tighten the connections between the cable and adapters.
2. For Instruments with K(m) test ports:
 - a. Install 33KFKF50B adapter to the K(F) end of the 3670K50-2 cable.
 - b. Use torque wrench to tighten the connections between the cable and adapter.
3. Power on the MS46524B and preset the instrument.
4. Connect the Thru 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 the mouse to move the Reference Line to one graticule below top scale.
9. Repeat [Step 5](#) through [Step 8](#) for Trace 2, setting Numerator to B2, Denominator to 1, and Driver Port to Port 1.
10. Repeat [Step 5](#) through [Step 8](#) for Trace 3, setting Numerator to B1, Denominator to 1, and Driver Port to Port 2.
11. Repeat [Step 5](#) through [Step 8](#) 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 (for example, very low power level).
13. Disconnect the Thru Cable from test port 1 and test port 2. Then, connect the Thru Cable between test port 3 and test port 4.
14. Select Trace 1.
15. Select Response | User-defined. The USER-DEFINED menu appears.
16. Set Numerator to A3, Denominator to 1, and Driver Port to Port 3.
17. Repeat [Step 14](#) through [Step 15](#) for Trace 2, setting Numerator to B4, Denominator to 1, and Driver Port to Port 3.
18. Repeat [Step 14](#) through [Step 15](#) for Trace 3, setting Numerator to B3, Denominator to 1, and Driver Port to Port 4.

19. Repeat [Step 14](#) through [Step 15](#) for Trace 4, setting Numerator to A4, Denominator to 1, and Driver Port to Port 4.
20. Observe whether any portions of these traces show any abnormality (for example, [Figure 4-5](#) shows a power drop from the A4/1[P4] plot at about 11 GHz).

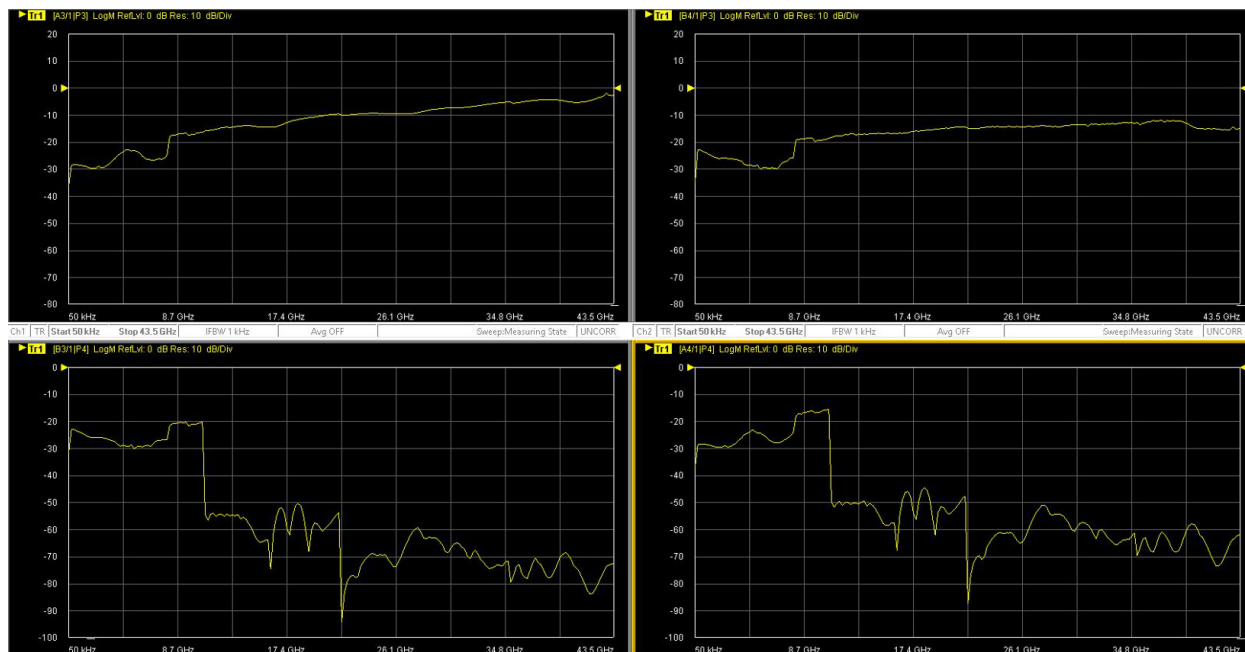


Figure 4-5. Abnormal Non-Ratio Power Level Trace

4-6 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 4-2.
 - a. If -48V is not present, replace the Power Supply.
 - b. If +19V is not present, replace the Back Plane PCB Assembly.
2. If all voltages are present and the CPU Fan is not running, then replace the CPU Assembly.

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. ShockLine Application Software update may not have completed. Re-install software.
2. If problem still exists, check if Windows UAC setting is set to high. If yes, reduce the security level to the lowest setting.

4-7 Troubleshooting Operating Problems

Frequency Related Problems

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

1. Perform [“10 MHz Time Base Adjustment” on page 3-5](#). If it does not help, go to [Step 2](#).
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 Back Plane PCB Assembly.
4. If the problem still exists, replace the VNA Module Assembly.

RF Power Related Problems

If the instrument exhibits RF Power Related Problems, do the following:

1. Perform [“Troubleshooting Test – MS46522B Non-Ratio Power Level Check” on page 4-5](#) or [“Troubleshooting Test – MS46524B Non-Ratio Power Level Check” on page 4-6](#).
2. If the power level shows any abnormality, do the following:
 - a. Verify that the flexible coaxial cable connection between test port adapter and VNA Module Assembly. Re-torque if necessary. For MS46522B with Option 82, separate the Millimeter-wave Modules and then re-connect.
 - b. Verify that the test port adapter is worn or damaged. Replace the test port adapter if necessary.
 - c. Replace VNA Module Assembly. For MS46522B with Option 82, replace the Millimeter-wave module if the low IF power is only shown on one port or replace the VNA PCB Assembly if the low IF power are shown on both ports.

4-8 Troubleshooting Measurement Problems

If the MS4652XB measurement quality is suspect, the following paragraphs provide guidelines and hints for determining possible quality problems.

VNA Measurement Quality

The quality of MS4652XB VNA measurements is determined by the following test conditions and variable:

- The condition of the MS4652XB.
- 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 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, “Performance Verification”](#)

Chapter 5 — MS4652xB Assembly Removal and Replacement

5-1 Introduction

This chapter describes the removal and replacement procedures for the various assemblies of the MS4652xB VNA. 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.

5-2 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 MS4652xB Vector Network Analyzer.

Warning	All electronic devices, components, and instruments can be damaged by electrostatic discharge. It is important to take preventative measures to protect the instrument and its internal subassemblies from electrostatic discharge.
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5-3 Removal and Installation Procedure

The removal and replacement assemblies include:

- [Section 5-4 “Front Panel Sub-Assemblies” on page 5-2](#)
- [Section 5-5 “MS46522B VNA Module Assembly” on page 5-7](#)
- [Section 5-8 “Chassis Cover Assembly” on page 5-10](#)
- [Section 5-9 “Chassis Assembly Parts” on page 5-16](#)
- [Section 5-10 “Fan Bracket Assembly” on page 5-20](#)
- [Section 5-11 “Baseplate Parts Assembly” on page 5-22](#)

Prepare Work Area

Prepare a clean and static free work area.

1. Make sure that the work area is well grounded.
2. Cover the work surface with a soft, clean anti-static mat.
3. Provide all personnel with appropriate anti-static grounding wrist straps and similar equipment.
4. Power down the VNA and unplug the AC power cord.
5. Place the VNA onto the anti-static mat.

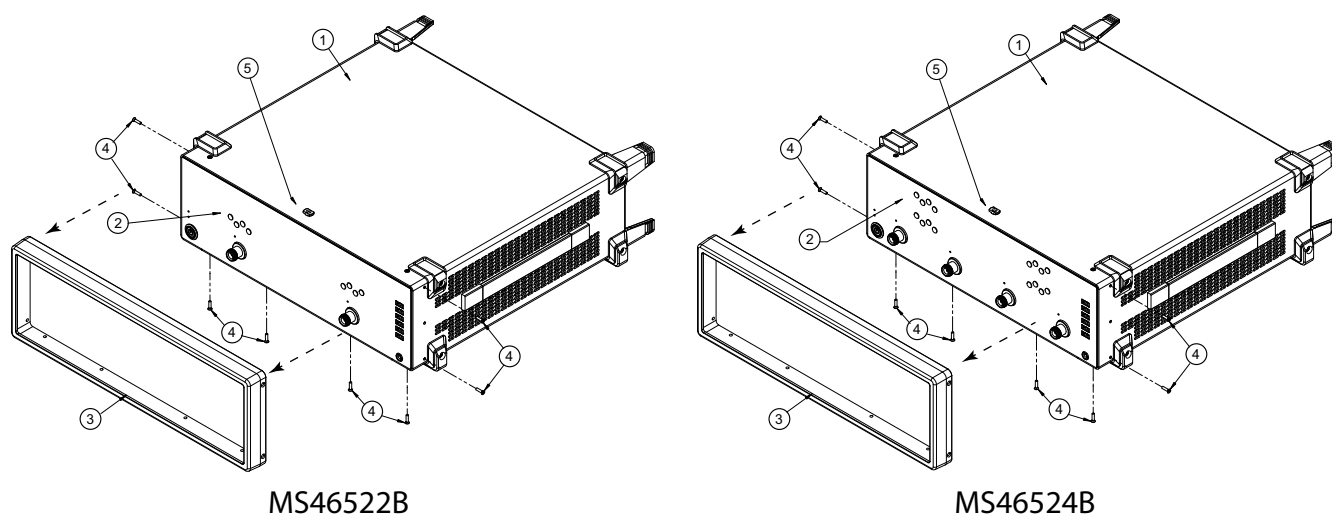
5-4 Front Panel Sub-Assemblies

Use this section to remove or install the MS4652xB front panel, bezel and front panel sub-assemblies. This section includes:

- Bezel Assembly– [Section “Bezel Assembly” on page 5-2](#)
- Front Panel Assembly– [Section “Front Panel Assembly” on page 5-3](#)
- Front Panel Sub-Assembly – [Section “Front Panel Sub-assembly” on page 5-4](#)

Bezel Assembly

Use this procedure to remove and replace the MS4652xB bezel.



1. Chassis Cover
2. Front Panel
3. Bezel

4. M3x12 Flat Head Phillips Screws (x8)
5. Bezel Bobbin Clip

Figure 5-1. Remove MS46522B Front Panel/Bezel Assembly

Remove the MS4652xB Front Panel Bezel Procedure

Refer to [Figure 5-1](#).

1. Position the MS4652xB (1) so the four bottom feet are resting flat on the static mat.
2. Locate the front panel bezel (3).
3. Remove the eight Phillips screws (4) that attach the bezel to the chassis (1).
4. Slide the bezel (3) from the front panel (2).

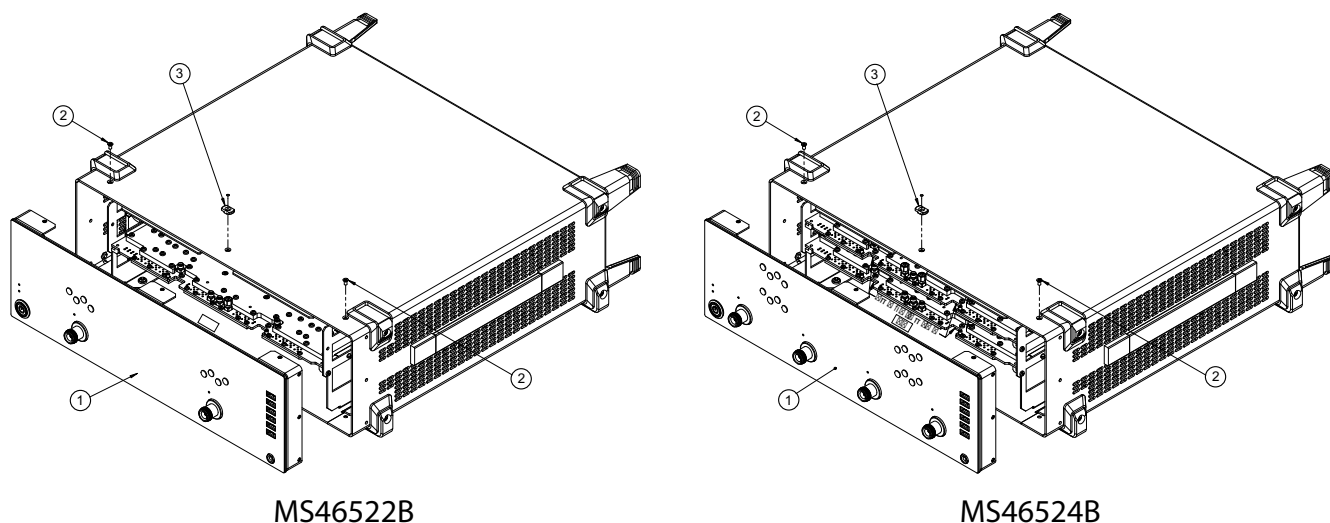
Install the Front Panel Bezel Procedure

Refer to [Figure 5-1](#).

1. Position the MS4652xB (1) so the four bottom feet are resting flat on the static mat.
2. Slide the front panel bezel (3) over the front panel so that the bezel bobbin slot, which is located on the back side of the bezel, slides over the bezel bobbin clip (5).
3. Install the six Phillips screws (4) as indicated in [Figure 5-1](#) to attach the bezel to the front panel.

Front Panel Assembly

Use this procedure to remove or replace the MS4652xB front panel assembly. Perform the bezel removal procedure in [Section “Remove the MS4652xB Front Panel Bezel Procedure”](#) on page 5-2 before removing the front panel.



- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Front Panel 2. M3x6 Flat Head Phillips Screws (2x) | <ol style="list-style-type: none"> 3. Bezel Bobbin Clip |
|--|--|

Figure 5-2. Remove MS4652xB Front Panel

Remove the Front Panel Procedure

Refer to [Figure 5-2](#).

1. Position the MS4652xB so the four bottom feet are resting flat on the static mat.
2. Locate the front panel (1).
3. Remove the two Phillips screws (2) to detach the front panel.

Refer to [Figure 5-5 on page 5-6](#) when removing harness cables.

4. Slide the front panel (1) off from the chassis frame.
 - If further disassembly is required, remove and retain the bezel bobbin clip (5).
5. Use a wrench to disconnect the coaxial cables from test port panel adapters.
6. The front panel can now be completely separated from the chassis.

Install the Front Panel Procedure

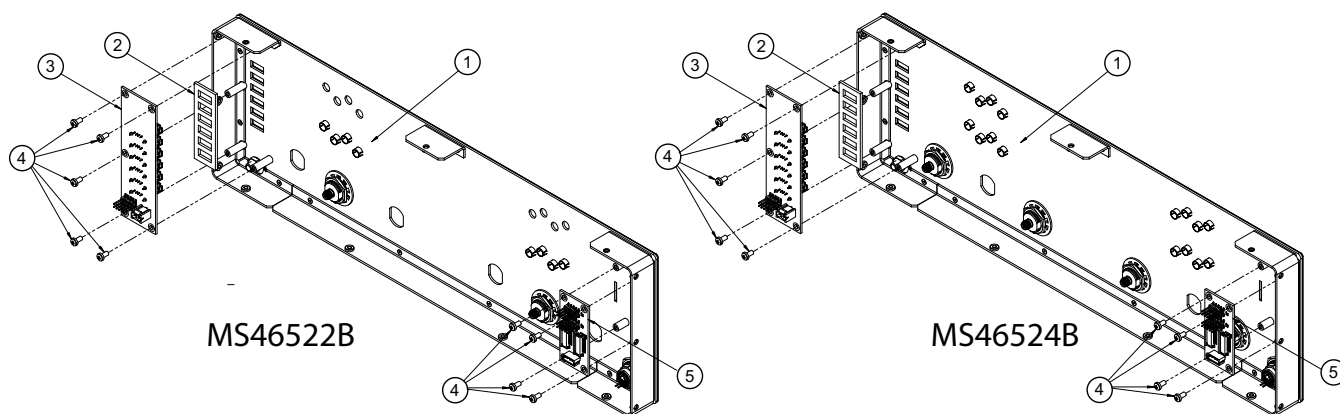
Refer to [Figure 5-2](#).

1. Position the MS4652xB so the four bottom feet are resting flat on the static mat.
2. Insert the bezel bobbin clip (5) into the chassis body hole located in [Figure 5-1](#).
3. Reconnect the coaxial cables to the test port panel adapters.
4. Tighten the RF connectors with a 5/16" 8 in·lbf torque wrench.

Front Panel Sub-assembly

Use this procedure to remove or install the MS4652xB front panel sub-assembly or any of its parts. The previous procedures that must be performed prior are:

- [Section “Remove the MS4652xB Front Panel Bezel Procedure” on page 5-2](#)
- [Section “Remove the Front Panel Procedure” on page 5-3](#)



1. Front Panel
2. Gasket
3. USB Hub Board

4. M3x6 Pan Head Phillips (9x)
5. LED Interface Board

Figure 5-3. MS4652xB Front Panel Assembly

Remove Front Panel Sub-Assemblies

Refer [Figure 5-3](#).

1. To remove the Front Panel USB Hub Board (3):
 - a. Locate and remove the five Phillips screws (4) to detach the USB Hub Board (3).
 - b. Unplug the cable harnesses that are plugged into the connectors of the USB Hub Board (3).
 - c. Remove the gasket (2).
2. To remove the Front Panel LED Interface Board (5):
 - a. Locate and remove the four (4) Phillips screws to detach the LED Interface Board.

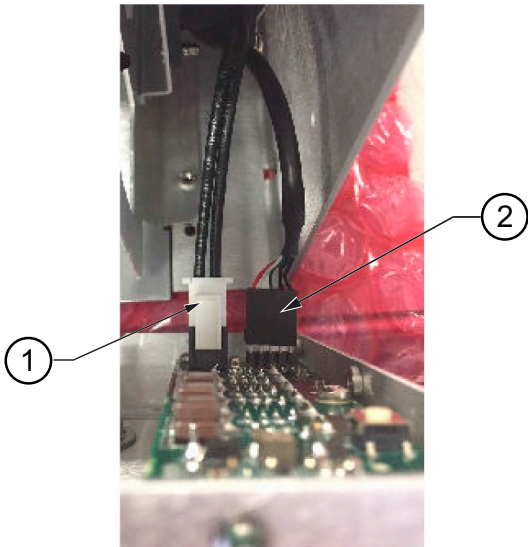
Install the Front Panel Sub-Assemblies

Refer [Figure 5-3](#).

1. To install the Front Panel USB Hub Board (3):
 - a. Find the mounting location on the backside of the front panel (1).
 - b. Align the gasket (2) so the holes of the gasket (2) align with the holes of the USB Hub Board (3).
 - c. Locate and install the five Phillips screws (4) through the mounting holes of the USB Hub Board (3) and the gasket (2) onto the front panel (1).
 - d. Plug the cable harnesses into the connectors of the USB Hub Board (3)
2. To install the Front Panel LED Interface Board (5):
 - a. Plug the cable harnesses into the Front Panel LED Interface Board.
 - b. Find the mounting location on the backside of the front panel (1).
 - c. Locate and install the four Phillips screws through the mounting holes of the LED Interface Board (5) onto the front panel (1).

The Front Panel USB Wire Connections

Use this procedure when connecting the wire harnesses to the Front Panel Hub PCB.



1. Backplane Power Cable to Hub P1 Connection	2. USB Cable From Motherboard to Hub J1 Connection
---	--

Figure 5-4. Hub PCB Connections

The Front Panel USB HUB Wire Connections Procedure

Refer to [Figure 5-4](#).

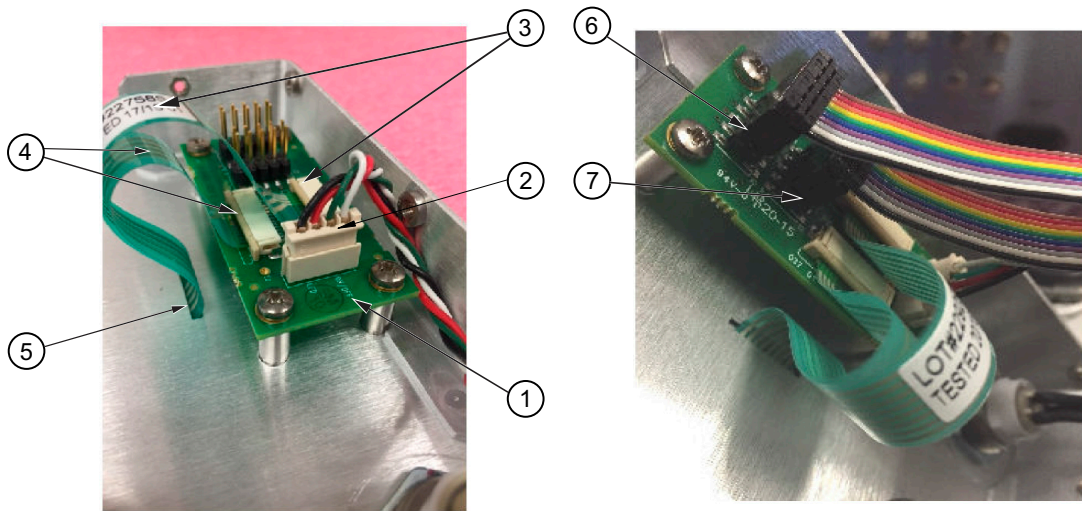
- 1. Insert the backplane power cable to USB HUB PCB P1 location.
- 2. Insert USB cable from motherboard to USB HUB PCB J1 Location.

Table 5-1. Wiring Harness Connections

Item	Connection 1	Connection 2
1	Backplane Power Cable	Hub P1
2	Motherboard USB Cable	Hub J1

The Front Panel LED Wire Connections

Use this procedure when connecting the wire harnesses to the Front Panel LED Interface PCB.



- | | |
|---|--|
| 1. LED Interface PCB | 5. Ribbon Cable Overlay Feed Thru Slot |
| 2. Switch Cable Harness | 6. J1 Location |
| 3. Long Ribbon Cable/P3 Connector Location | 7. J2 Location |
| 4. Short Ribbon Cable/P2 Connector Location | |

Figure 5-5. LED Interface PCB Wiring Connections

Connecting the Front Panel LED Wire Harness Procedure

Refer to [Figure 5-5](#) and [Table 5-2](#)

1. Route the ribbon cables (3) (4) through the overlay slot (5) as shown.
2. Insert the short ribbon cable (4) into P2 on LED interface PCB.
3. Insert the long ribbon cable (3) into P3 on LED interface PCB.
4. Plug in harness from switch (2) into P1 on LED interface PCB.
5. Insert Cable (6) into LED interface J1.
6. Insert Cable (7) into LED interface J2.

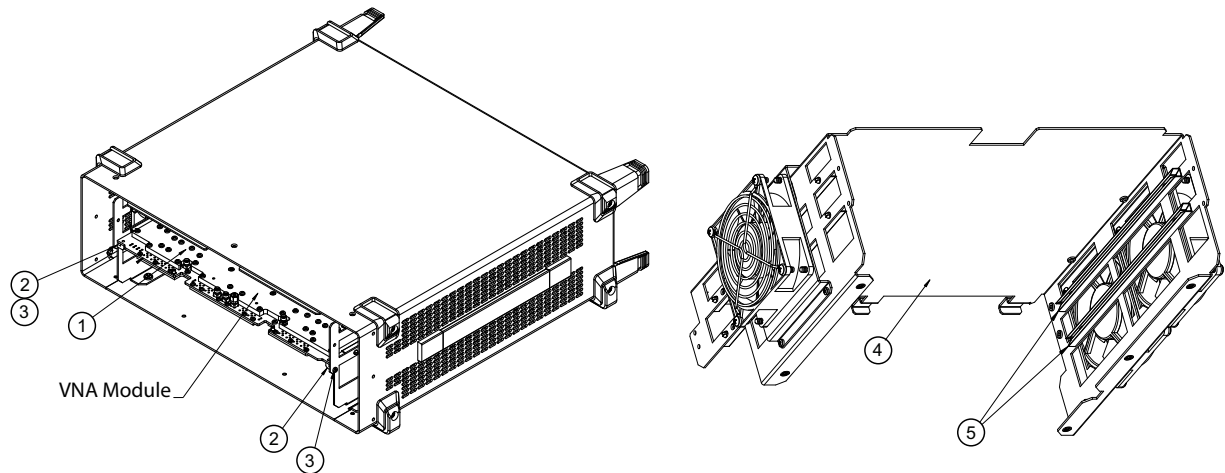
Table 5-2. Wiring Harness Connections

Item	Connection 1	Connection 2
2	Front Panel Switch Harness	LED Interface P1
3		LED Interface P2
4		LED Interface P3
6	LED Interface J1	Backplane
7	LED Interface J2	Backplane

5-5 MS46522B VNA Module Assembly

Use this section to remove or install the MS46522B VNA module(s). The previous procedures that must be performed prior are:

- “Remove the MS4652xB Front Panel Bezel Procedure” on page 5-2
- “Remove the Front Panel Procedure” on page 5-3



1. MS46522B VNA Module Assembly (1x)	3. M3x6 Phillips Screws (2x) (4x for REV3 units)
2. VNA support bracket (REV3 units have a different bracket with extra screw hole)	4. Card Cage (underside)
	5. PCB Guides

Figure 5-6. Remove MS46522B VNA Module Assembly

Remove the VNA Module Assembly

Refer to [Figure 5-6](#).

1. Remove the Phillips Screws (3) from the support brackets (2) to detach the VNA Module Assembly.
2. Pull the module forward to disengage the module from the backplane connectors.
3. Continue to slide the module forward to remove the VNA module assembly from the MS4652xB chassis.
4. Transfer the test port coaxial cables from this assembly to the new replacement assembly.

Install the VNA Module Assembly

Note

Some REV1 and REV2 units have been modified to use the REV3 Support Brackets. Transferring of the brackets from the original VNA module assemblies to the replacement module may be required.

Refer to [Figure 5-6](#).

1. Locate the PCB Guides (5) located inside the card cage (5).
2. Position the Module so the two rear sides of the VNA Module Assembly is inserted into the module guides first.
3. Slide the module forward to engage the module into the backplane connectors.
4. Locate and insert the Phillips screws (3) into the support brackets (2) to attach the VNA Module Assembly to the card cage (4).

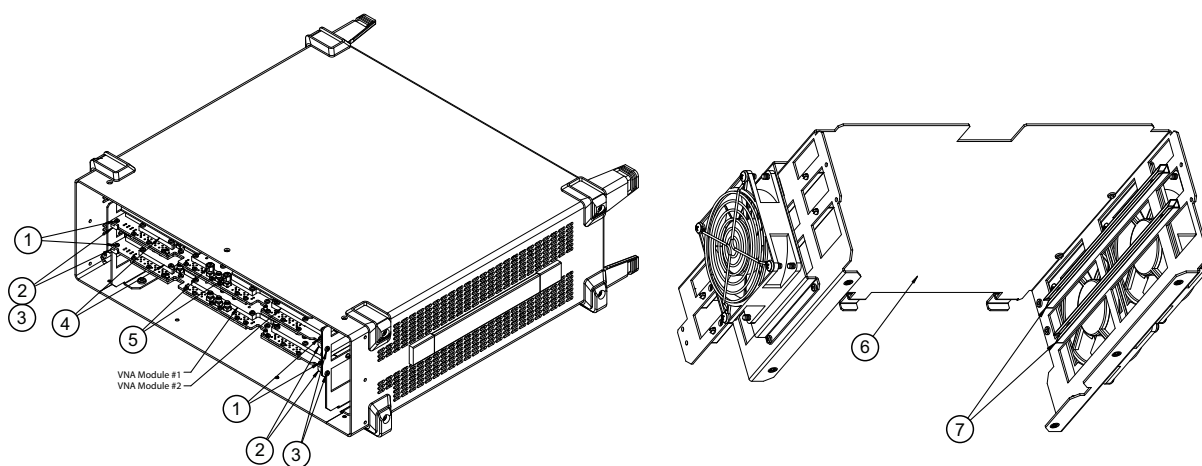
5-6 MS46522B VNA Module Assembly Option 82

To remove and install the VNA Module Assembly into the MS46522B with Option 82, refer to [Chapter 6, “MS46522B Option 82/83 Removal and Replacement”](#).

5-7 MS46524B VNA Module Assembly

Use this section to remove or install the MS46524B VNA module(s). The previous procedures that must be performed prior are:

- [“Remove the MS4652xB Front Panel Bezel Procedure”](#) on page 5-2
- [“Remove the Front Panel Procedure”](#) on page 5-3



- | | |
|--|--------------------------|
| 1. M2.5x4 Phillips Screws (4x) | 4. Low Frequency Module |
| 2. Card Cage Bracket (4x)(REV3 units have a different bracket with extra screw hole) | 5. 50 Ohm Terminations |
| 3. M3x6 Phillips Screws (8x) | 6. Card Cage (underside) |
| | 7. PCB Guides |

Figure 5-7. Remove MS46524B VNA Module Assembly

Remove the VNA Module Assembly

Refer to [Figure 5-7](#).

1. Disconnect the coaxial cable between VNA1 J9 and VNA2 J12.
2. Remove the Phillips Screws (3) from the support brackets (2) to detach the VNA Module Assembly.
3. Pull the module forward to disengage the module from the backplane connectors.
4. Continue to slide the module forward to remove the VNA module assembly from the MS4652xB chassis.
5. Transfer the test port coaxial cables from this assembly to the new replacement assembly.

Install the VNA Module Assembly

Refer to [Figure 5-8](#).

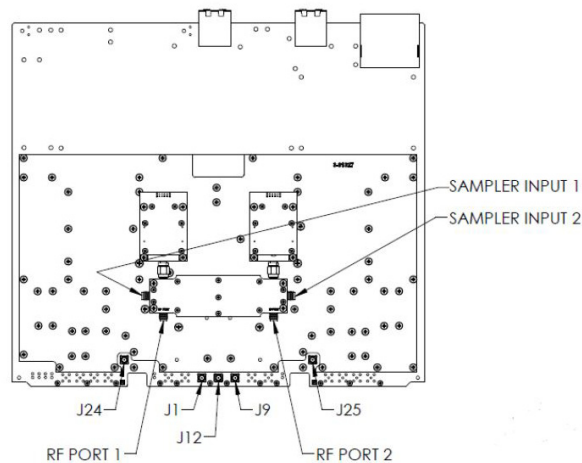


Figure 5-8. VNA Module Assembly Cabling

1. Locate the PCB Guides (5) located inside the card cage (6).
2. Position the Module so the two rear side of the VNA Module Assembly is inserted into the module guides first.
3. Slide the module forward to engage the module into the backplane connectors.
4. Locate and insert the Phillips screws (3) into the support brackets (2) to attach the VNA Module Assembly to the Card Cage (4).
5. Perform the following verifications based on Figure 5-8.
 - Verify cable is connected between Sampler Input 1 and J24 on VNA1 and VNA2
 - Verify cable is connected between Sampler Input 2 and J25 on VNA1 and VNA2
 - Verify cable is connected between J9 of VNA1 to J12 of VNA2
 - Verify cable is connected between J1 of VNA1 to J12 of VNA1
 - Verify terminations are installed on J1 of VNA2 and J9 of VNA2
 - Verify cable is connected between RF Port 1 of VNA1 to External RF Port 1
 - Verify cable is connected between RF Port 2 of VNA1 to External RF Port 2
 - Verify cable is connected between RF Port 1 of VNA2 to External RF Port 3
 - Verify cable is connected between RF Port 2 of VNA2 to External RF Port 4

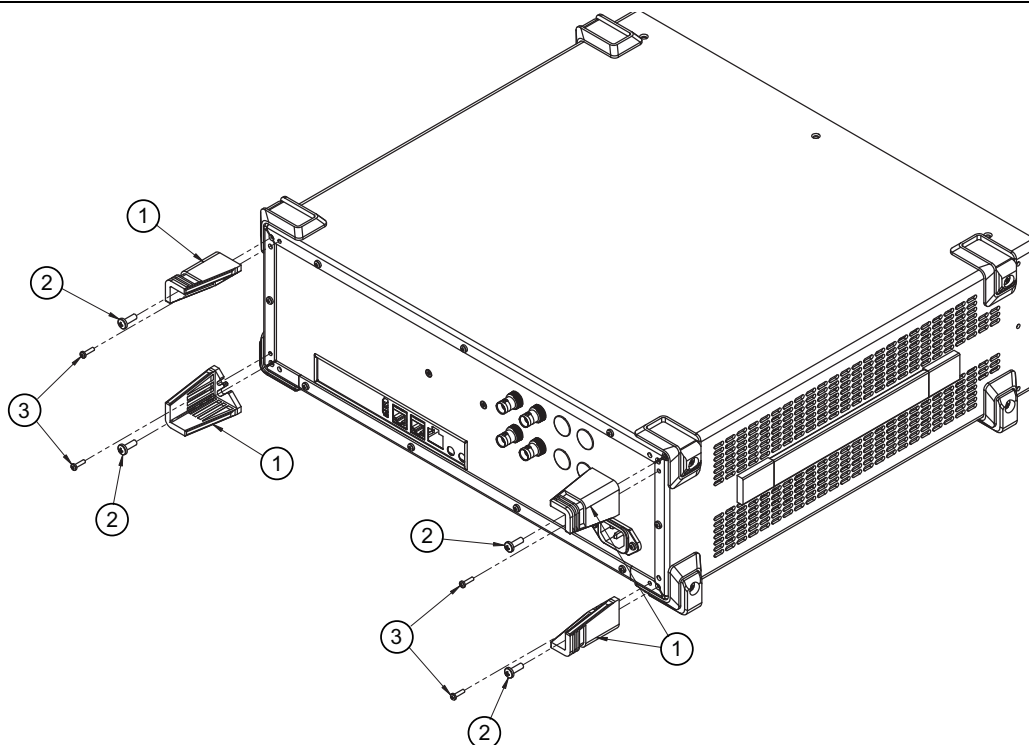
5-8 Chassis Cover Assembly

Use this section to remove or install the chassis cover assembly. This section includes:

- [Section “Rear Extensions” on page 5-10](#)
- [Section “Side Handle and Feet” on page 5-11](#)
- [Section “Chassis Cover/Card Cage Assembly” on page 5-13](#)

Rear Extensions

Use this procedure to remove or install the rear feet extensions.



1. Rear Foot Extension (4x)

2. M2.5x10 Pan Head Phillips Screw (4x)

3. M4x12 Pan Head Phillips Screw (4x)

Figure 5-9. MS4652xB Rear Extensions

Remove the Rear Feet Extension Procedure

Refer to [Figure 5-9](#)

1. Locate and remove the Phillips screws (2) (3) from each rear panel extension.
2. Remove each rear panel extension.

Install the Rear Feet Extension Procedure

Refer to [Figure 5-9](#).

1. Place each rear foot extension over each mounting location so the mounting holes of the rear foot extension aligns with the mounting holes at the rear panel mounting location.

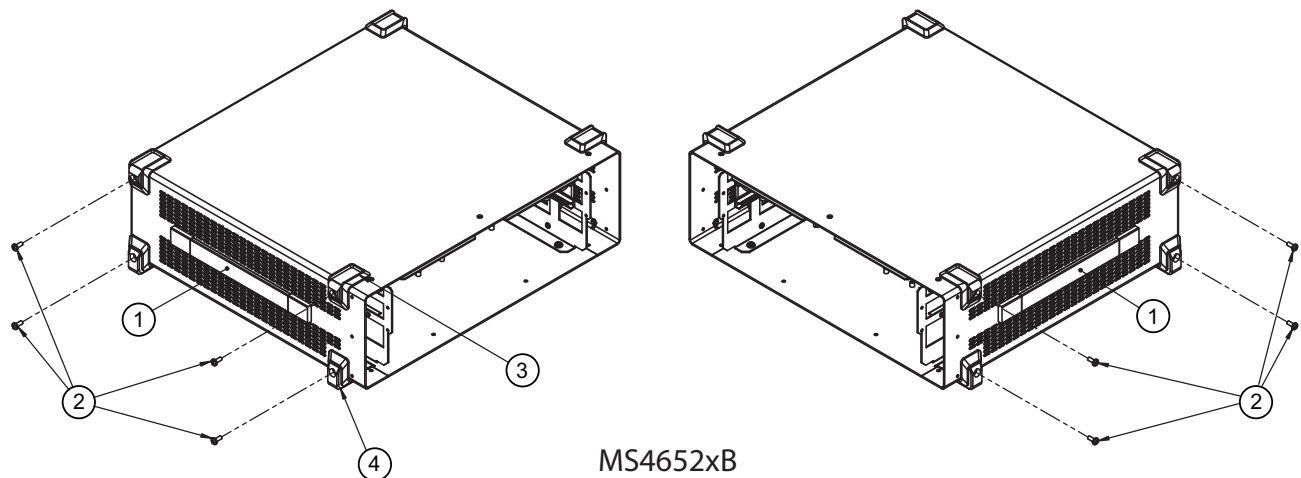
Note

There is a different size and installation location for the two mounting screws for each rear foot extension. Installing a screw into its incorrect location may damage the screw or mounting hole.

2. Install the two types of Phillips screws (2) (3) into each of the rear foot extensions to attach the feet to the rear corners of the chassis frame.

Side Handle and Feet

Use this procedure to remove or install the side handles and feet assembly.



- | | |
|---------------------------------------|---------------------|
| 1. Side Handle (2x) | 3. Upper foot (4x) |
| 2. M4x10 Pan Head Phillips Screw (8x) | 4. Bottom Foot (4x) |

Figure 5-10. MS4652xB Feet Removal

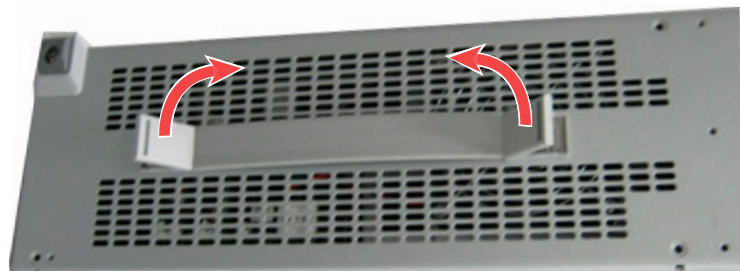


Figure 5-11. Side Handle Lift Tabs

Remove the Side Handle Procedure

Refer to [Figure 5-10](#).

1. Locate the side handles (1).
2. Locate the side handle lift tabs.
 - Refer to [Figure 5-11](#) for the location of the side handle lift tabs.
3. Remove the Phillips screw that is located under each lift tab.
4. Retain the Phillips screw if re-installing the same handle.
5. Remove the side handle (1).

Install the Side Handle Procedure

Refer to [Figure 5-11](#).

1. Flip the side handle flip tabs to allow access to the mounting screw holes.

Refer to [Figure 5-10](#).

- If re-installing original handle, use the Phillips screw that was initially removed.
 - If installing a new handle, the mounting screws are included in the new handle assembly.
2. Insert a Phillips screw into the mounting hole of each handle and tighten.
 3. Close the flip tab so that it snaps over the mounting location.

Remove the Chassis Feet Procedure

Refer to [Figure 5-10](#)

1. Locate the four upper feet (3) of the chassis body.
2. Remove each Phillips screw (2) that attaches each upper foot to the chassis body.
3. Remove each top foot.
4. Flip the MS4652xB chassis body onto its top so that the bottom feet are now on the top.
5. Locate the four bottom feet (4) of the chassis body.
6. Remove each Phillips screw (2) that attaches the foot to the chassis body.
7. Re-flip the chassis body so that the chassis top is on the top side again.

Install the Chassis Feet Procedure

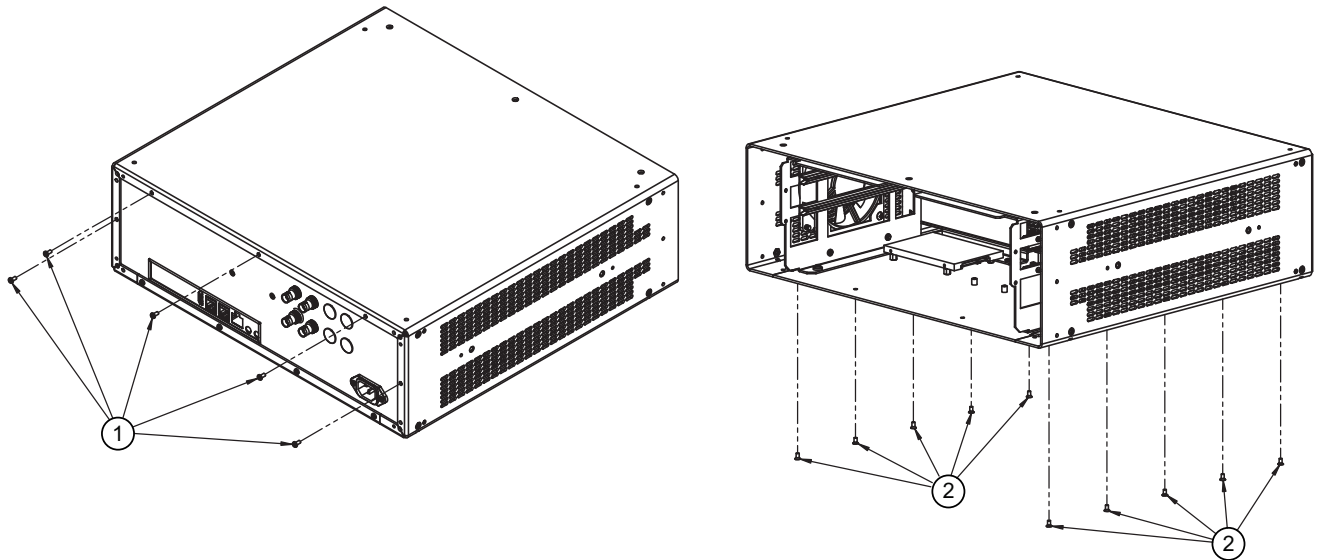
Refer to [Figure 5-10](#).

1. Position the upper feet (3) into the chassis body mounting locations.
2. Insert the Phillips screws (2) into the mounting hole of each top foot and tighten.
3. Flip the MS4652xB chassis body onto its top-side so that the chassis body top feet rests flat on the static mat.
4. Position the bottom feet (3) into the chassis body mounting locations.
5. Insert a Phillips screw (2) into the mounting hole of each bottom foot and tighten.
6. Re-flip the chassis body so the bottom feet are now resting flat on the static mat.

Chassis Cover/Card Cage Assembly

Use this procedure to remove or install the MS4652xB chassis cover and card cage assembly. The previous procedures that must be performed prior are:

- “Remove the MS4652xB Front Panel Bezel Procedure” on page 5-2
- “Remove the Front Panel Procedure” on page 5-3
- “Remove the Rear Feet Extension Procedure” on page 5-10



1. M3x6 Pan Head Phillips Screws (5x)

2. M3x6 Flat Head Phillips Screws (10x)

Figure 5-12. MS46522B Chassis Cover

Remove the Chassis Cover Procedure

Refer to [Figure 5-12](#).

1. Locate and remove the ten Phillips screws on the underside of the MS4652xB.

Refer to [Figure 5-13](#).

2. Place a 12x14x2 in foam pad on the static mat next to the MS4652xB.
3. Lift and place the MS4652xB so that the top rests on the foam pad.
4. Remove the bottom-side flat chassis screws (2).
5. Lift and place the MS4652xB so that the bottom rests on the foam pad.

6. Position the MS4652xB so that the rear panel side is pointing away from you.

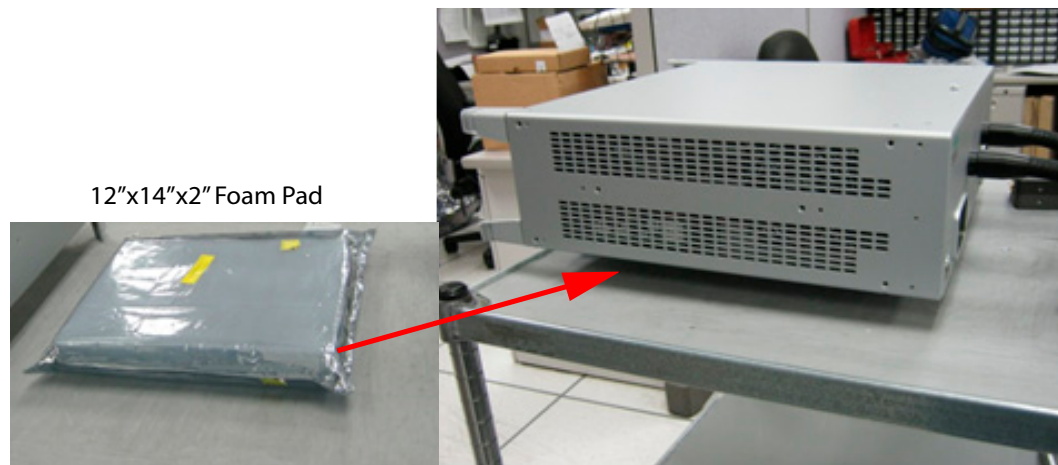


Figure 5-13. Place Foam Pad Under MS4652xB

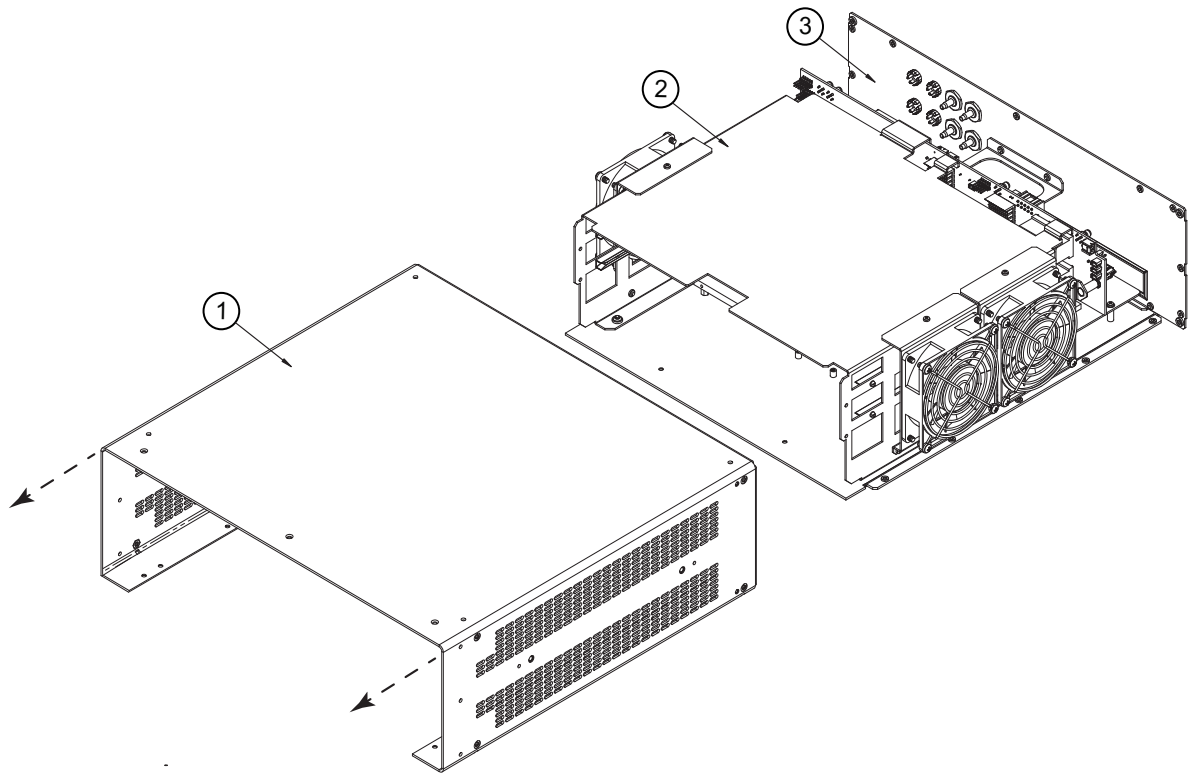


Figure 5-14. Manually Remove Chassis Cover

7. Position yourself in front of the chassis cover/chassis baseplate assembly.
8. Grab the chassis cover with both hands as shown in [Figure 5-14](#).

Refer to [Figure 5-15](#).

9. Pull the chassis cover (1) in the direction that is away from the rear panel assembly (3) to expose the chassis baseplate assembly (2).



1. Outer Chassis Cover	3. Rear Panel Assembly
2. Chassis Baseplate Assembly	

Figure 5-15. MS4652xB Chassis Assembly Removal

Install the Chassis Cover Procedure

Refer to [Figure 5-13](#).

1. Place the 12x14x2 in foam pad on the static mat next to the MS4652xB.

Refer to [Figure 5-15](#).

2. Lift and place the MS4652xB chassis assembly (2) so that the bottom rests on the foam pad.
3. Grab the chassis cover as shown in [Figure 5-14](#) and slide it onto the chassis baseplate (2).

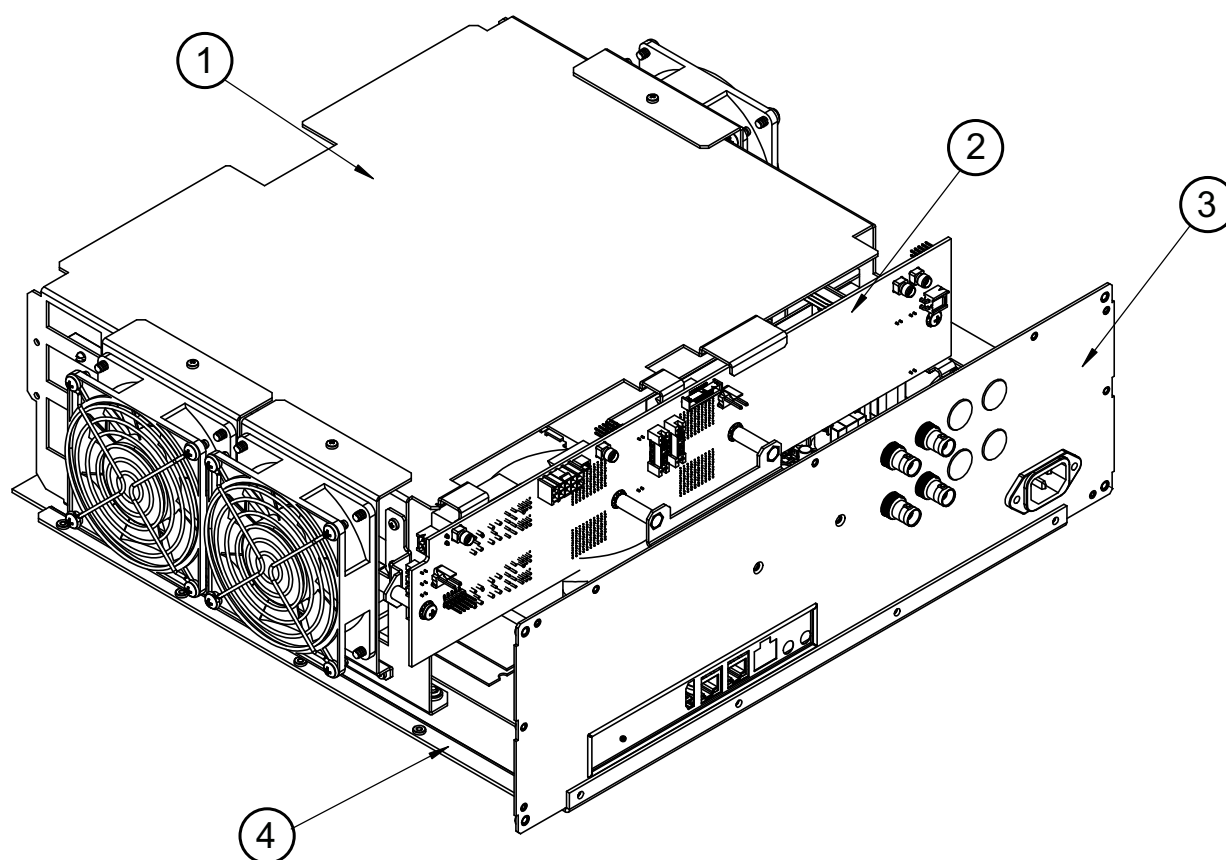
Refer to [Figure 5-12](#).

4. Insert the five Phillips screws (1) into the rear panel mounting holes and tighten.
5. Lift and place the MS4652xB so that the top rests on the foam pad.
6. Locate and insert the ten Phillips screws (2) into the mounting holes of the chassis cover and tighten.
7. Lift and place the MS4652xB so that the bottom rests on the foam pad.

5-9 Chassis Assembly Parts

Use these section to remove and replace the MS4652xB chassis assembly parts. The chassis assembly consists of three sub-assemblies.

- [Section “Rear Panel Assembly” on page 5-17](#)
- [Section “Card Cage Assembly” on page 5-18](#)
- [Section “Backplane PCB Assembly” on page 5-19](#)



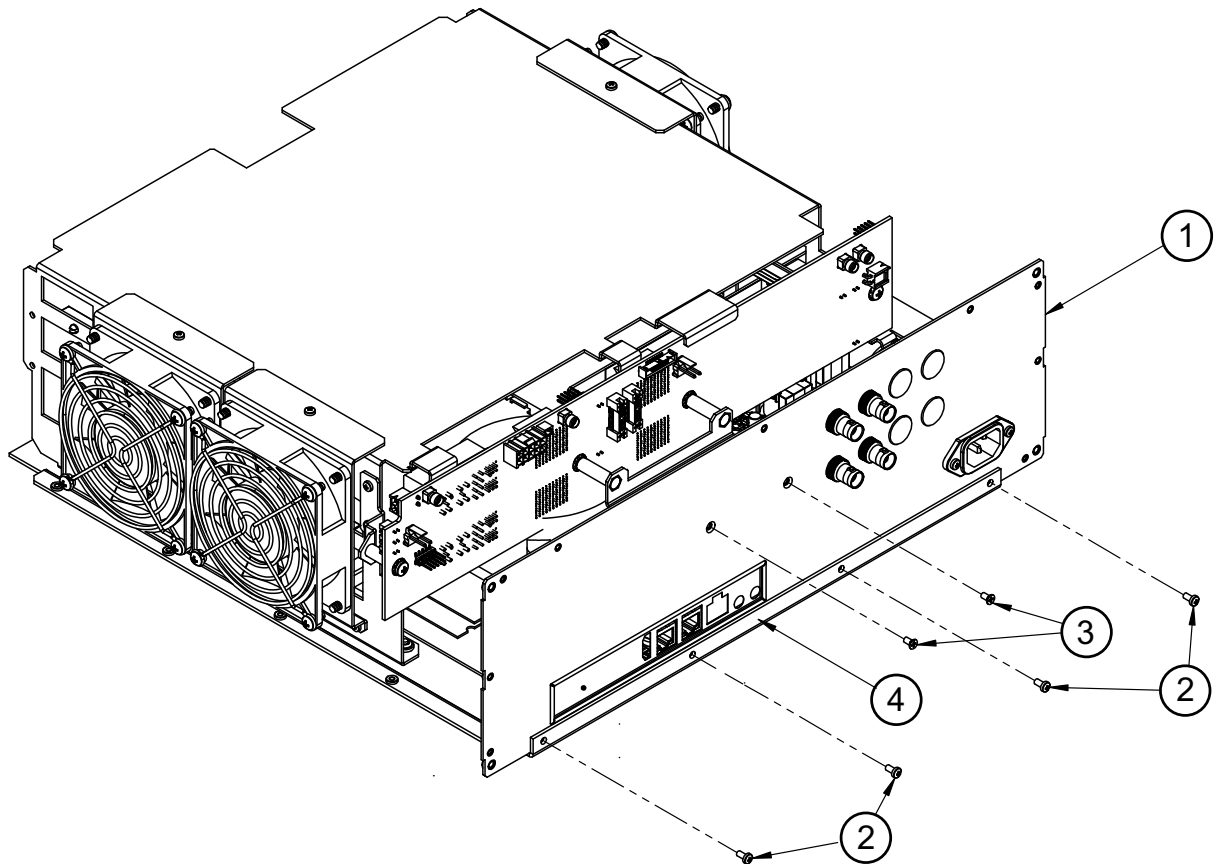
1. Card Cage Assembly	3. Rear Panel Assembly
2. Back Plane Assembly	4. Baseplate Assembly

Figure 5-16. MS4652xB Chassis Assembly

[Figure 5-16](#) identifies the four subassemblies of the Chassis.

Rear Panel Assembly

Use these procedures to remove or install the rear panel.



1. Rear Panel Assembly	3. M3x6 Flat Head Phillips Screws (2x)
2. M3x6 Pan Head Phillips Screws (4x)	4. Baseplate

Figure 5-17. Remove Rear Panel

Remove the Rear Panel Procedure

Refer to [Figure 5-17](#).

8. Locate and remove the two Phillips screws (3) that connect the rear panel to the backplane rear bracket.
9. Locate and remove the four Phillips screws (2) from the baseplate (4).
10. Lift and remove the rear panel (1) from the baseplate (4).
11. Disconnect the 4 coaxial cables linking the rear panel and the Back Plane PCB Assembly.

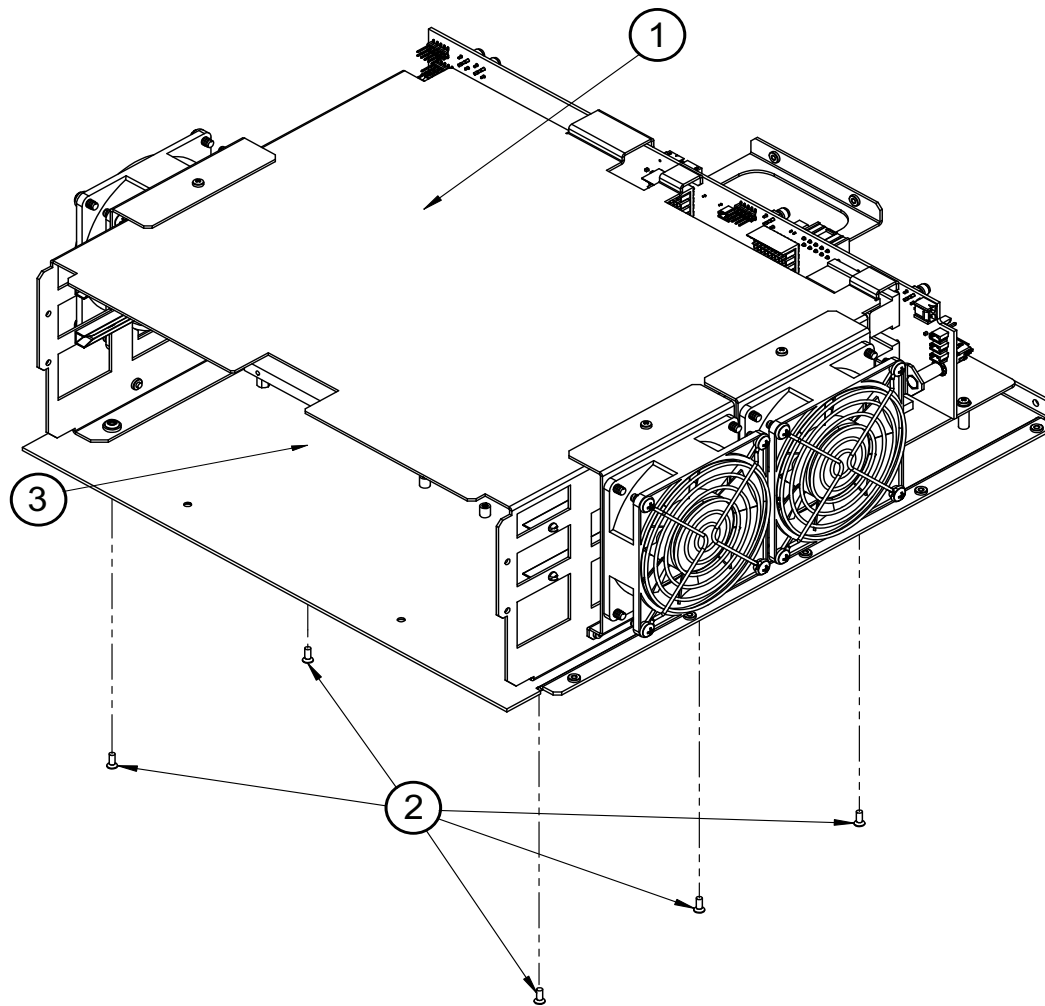
Install the Rear Panel Assembly

Refer to [Figure 5-17](#).

1. Position the rear panel assembly (1) onto its baseplate (4) location.
2. Locate and insert the four Phillips screws (2) and tighten.
3. Reconnect the 4 coaxial cables linking the rear panel and the Back Plane PCB Assembly.
4. Locate and insert the two Phillips screws (3) that connect the rear panel and the backplane rear bracket and tighten.

Card Cage Assembly

Use this procedure to remove or install the card cage cover.



- | | |
|--|--------------|
| 1. Card Cage Assembly | 3. Baseplate |
| 2. M3x8 Flat Head Phillips Screws (5x) | |

Figure 5-18. MS4652xB Chassis

Remove the Card Cage Assembly

Refer to [Figure 5-18](#).

1. Flip the card cage (1) over so that the baseplate (3) is now on top.
2. Locate and remove the five screws (2) that hold the card cage assembly (1) onto the baseplate assembly (3).
3. Lift the card cage (1) from the baseplate assembly (3) and place it onto a smooth flat surface.

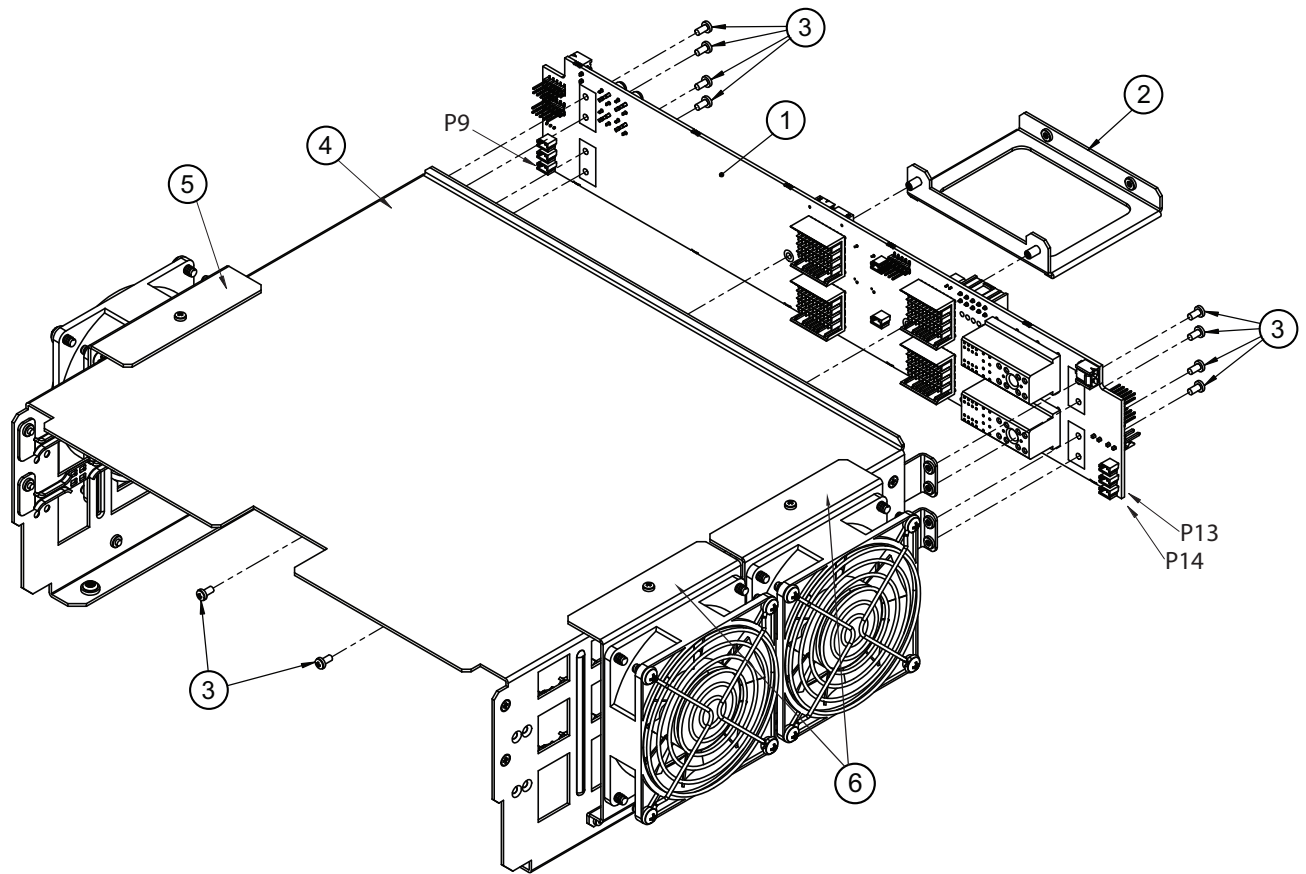
Install the Card Cage Assembly Procedure

Refer to [Figure 5-18](#).

1. Flip and place the card cage (1) so that it is lying bottom-side up on a static mat.
2. Place and align the mounting holes of the baseplate (3) over the card cage (1).
3. Insert the five Phillips screws (2) and tighten.

Backplane PCB Assembly

Use this procedure to remove or install the backplane PCB assembly.



- | | |
|--|-------------------------------|
| 1. Backplane PCB Assembly | 4. Card Cage Cover |
| 2. Backplane Rear Bracket | 5. In-Flow Fan Assembly |
| 3. M3x10 Pan Head Phillips Screws (2x) | 6. Out-Flow Fan Assembly (2x) |

Figure 5-19. MS46522B Chassis

Remove the Backplane PCB Assembly Procedure

Refer to [Figure 5-19](#).

1. Disconnect all the ribbon cables and bias cables plugged in both sides of the Backplane PCB Assembly.
2. Disconnect the in-flow fan assembly (8) wire harness from backplane connector P9.
3. Disconnect the out-flow fan assembly (9) wire harness from backplane connector P13 and P14.
4. Locate and remove the two screws (3) that hold the backplane rear bracket (2).
5. Locate and remove the two Phillips screws (3) located at the component side of the Backplane PCB Assembly.
6. Pull the backplane PSB assembly (1) away from the chassis card cage (4).

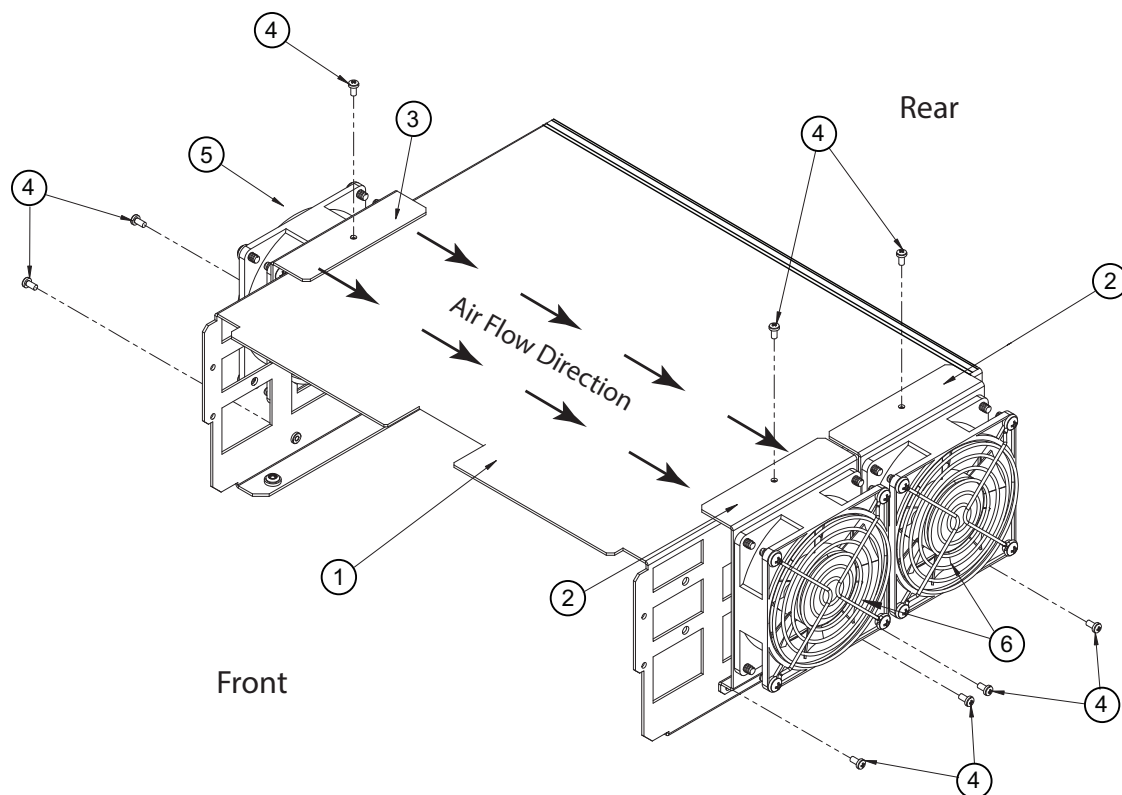
Install the Backplane PCB Assembly Procedure

Refer to [Figure 5-19](#).

1. Reverse the procedures from [Section “Remove the Backplane PCB Assembly Procedure”](#) on page 5-19.

5-10 Fan Bracket Assembly

Use this section to remove or install the MS4652xB fan bracket assembly and parts. The fan bracket assembly consists of two sub-assemblies. See [Section 5-10 “Fan Bracket Assembly” on page 5-20](#).



- | | |
|---|---------------------------------------|
| 1. Card Cage | 4. M3x6 Pan Head Phillips Screws (9x) |
| 2. Fan Bracket (2x) (Supports the Air Out-Flow Fan) | 5. Air In-Flow Fan Assembly (1x) |
| 3. Fan Bracket (1x) (Supports the Air In-Flow Fan) | 6. Air Out-Flow Fan Assembly (2x) |

Figure 5-20. MS4652xB Fan Airflow Direction

Remove Fan Bracket Assembly Procedure.

Note When replacing the fan assemblies, position the fans for proper air flow as indicated in [Figure 5-20](#).

Refer to [Figure 5-20](#).

1. Position the chassis (1) with the notch facing forward.
2. Locate and remove the six Phillips screws (4) to detach both outflow fan brackets (2) assemblies.
3. Locate and remove the Phillips screws (4) to detach the inflow fan bracket (3) assembly.
4. Remove the three fan assemblies (2) (3).

Install the Fan Bracket Assembly Procedure

Refer to [Figure 5-20](#).

1. Position the chassis (1) with the notch facing forward.
2. Reverse the procedure from [Section “Remove Fan Bracket Assembly Procedure.”](#)

When reinstalling the original fan or installing a new fan, note the position of the fan mounting location on the chassis assembly as indicated in [Figure 5-20](#). Assemble the fan as indicated so that the direction of air flow is correct and the cable wire assembly is positioned properly when assembled and installed.

Note

Failure to install the fan properly (left or right) so the direction of air flow is as indicated in [Figure 5-20, “MS4652xB Fan Airflow Direction” on page 5-20](#) may cause overheating of the VNA and result in internal damage to the VNA.

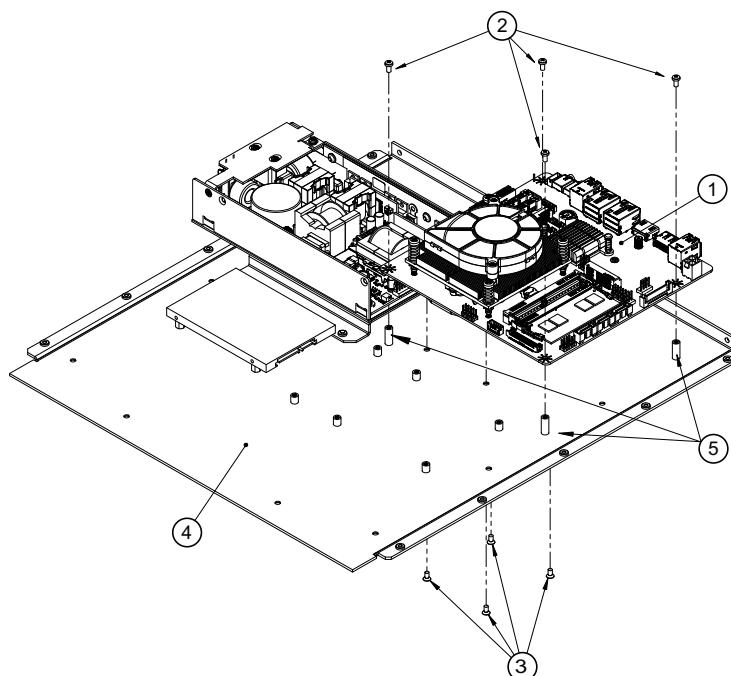
5-11 Baseplate Parts Assembly

Use this section to remove or replace the MS4652xB baseplate sub-assemblies. The backplane parts sub-assemblies include:

- [Section “CPU Assembly” on page 5-22](#)
- [Section “Solid State Drive \(SSD\)” on page 5-27](#)
- [Section “Power Supply” on page 5-28](#)

CPU Assembly

Use this procedure to remove and replace the CPU assembly.



1. CPU Assembly	4. Baseplate
2. M3x6 Pan Head Phillips Screw (4x)	5. Standoff (4x)
3. M3x6 Flat Head Phillips Screw (4x)	

Figure 5-21. MS4652xB CPU Assembly

Remove the CPU Assembly Procedure

Refer to [Figure 5-21, “MS4652xB CPU Assembly”](#).

1. Unplug all the cables connected to the CPU Assembly.
2. Locate and remove the four Phillips screws (2) to detach the CPU assembly (1).
3. (For Rev 3 units only) Locate and remove the four Phillips screws (3) to detach the CPU assembly (1).
4. Remove the CPU assembly (1) from the baseplate (4).

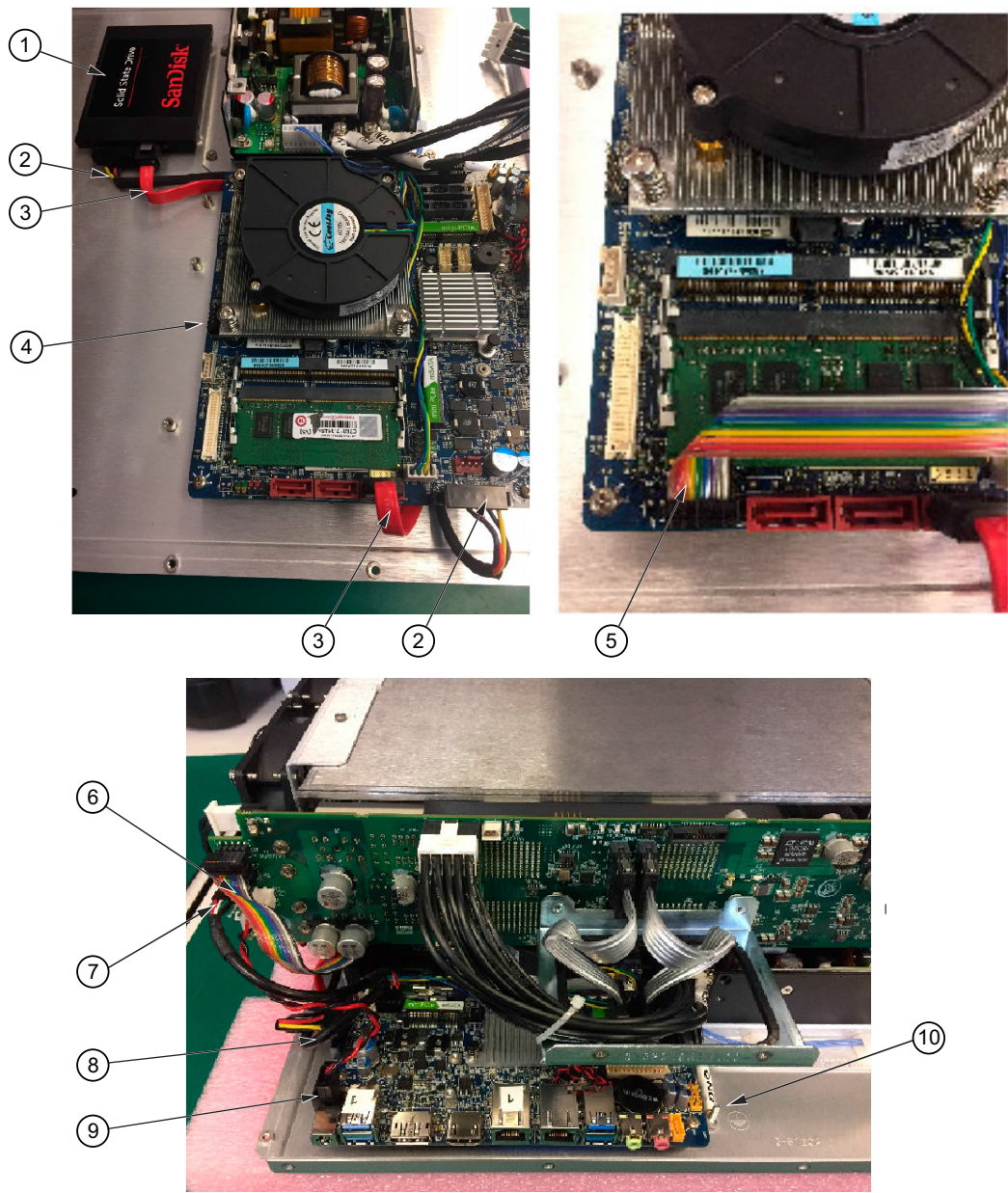
Install the CPU Assembly Procedure

Refer to [Figure 5-21, “MS4652xB CPU Assembly”](#)

1. Locate the mounting location for the CPU assembly.
2. Align the mounting holes.
3. Install the four Phillips screws (2) and tighten into the baseplate (4) standoffs (5).
4. (For Rev 3 units only) Locate and install the mounting four Phillips screws (3) and tighten into the baseplate's standoffs (5).

CPU Assembly Wiring (For Rev 3 Units)

Use this procedure to wire the CPU Assembly for REV 3 and 5 units.



1. SSD	6. 10-Pin, 2 Row Cable Assembly
2. SATA Power Cable	7. 5-Pin USB
3. SATA Data Cable	8. 5-Pin USB
4. CPU Motherboard	9. 19V MB Cable
5. 10-Pin, 2 Row Cable Assembly	10. Power Supply Ground (Location of ground symbol inscribed on Baseplate)

Figure 5-22. CPU Assembly Wiring Illustrated (For Rev 3 Units)

Installing the CPU Assembly Cables Procedure

Refer to [Figure 5-22](#).

1. Route the SATA power cable (2) and the SATA data cable (3) under the CPU motherboard (4).

Refer to [Section “CPU Assembly” on page 5-22](#).

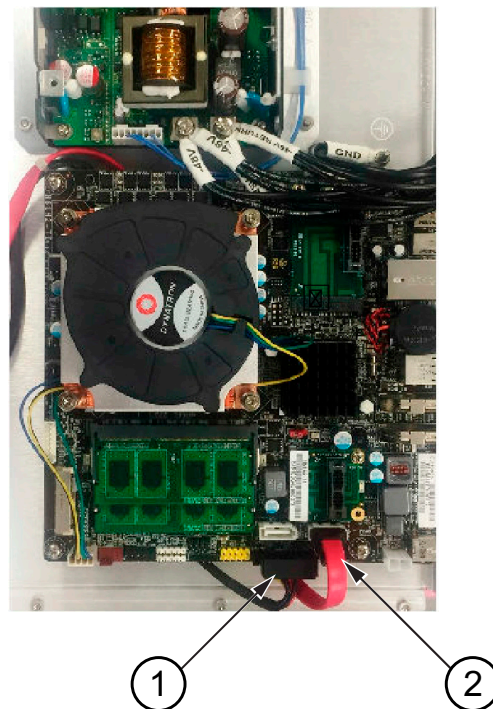
2. Use caution not to pinch the SATA power cable (2) and the SATA data cable (3) between the CPU assembly (1) and mounting standoffs (5) when routing the cables and mounting the CPU Motherboard.

Refer to [Figure 5-22](#).

3. Locate the SATA power cable (2) and insert it into its designated connectors on the SSD (1) and CPU Assembly (4).
4. Locate and insert the SATA data cable (3) into its designated connectors located on the SSD (1) and CPU Assembly (4).
5. Locate and insert the 10 pin, 2 row (5) cable assembly connector into J30 on the CPU Motherboard (4).
6. Locate and insert the 10 pin, 2 row (6) cable assembly connector into backplane J2.

CPU Assembly Wiring (For Rev 1 and Rev 2 Units)

Refer to [Figure 5-23](#).



1. SATA Power Cable Connection
2. SATA Drive Cable Connection

Figure 5-23. Rev 1 and 2 CPU Assembly

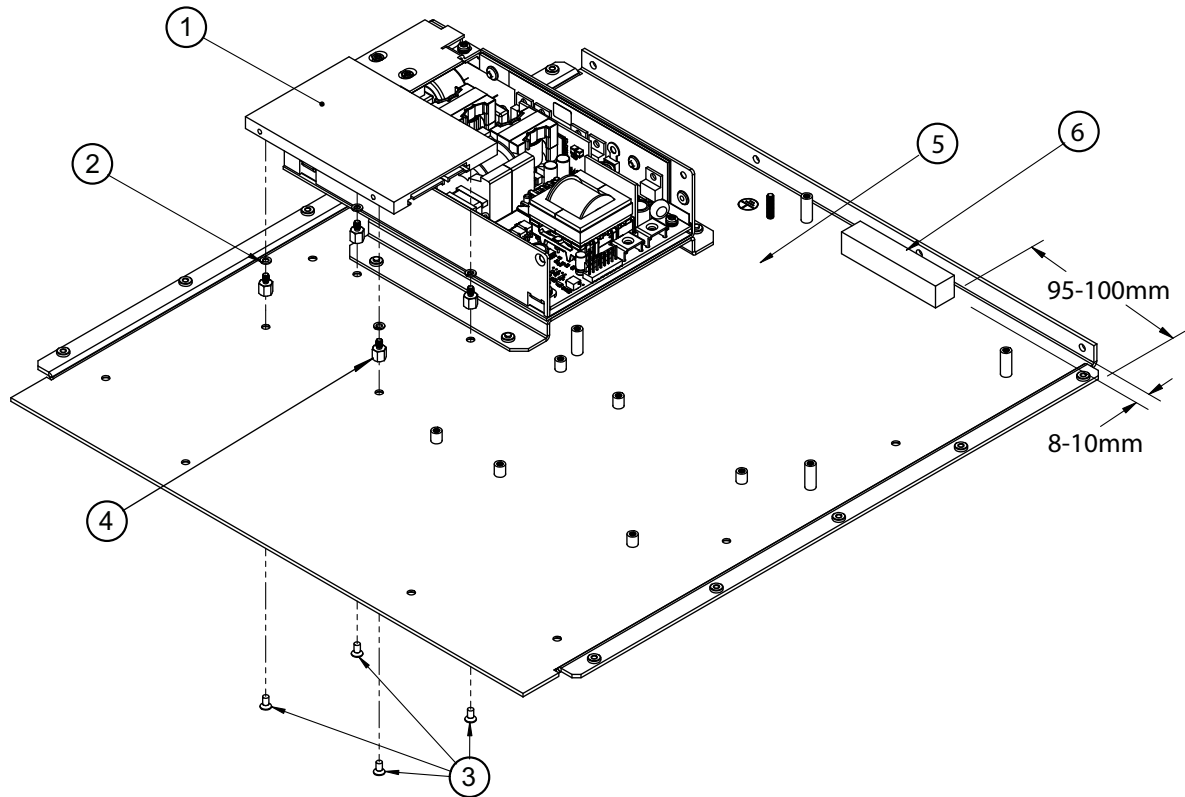
Installing the CPU Assembly Cable Procedure

1. Route the SATA Power Cable (1) and the SATA Drive cable (2) under the Motherboard Assembly and connect as shown,
2. Plug the cable harness from J12 of the Back Plane PCB Assembly to the inside row of the F USB connector of the CPU Assembly with the red wire on the front panel side.

3. Plug the cable harness from the Front Panel USB Hub PCB to the outside row of F USB connector of the CPU Assembly.
4. Plug the cable harness from J2 of the Back Plane PCB Assembly to F PANEL connector of the CPU Assembly.
5. Plug the Bias Cable from P4 of the Back Plane PCB Assembly to the DC_IN connector of the CPU Assembly.

Solid State Drive (SSD)

Use this procedure to remove or install the SSD.



1. SSD	4. Standoff (4x)
2. Split Washer (4x)	5. Baseplate
3. M3x6 Flat Head Phillips Screw (4x)	6. Foam Dampening block

Figure 5-24. MS4652xB Solid State Drive

Remove the SSD Procedure

Refer to [Figure 5-24](#).

1. Locate and remove the four screws (3) to detach the SSD standoffs (4) from the baseplate (5).
2. Lift the SSD (1) from the baseplate (5).
3. Rest the SSD (1) so that it lies flat with the standoffs (4) pointing upward.
4. Using a 6mm hex wrench, remove the standoffs (4) from the SSD (1).
5. Retain the washers (2) attached to the standoffs (4) to be available for re-installation.

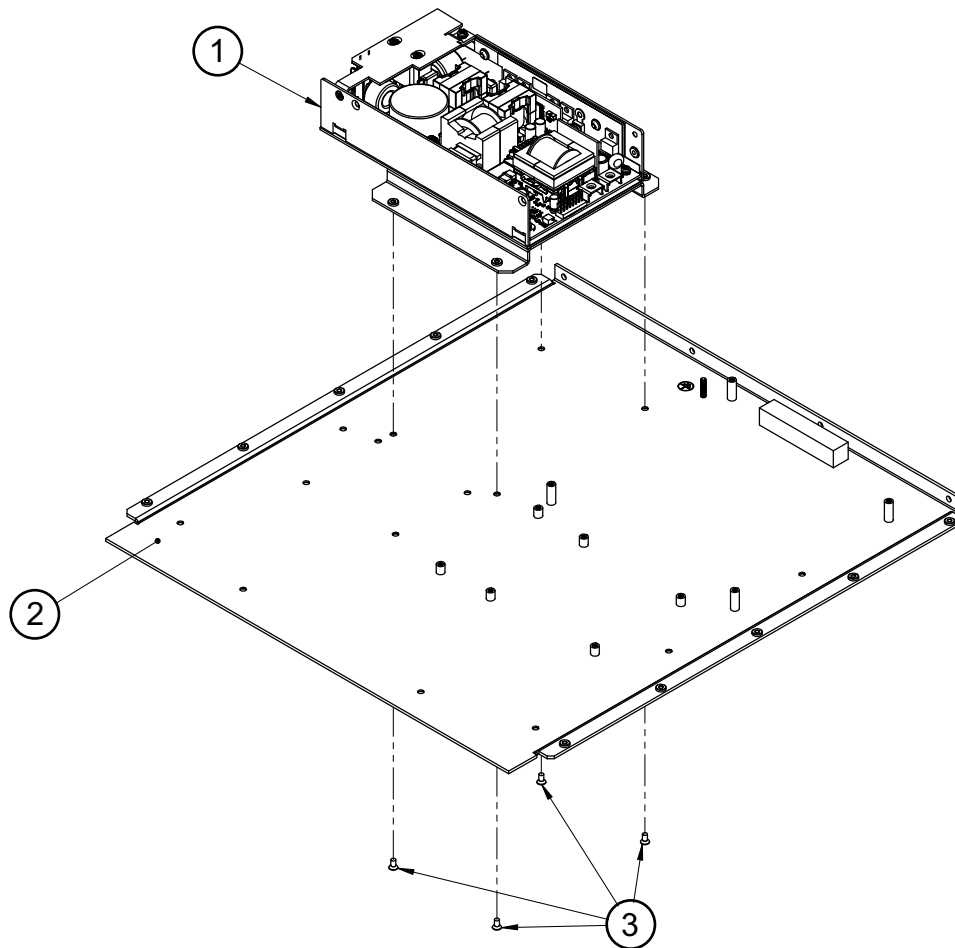
Install the SSD

Refer to [Figure 5-24](#).

1. Slip the washers (2) onto the standoffs (4).
2. Use a 6mm open end wrench to install the standoffs to the SSD (1).
3. Locate and align the SSD onto the mounting holes of the baseplate.
4. Insert the Phillips screws (3) through the baseplate to attach SSD and tighten.
5. Refer to [Section "CPU Assembly" on page 5-22](#) when installing the SSD program kit (1) cable harnesses.

Power Supply

Use this procedure to remove or install the power supply assembly.



1. Power Supply
2. Baseplate

3. M3x6 Flat Head Phillips Screws (4x)

Figure 5-25. MS4652xB Power Supply Baseplate Assembly

Remove the Power Supply Procedure

Refer to [Figure 5-25](#).

1. Locate and remove the four Phillips screws (3) to detach the power supply (1) from the baseplate (2).
2. Lift the power supply (1) from the baseplate (2).

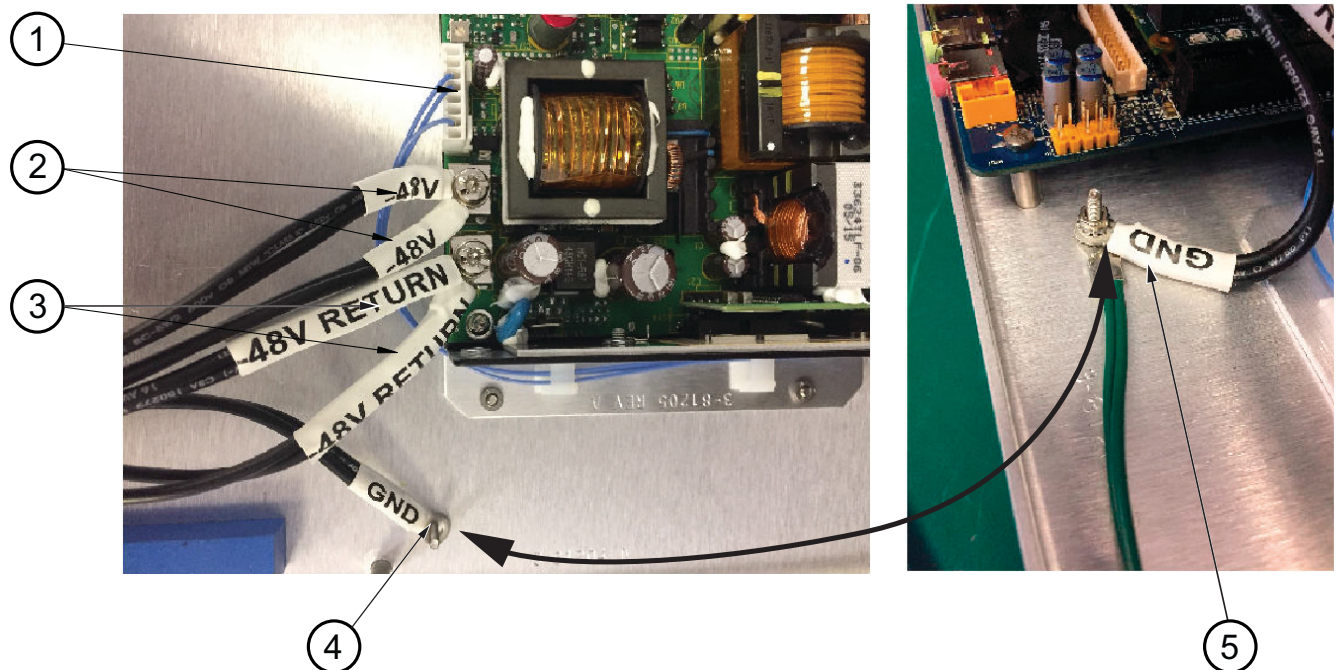
Install the Power Supply

Refer to [Figure 5-25](#).

1. Place and align the power supply (1) over the mounting holes of the baseplate (2).
2. Insert the Phillips screws (3) and tighten.
3. Refer to [Figure 5-26](#), “MS4652xB Power Supply Wiring” on page 5-29 when attaching the voltage cables.

Power Supply Wiring

Use this procedure to connect the wire connections to the power supply



- | | |
|--------------------------------|-------------------------------------|
| 1. Logic Cable | 4. Ground (unattached in image) |
| 2. -48V Connection (2x) | 5. Secured Power Supply Ground Wire |
| 3. -48V Return Connection (2x) | |

Figure 5-26. MS4652xB Power Supply Wiring

Connecting the Power Supply Wiring

Refer to [Figure 5-26](#).

1. Connect the logic cable (1) and route cable through clips as shown.
2. Connect the two -48V (2) wires together onto the lug as shown.
3. Connect the two -48V Return (3) wires together onto the lug as shown.
4. Locate the loose end of the Power Supply Ground (4).
5. Locate the ground mounting location indicated by the ground symbol on the baseplate. See item (10) of [Figure 5-22, “CPU Assembly Wiring Illustrated \(For Rev 3 Units\)”](#) on page 5-24.
6. Route ground wire (4) onto mounting lug and secure with kepinut as shown (5).

5-12 Wiring and Connections

Table 5-3. Rev 1 and 2 Comprehensive Wiring Harness Connections

Connection 1	Connection 2
CPU Motherboard ITX DC_IN19V	Backplane – P4
Backplane – J8	CPU Motherboard Half Mini PCIe – J2
Backplane – J9	CPU Motherboard Full Mini PCIe – J2
Rear Panel – 10 MHz In	Backplane – J11
Rear Panel – 10 MHz Out	Backplane – J6
Rear Panel – Trigger In	Backplane – J5
Rear Panel – Trigger Out	Backplane – J1
Backplane J3	LED Interface PCB – J1
Backplane – J13	LED Interface PCB – J2

Table 5-4. Rev 3 and 5 Comprehensive Wiring Harness Connections

Connection 1	Connection 2
CPU Motherboard – J30	Backplane – J2
CPU Motherboard – J29	Backplane – J12
CPU Motherboard – J29	No Connection
Backplane – J8	CPU Mini PCIe – J2
Backplane – J9	CPU Mini PCIe – J3
Backplane – P4	CPU Motherboard – J40
Backplane – J3	LED Interface PCB – J1
Backplane – J13	LED Interface PCB – J2
Rear Panel – 10 MHz In	Backplane – J11
Rear Panel – 10 MHz Out	Backplane – J6
Rear Panel – Trigger In	Backplane – J5
Rear Panel – Trigger Out	Backplane – J1

Chapter 6 — MS46522B Option 82/83

Removal and Replacement

6-1 Introduction

This chapter describes the removal and replacement procedures for the MS46522B with Option 82 or 83. 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 MS46522B ShockLine Vector Network Analyzer.

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

Prepare Work Area

Prepare a clean and static free work area.

1. Make sure that the work area is well grounded.
2. Cover the work surface with a soft, clean anti-static mat.
3. Provide all personnel with appropriate anti-static grounding wrist straps and similar equipment.
4. Power down the VNA and unplug the AC power cord.
5. Place the VNA onto the anti-static mat.

6-3 Positioning the MS46522B for Assembly Removal

Use this procedure to properly position the MS46522B.



Figure 6-1. Stand MS46522B Upright for Tether Removal

Position the MS46522B-082/083

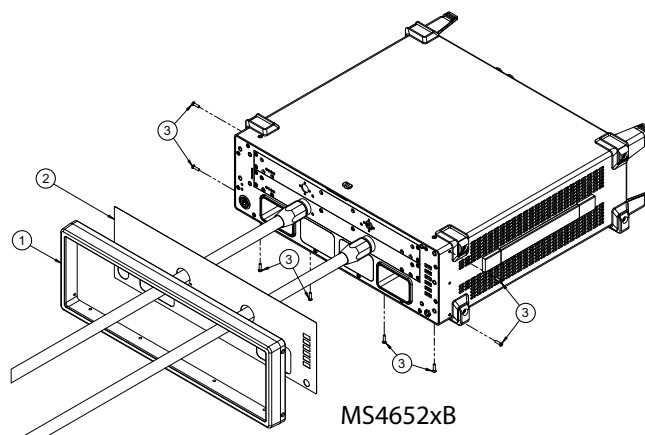
Refer to [Figure 6-1](#).

1. Lift and place the MS46522B so that it is resting upright on its rear feet extensions.
2. Run the cables along the backside of the MS4652xB.

Note	Do not attempt to detach the tether cable harness from the front panel at this point. The tether harness cable removal is covered in Section 6-7 .
-------------	--

6-4 Remove the Front Panel Bezel

Use this procedure to remove the front panel bezel with Option 82. .



- | | |
|--|---|
| 1. Bezel
2. Front Panel Overlay (Must be peeled off to expose screws for disassembly) | 3. M3x12 Flat Head Phillips Screws (8x) |
|--|---|

Figure 6-2. MS46522B Routing Cable Connection

Remove the Front Panel Bezel

Note

Do not attempt to detach the tether cable harness from the front panel at this point. The tether harness cable removal is covered in [Section 6-7](#).

Refer to [Figure 6-2](#).

1. Remove the eight Phillips screws (3) to detach the bezel.

Refer to [Figure 6-3](#).

2. Pull the bezel over and through the Option 82 tether cable assembly.
3. Peel off the front panel overlay and discard. Clean the adhesive off the front panel with Isopropyl alcohol.



Lift Off Bezel

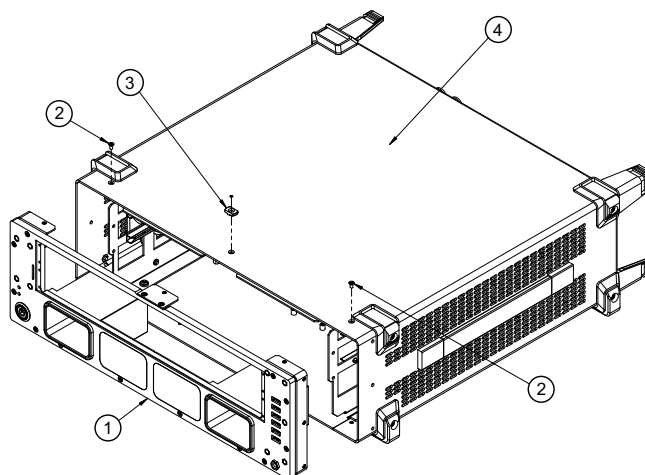


Slide Through Tether Cables

Figure 6-3. Slide Bezel Through Frequency Extension Cables

6-5 Remove MS46522B Tether Flat Panel

Use this procedure to remove or install the MS46522B tether flat panel from the chassis.



1. Flat Panel 2-Port Tether	3. Bezel Bobbin Clip
2. M3x6 Flat Head Phillips Screws (2x)	4. Chassis

Figure 6-4. MS46522B Tether Flat Panel

Remove MS46522B Tether Flat Panel

For simplicity, the tether harness assembly is not depicted in [Figure 6-4](#).

Refer to [Figure 6-4](#).

1. Position the MS46522B so the four bottom feet are resting flat on the static mat.
2. Remove the two Phillips screws (2) to detach the tether flat panel (1) from the chassis (4).
3. Retain the bezel clip (3) to use for when installing the tether flat panel (1).

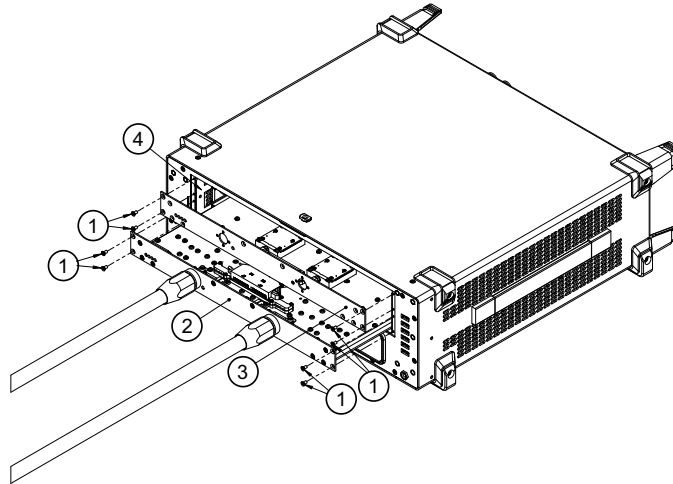
Install the MS46522B Tether Flat Panel

Refer to [Figure 6-4](#).

1. Position the MS46522B so the four bottom feet are resting flat on the static mat.
2. Install the bezel bobbin clip (3) into the chassis hole.
3. Slide the flat tether panel (1) over the chassis frame (4).
4. Install the two Phillips screws (2) as indicated in [Figure 6-4](#).

6-6 Remove VNA Module Assembly From Flat Panel

Use this procedure to remove or install the VNA Module Assembly to the Tether Flat Panel.



MS46522B

1. M3x6 Flat Head Phillips Screws (8x)	3. Top Tether Board Panel
2. Bottom Tether Panel / VNA Module Assembly	4. Card Cage

Figure 6-5. MS46522B Tether Cable Connection

Remove the Tether Cable/VNA Module Assembly

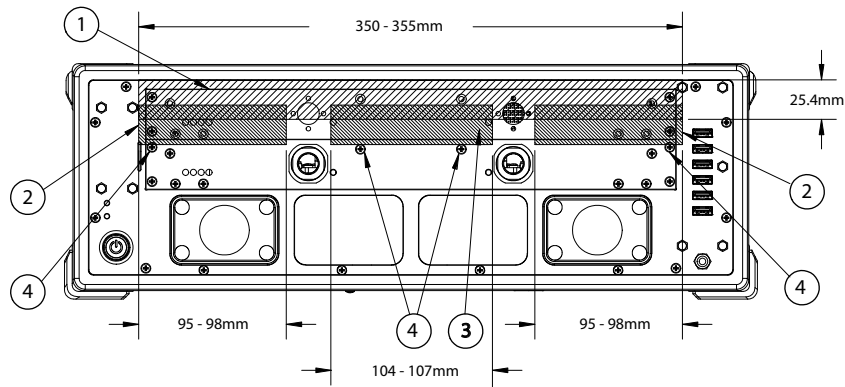
Refer to [Figure 6-5](#).

1. Remove the eight Phillips screws (1).
2. Remove the top tether board panel (3).
3. With the tether cables still attached to the bottom board panel, slide the entire tether cable / VNA Module Assembly (2) out from the Tether Flat Panel (4).

Install the Tether Cable/VNA Module Assembly

Refer to [Figure 6-6](#).

1. Reverse the procedures from “[Remove the Tether Cable/VNA Module Assembly](#)” on page 6-5.
2. Apply the foil tape (APN 3-850-66) to the back of the top and bottom board panel as described below.



- | | |
|---------------------------------|---------------------------------|
| 1. Foil Tape 350-355mm x 25.4mm | 3. Foil Tape 104-107mm x 25.4mm |
| 2. Foil Tape 95-98mm x 25.4mm | 4. Reference Screws |

Figure 6-6. Apply Foil Tape

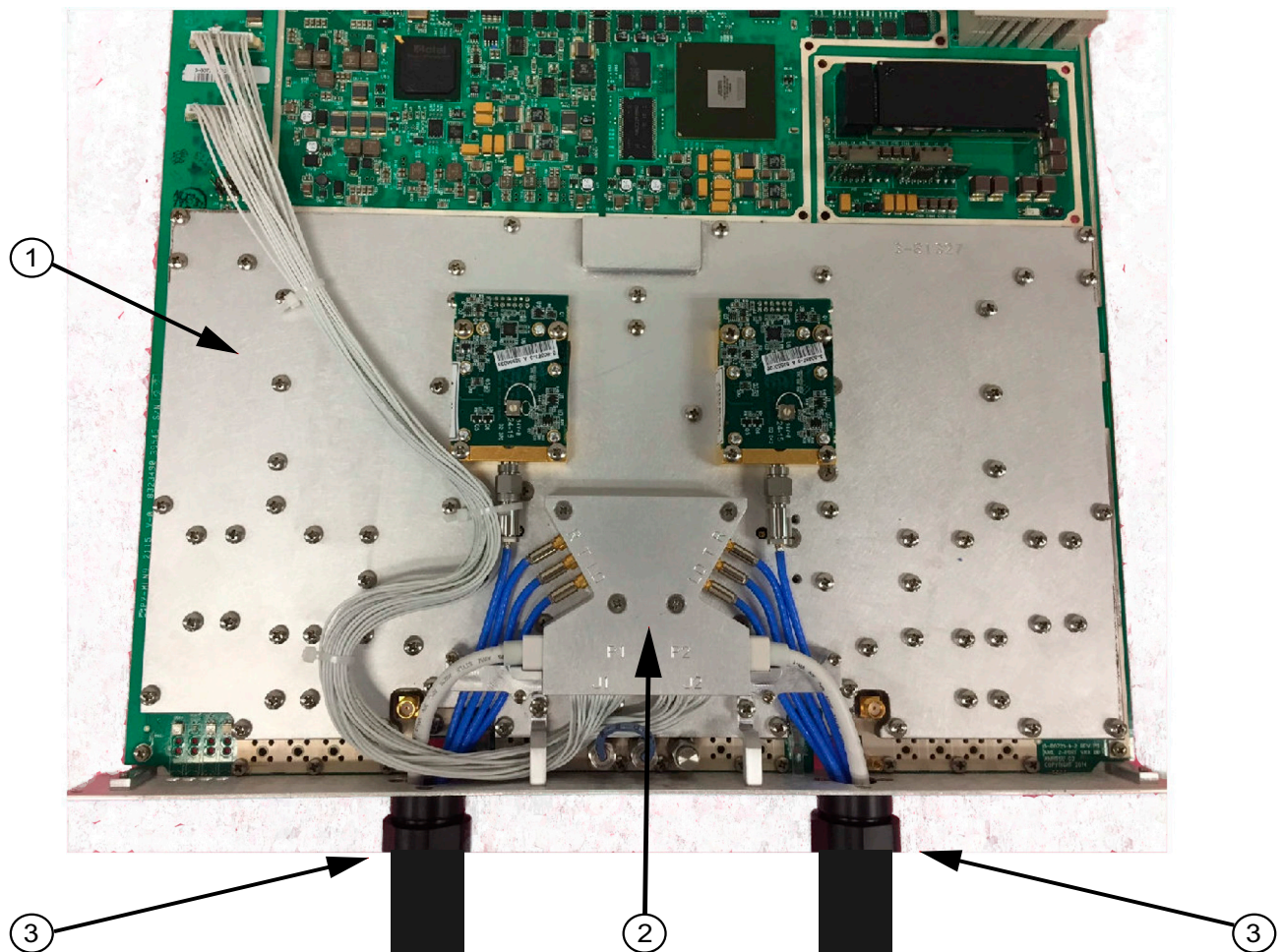
3. Cut foil tape (1) per the dimensions illustrated.
4. Position and attach the foil tape.
5. Cut 2 pieces of foil tape (2) per the dimensions illustrated.
6. Position the two strips of foil tape (2) as shown with reference to screws (4) and attach over tape (1).
7. Cut foil tape (3) per the dimensions illustrated.
8. Position the foil tape (3) as shown with reference to screws (4) and attach over tape (1).

6-7 Remove Tether Cable Harnesses from VNA Module

Use this procedure to detach the tether cable harness from the VNA module assembly. The VNA module assembly and the tether cable harness must be removed from the Tether Flat Panel before proceeding to this section. Refer to [Figure 6-7](#).

Related procedures include:

- “Remove Tether Cable Harnesses From Module” on page 6-8
- “Remove Tether Board Panel From VNA Module” on page 6-9
- “Remove the Tether Cable Harness Assembly From the Tether Panel” on page 6-10
- “Install the Tether Cable/VNA Module Assembly” on page 6-6
- “Attach Tether Wires to Interface and Source Module” on page 6-12



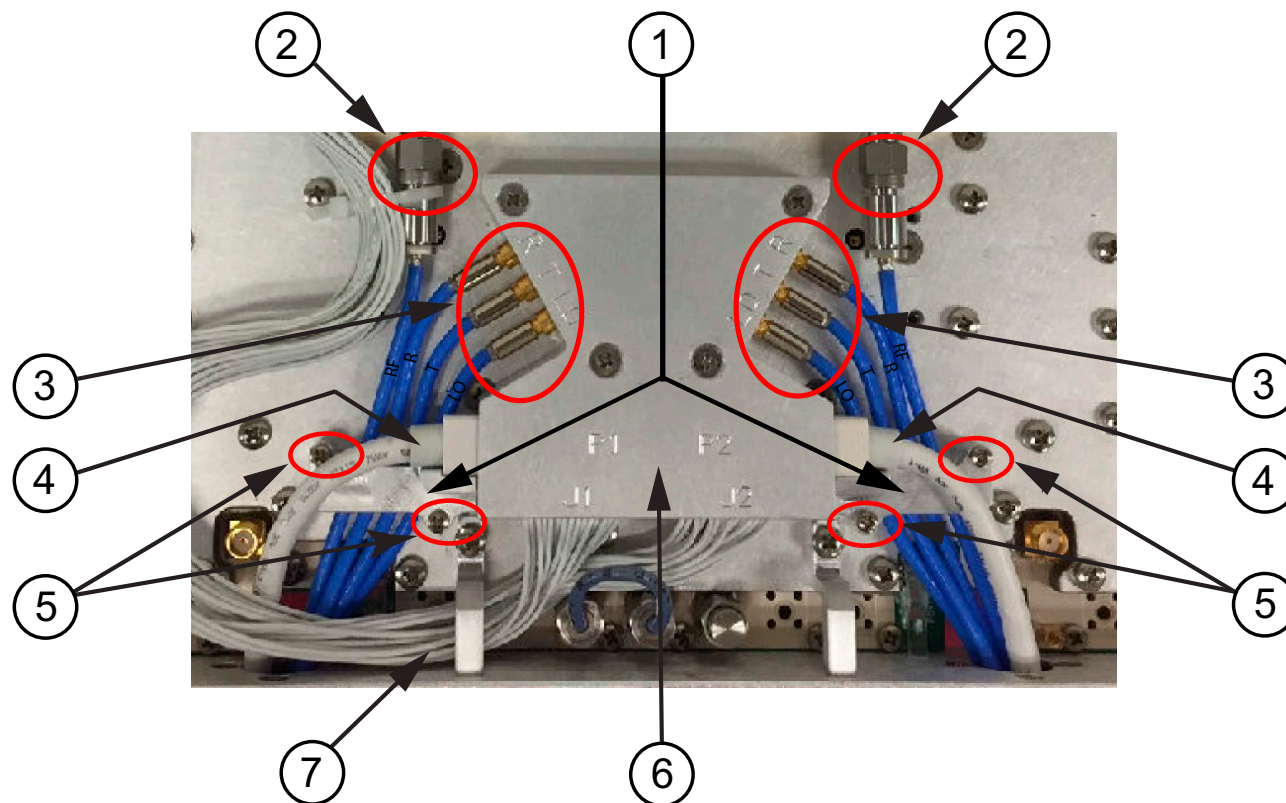
1. VNA Module Assembly
2. Tether Interface

3. Input Cable Harness

Figure 6-7. MS46522B Option 82/83 VNA Module Assembly and Tether Harness Connections Illustrated

Remove Tether Cable Harnesses From Module

Use this procedure to remove or install the tether cable harness.



- | | |
|---|---|
| 1. Tether Harness Clamp (2x) | 5. M2x6 Phillips Pan Head Screws (4x) |
| 2. 7/16 Sampler Module Connector (Labeled RF) | 6. Tether Interface Block |
| 3. "R", "T", "LO" Cables | 7. 15 Pin Single Row Ribbon Cable (2x) |
| 4. Gray Cable – 1m Mini Displayport | (Disconnecting this cable is not required when replacing VNA Module Assembly) |

Figure 6-8. Tether Interface Connections

Remove the Tether Cable Harness Procedure

Refer to [Figure 6-8](#).

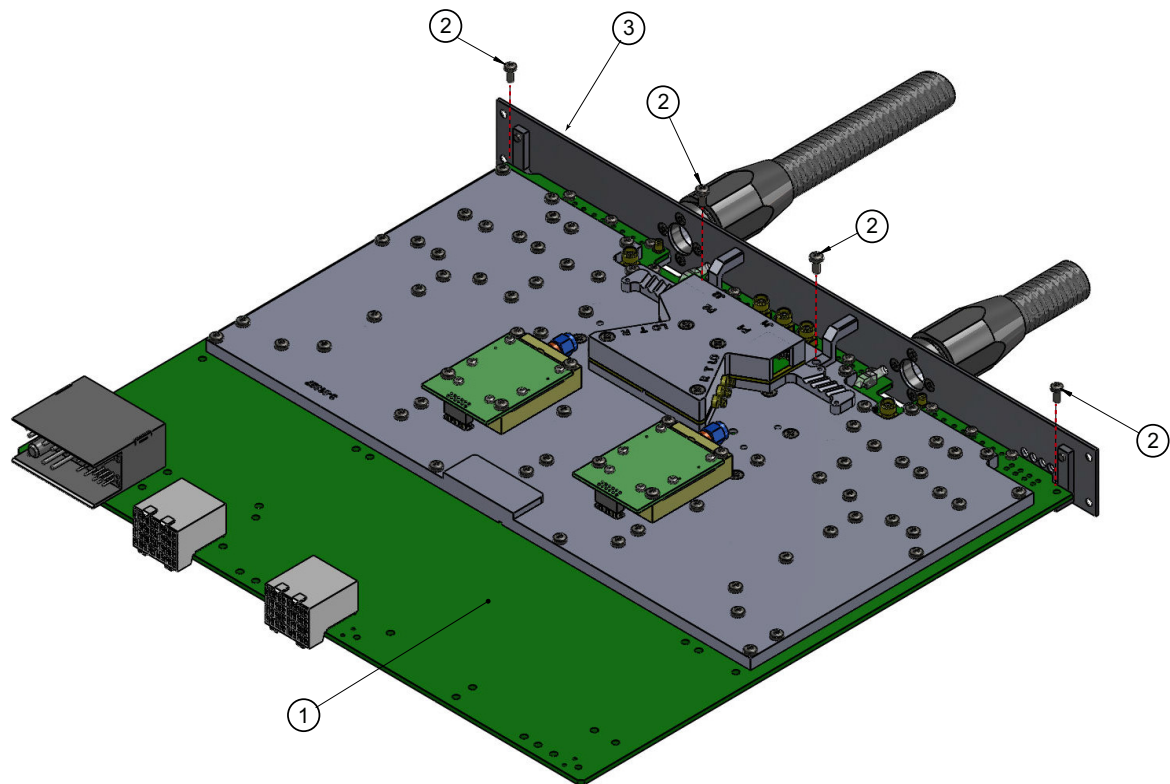
1. Locate the two harness clamps (1).
2. Remove the two Phillips screws (5) for each harness clamp.
3. Using a 7/16 open end torque wrench, turn the source module connectors (2) counter-clockwise to loosen and remove the attached cable.
4. Remove the Mini Displayport cable (4) from the tether interface (6).
5. Use a 0.125 inch open-end wrench to loosen the coupling nuts and then pull to detach each of the R, T, LO cables from the tether interface block
 - If not already labeled, label each cable with its corresponding designator inscribed on the tether interface block.

Install the Tether Cable Harness

Refer to [Section 6-10 "Install the Tether Cable Harness" on page 6-11](#).

6-8 Remove Tether Panel From VNA Module Assembly

Use this procedure to remove or install the tether board panel.



1. VNA Module Assembly	3. Tether Board Panel
2. M3x6 Phillips Pan Head Screws (4)	

Figure 6-9. Detach Tether Board Panel

Remove Tether Board Panel From VNA Module

Note The tether board panel must be removed before removal of the tether cable harness.

Refer to [Figure 6-9](#).

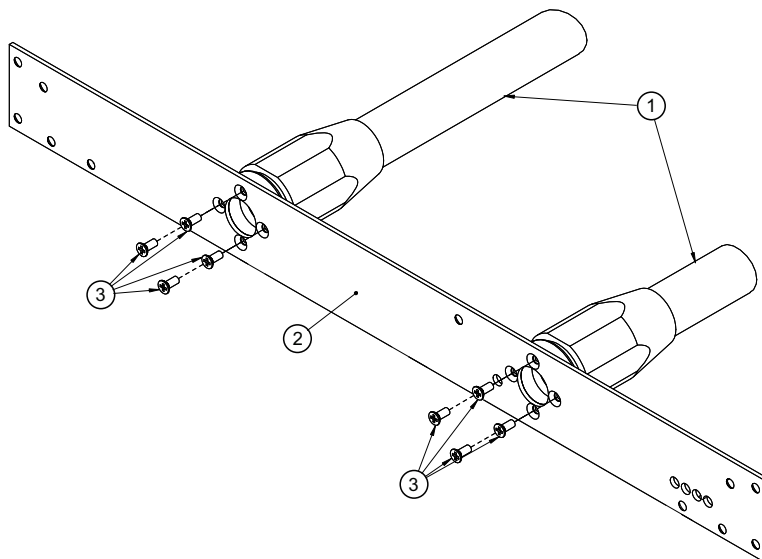
1. Locate the four Phillips Screws (2) that attach the tether panel (3) to the AXIe VNA module (1).
2. Remove the four Phillips Screws (2).
3. Carefully remove the tether panel board (3) and cable harness assembly from the AXIe module (1).

Install the Tether Panel to the VNA Module

1. Reverse the procedure from [“Remove Tether Board Panel From VNA Module”](#) on page 6-9.

6-9 Remove Tether Cable Harness from Tether Panel

Use this procedure to remove or install the tether cable harnesses.



1. Tether Cable Harness

2. Tether Board Panel

3. M3x6 Phillips Flat Head Screws (8x)

Figure 6-10. Tether Harness and Tether Board Panel Assembly

Remove the Tether Cable Harness Assembly From the Tether Panel

Refer to [Figure 6-10](#).

1. Locate and remove the eight Phillips screws (3) to detach the tether cable harness (1) from the tether board panel (2).
2. Pull the tether harness wires through the tether board panel.
 - You see the removed tether harness as in [Figure 6-11](#).

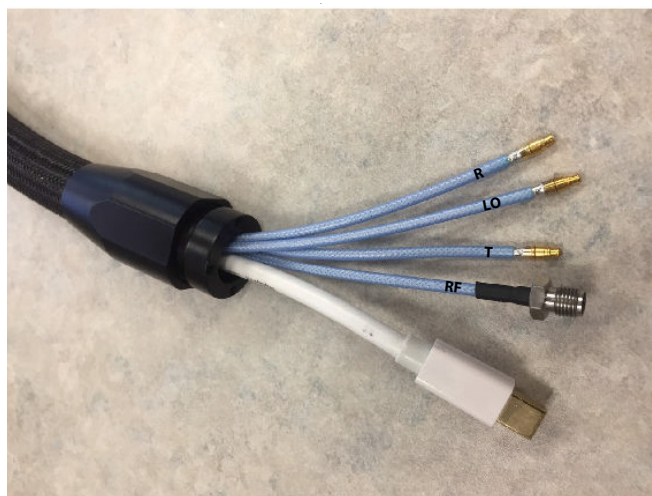


Figure 6-11. Tether Cable Harness Labeled Wires

6-10 Install the Tether Cable Harness

Use this procedure to install the tether cable harness to the VNA module assembly.

Tether Cable Harness Preparation

Refer to [Figure 6-11](#).

1. Verify that the four wires that extend from the tether cable harness are labeled as R, LO, RF, and T along with the Mini Displayport cable

Refer to [Figure 6-13](#).

2. Verify that the cable harness wire labels R, LO, RF, and T correspond with the inscribed designations on the tether interface block.
3. Confirm that the center pin of the male wire connectors are not damaged and are clean.

Attach Tether Cable Harness to Tether Board Panel

1. Lay the tether cable harness on a flat surface.

Refer to [Figure 6-12](#).

2. Grab the five wires that protrude from the cable harness and slide them through the tether board panel hole.
3. Reverse the procedure from [“Remove the Tether Cable Harness Assembly From the Tether Panel”](#) on page 6-10

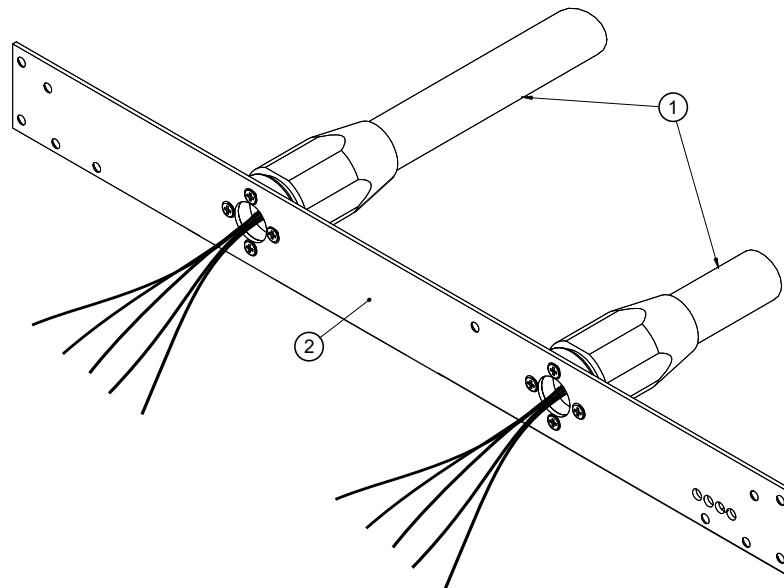
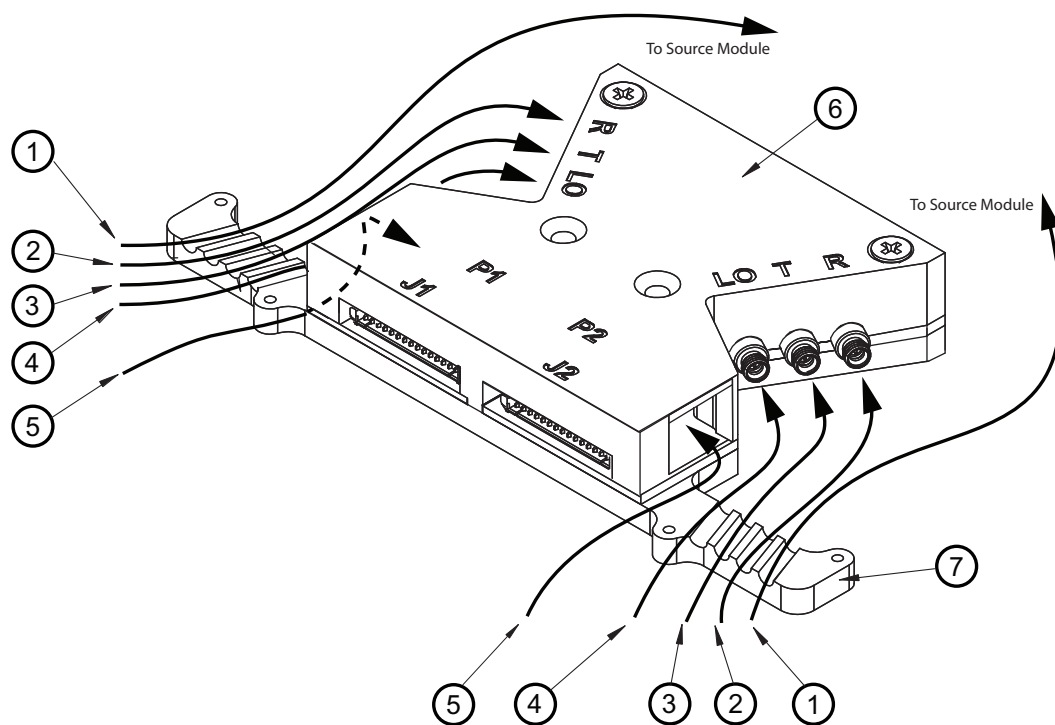


Figure 6-12. Installing MS46522B Tether Cable to Tether Board Panel

6-11 Attach Tether Wires to Interface and Source Module

Use this procedure to connect the four wires and the Mini Displayport cable to the tether interface block.



- | | |
|---------------------------|--|
| 1. Wire Labeled "RF" | 5. Mini Displayport (2x) at P1 and P2 Designations |
| 2. Wire Labeled "R" (2x) | 6. Tether Interface Block |
| 3. Wire Labeled "T" (2x) | 7. Tether Interface Bottom Shield |
| 4. Wire Labeled "LO" (2x) | |

Figure 6-13. Tether Cable Wiring Diagram

Refer to [Figure 6-13](#).

1. Remove the cover of the Tether Interface Block by removing the four fastening screws highlighted in red in [Figure 6-14](#).

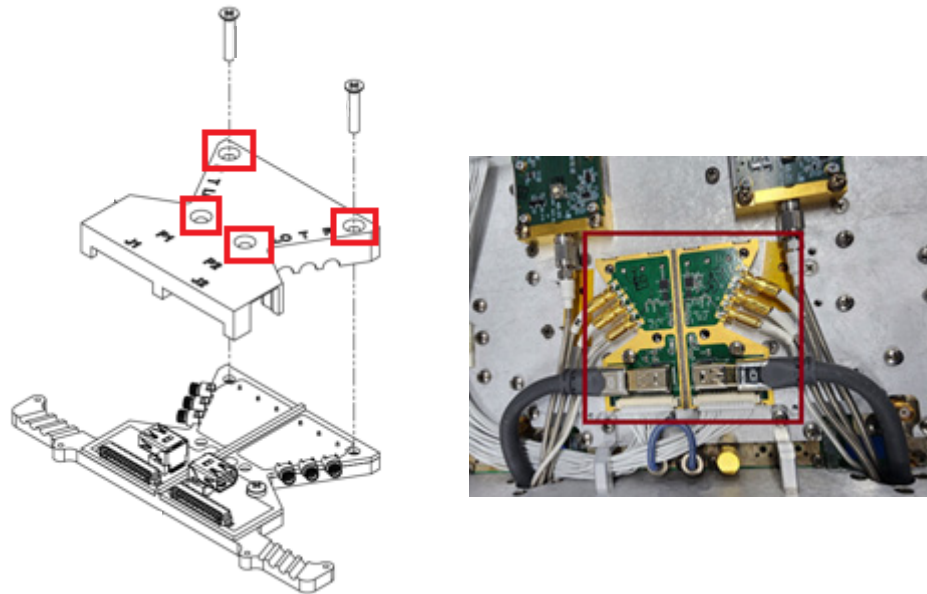


Figure 6-14. Tether Interface Block Screw Locations

2. Locate each of the wire's designation labels: RF (1), R (2), T (3), LO (4). Use the 5/16 inch open-end wrench to tighten the coupling nut of the RF cable and use the 0.125 inch open-end wrench to tighten the coupling nuts of the SMPM-T connectors.
 - Torque Specifications:
 - T and R (SSMC) connectors: 1.5 lbf in
 - LO, SRC, and RF connectors: 8 lbf in
3. Attach each wire (1) (2) (3) (4) to the corresponding designator on the tether interface block (6).
4. Snap in the Mini Displayport cable (5) into its designated location on the tether interface block.
5. Locate the two source module wire (1) with the female RF connector.
6. Locate the two source module on the VNA module assembly,
7. Connect each source module RF connector (1) to the corresponding source module.
8. Turn the source module male connector clockwise until finger tight.
9. With a 5/16 in. open end torque wrench, tighten the connector to 8 in lbf. Refer to [Figure 6-8 on page 6-8](#)
10. Find the harness clamp (1) and attach it to the tether interface (6) by installing the Phillips screws (5) through the mounting holes and tighten.
11. Reattach Tether Interface Block cover that was removed in [Step 1](#).

Connect the Tether Board Panel to the VNA Module Assembly.

1. Reverse the procedures from [“Remove VNA Module Assembly From Flat Panel” on page 6-5](#).

6-12 Left or Right Millimeter-wave Module

The replacement modules are supplied with the Tether Cable Harness pre-installed. Use this procedure to remove or install the Millimeter-wave module.

Remove Millimeter-wave Module

1. Perform [“Remove the Front Panel Bezel” on page 6-3](#).
2. Perform [“Remove MS46522B Tether Flat Panel” on page 6-4](#).
3. Perform [“Remove VNA Module Assembly From Flat Panel” on page 6-5](#).
4. Perform [“Remove Tether Panel From VNA Module Assembly” on page 6-9](#).
5. Perform [“Remove Tether Cable Harness from Tether Panel” on page 6-10](#)

Note

Both modules must be removed even if only one is required to be replaced. Install Millimeter-wave module procedure.

Install Millimeter-wave Module

1. Reverse the [“Remove Millimeter-wave Module” on page 6-14](#).

Before re-attaching the tether cable harnesses to the tether board panel, make sure the two cable harness has passed through the two openings on the replacement overlay with the adhesive back facing the tether flat panel. Refer to [Figure 6-2](#).

Do not affix the overlay to the tether flat panel until all system verification tests are completed.

6-13 VNA Module Assembly

Use this procedure to remove or install the VNA Module Assembly.

Remove VNA Module Assembly

1. Perform [“Remove the Front Panel Bezel”](#) on page 6-3.
2. Perform [“Remove MS46522B Tether Flat Panel”](#) on page 6-4.
3. Perform [“Remove the Tether Cable/VNA Module Assembly”](#) on page 6-5.
4. Perform [“Remove Tether Cable Harnesses From Module”](#) on page 6-8.
5. Perform [“Remove the Tether Cable Harness Assembly From the Tether Panel”](#) on page 6-10.

Install VNA Module Assembly

1. Reverse the [“Remove VNA Module Assembly”](#) on page 6-15” Procedure.

Before re-attaching the tether cable harnesses to the tether board panel, make sure the two cable harnesses have passed through the two openings on the replacement overlay with the adhesive back facing the tether flat panel. Refer to [Figure 6-2](#).

Do not install the top tether board panel to the tether flat panel. This allow access to the key connector for system LO calibration.

Do not affix the overlay to the tether flat panel until all system verification tests are completed.

Appendix A — Test Records

A-1 Introduction

This appendix provides test records that can be used to record the performance of the ShockLine MS4652xB.

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 MS4652xB System Performance – Units with Opt. 10, 20, 40, or 43” on page A-2
- “ShockLine MS46522B Performance – Units with Opt. 10, 20, or 40 (Rev 4 and below)” on page A-3
- “ShockLine MS46522B Performance – Units with Opt. 10 Rev 5, Opt. 20 Rev 5, or Opt. 43 Rev 1” on page A-14
- “ShockLine MS46522B Performance – Units with Opt. 82” on page A-33
- “ShockLine MS46522B Performance – Units with Opt. 83” on page A-35
- “ShockLine MS46524B Performance – Units with Opt. 10, 20, or 40 Rev 4 and below” on page A-36
- “ShockLine MS46524B Performance – Units with Opt. 10 Rev 5, Opt. 20 rev 5, or Opt. 43 Rev 1” on page A-57

Instrument Information

Model:	Serial Number:	Operator:
Options:	Software Revision:	Date:

A-2 ShockLine MS4652xB System Performance – Units with Opt. 10, 20, 40, or 43

System Performance Verification

This test is automated using the MS4652xB ShockLine VNA System Verification software.

NotePass/Fail criteria is determined from EnR, EnR <= 1 = PASS, EnR > 1 = FAIL
where EnR = |Ma-Mb|/sqrt(Ua^2+Ub^2)

Test Data Report generated by the MS4652xB ShockLine VNA System Verification Software is attached []

Instrument Information

Model: MS46522B	Serial Number:	Operator:
Options:	Software Revision:	Date:

A-3 ShockLine MS46522B Performance – Units with Opt. 10, 20, or 40 (Rev 4 and below)

Output Power Accuracy (Operational Test)

(Output Power = 0 dBm)

Table A-1. 0 dBm Output Power Accuracy (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
0.3			0.37
1			0.37
10			0.37
100			0.37
1000			0.37
2000			0.37
3000			0.37
4000			0.37
5000			0.37
6000			0.37
7000			0.37
8000			0.37
8500			0.37
9000			0.50
10000			0.50
11000			0.50
12000			0.50
13000			0.50
14000			0.50
15000			0.50
16000			0.50
17000			0.50
18000			0.50
19000			0.50
20000			0.50

Table A-1. 0 dBm Output Power Accuracy (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
21000			0.84
22000			0.84
23000			0.84
24000			0.84
25000			0.84
26000			0.84
27000			0.84
28000			0.84
29000			0.84
30000			0.84
31000			0.84
32000			0.84
33000			0.84
34000			0.84
35000			0.84
36000			0.84
37000			0.84
38000			0.84
39000			0.84
40000			0.84

Maximum Power (Operational Test)**Table A-2.** Maximum Power (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
0.3			
1			
10			
100			
1000			
2000			
3000			
4000			
5000			
6000			
7000			
8000			

Table A-2. Maximum Power (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)
8100			
8200			
8300			
8400			
8500			
9000			
10000			
11000			
12000			
13000			
14000			
15000			
16000			
17000			
18000			
19000			
20000			
21000			
22000			
23000			
24000			
25000			
26000			
27000			
28000			
29000			
30000			
31000			
32000			
33000			
34000			
35000			
36000			
37000			
38000			
39000			
40000			

System Dynamic Range*(High Power, 10 Hz IFBW, RMS)***Table A-3.** S12 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			120 118 (Opt. 10 Rev 4) 118 (Opt. 20/40 Rev 4)	
> 8.5 to 12			117 114 (Opt. 20/40 Rev 4)	
> 12 to 25			117	
> 25 to 40			120 119 (Opt. 20/40 Rev 4)	

Table A-4. S21 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			120 118 (Opt. 10 Rev 4) 118 (Opt. 20/40 Rev 4)	
> 8.5 to 12			117 114 (Opt. 20/40 Rev 4)	
> 12 to 25			117	
> 25 to 40			120 119 (Opt. 20/40 Rev 4)	

High Level Noise

(100 Hz IFBW, RMS)

Table A-5. High Level Noise – S21 Magnitude (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
3000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
4001		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
5000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
6000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
7000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8500		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
9000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
10000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
11000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
12000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
13000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	

Table A-5. High Level Noise – S21 Magnitude (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
14000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
15000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
16000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
17000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
18000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
19000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
20000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
21000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
22000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
23000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
24000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
25000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	

Table A-6. High Level Noise – S21 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.00066	0.05	
10000		0.00066	0.05	
11000		0.00066	0.05	
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	

Table A-6. High Level Noise – S21 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	

Table A-7. High Level Noise – S12 Magnitude (1 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
3000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
4001		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
5000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
6000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
7000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	

Table A-7. High Level Noise – S12 Magnitude (2 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
8000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8500		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
9000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
10000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
11000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
12000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
13000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
14000		0.000070	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
15000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
16000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
17000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
18000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
19000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
20000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
21000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
22000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
23000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
24000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
25000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	

Table A-7. High Level Noise – S12 Magnitude (3 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	

Table A-8. High Level Noise – S12 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
900		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	

Table A-8. High Level Noise – S12 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	

Frequency Accuracy (Operational Test)

Table A-9. Frequency Accuracy – Port 1

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)
1		32

Instrument Information

Model: MS46522B	Serial Number:	Operator:
Options: 082	Software Revision:	Date:

A-4 ShockLine MS46522B Performance – Units with Opt. 10 Rev 5, Opt. 20 Rev 5, or Opt. 43 Rev 1

Output Power Accuracy (Operational Test)

(Output Power = 0 dBm)

Table A-10. 0 dBm Output Power Accuracy (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
0.3			0.37	±1.5	
1			0.37	±1.5	
10			0.37	±1.5	
100			0.37	±1.5	
1000			0.37	±1.5	
2000			0.37	±1.5	
3000			0.37	±1.5	
4000			0.37	±1.5	
5000			0.37	±1.5	
6000			0.37	±1.5	
7000			0.37	±1.5	
8000			0.37	±1.5	
8500			0.37	±1.5	
9000			0.50	±2.0	
10000			0.50	±2.0	
11000			0.50	±2.0	
12000			0.50	±2.0	
13000			0.50	±2.0	
14000			0.50	±2.0	
15000			0.50	±2.0	
16000			0.50	±2.0	
17000			0.50	±2.0	
18000			0.50	±2.0	
19000			0.50	±2.0	
20000			0.50	±2.0	

Table A-10. 0 dBm Output Power Accuracy (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
21000			0.84	±2.0	
22000			0.84	±2.0	
23000			0.84	±2.0	
24000			0.84	±2.0	
25000			0.84	±2.0	
26000			0.84	±2.5	
27000			0.84	±2.5	
28000			0.84	±2.5	
29000			0.84	±2.5	
30000			0.84	±2.5	
31000			0.84	±2.5	
32000			0.84	±2.5	
33000			0.84	±2.5	
34000			0.84	±2.5	
35000			0.84	±2.5	
36000			0.84	±2.5	
37000			0.84	±2.5	
38000			0.84	±2.5	
39000			0.84	±2.5	
40000			0.84	±2.5	
41000			1.2	±3.0	
42000			1.2	±3.0	
43000			1.2	±3.0	
43500			1.2	±3.0	

Maximum Power (Operational Test)**Table A-11.** Maximum Power (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
0.3				+15	
1				+15	
10				+15	
100				+15	
1000				+15	
2000				+15	
3000				+15	
4000				+15	
5000				+15	
6000				+15	
7000				+12 (Opt 10)	
8000				+12 (Opt 10)	
8100				+10	
8200				+10	
8300				+10	
8400				+10	
8500				+10	
9000				+6	
10000				+6	
11000				+6	
12000				+6	
13000				+6	
14000				+6	
15000				+6	
16000				+6	
17000				+6	
18000				+6	
19000				+6	
20000				+6	
21000				+6	
22000				+6	
23000				+6	
24000				+6	
25000				+6	
26000				+6	
27000				+6	

Table A-11. Maximum Power (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
28000				+6	
29000				+6	
30000				+6	
31000				+6	
32000				+6	
33000				+6	
34000				+6	
35000				+6	
36000				+6	
37000				+6	
38000				+6	
39000				+6	
40000				+6	
41000				+2	
42000				+2	
43000				+2	
43500				+2	

System Dynamic Range*(High Power, 10 Hz IFBW, RMS)***Table A-12.** S12 System Dynamic Range with Serial Numbers < 2324xxx

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-13. S21 System Dynamic Range with Serial Numbers < 2324xxx

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-14. S12 System Dynamic Range with Serial Numbers $\geq 2324xxx$

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 1.8 GHz			140	
> 1.8 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-15. S21 System Dynamic Range with Serial Numbers $\geq 2324xxx$

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 1.8 GHz			140	
> 1.8 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

High Level Noise*(100 Hz IFBW, RMS)***Table A-16.** High Level Noise – S21 Magnitude with Serial Numbers < 2404xxx (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-16. High Level Noise – S21 Magnitude with Serial Numbers < 2404xxx (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-17. High Level Noise – S21 Phase with Serial Numbers < 2404xxx (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.00066	0.05	
10000		0.00066	0.05	

Table A-17. High Level Noise – S21 Phase with Serial Numbers < 2404xxx (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
11000		0.00066	0.05	
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-18. High Level Noise – S12 Magnitude with Serial Numbers < 2404xxx (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	

Table A-18. High Level Noise – S12 Magnitude with Serial Numbers < 2404xxx (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-19. High Level Noise – S12 Phase with Serial Numbers < 2404xxx (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	

Table A-19. High Level Noise – S12 Phase with Serial Numbers < 2404xxx (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-20. High Level Noise – S21 Magnitude (1 of 2) with Serial Numbers $\geq 2404xxx$

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.02	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	

Table A-20. High Level Noise – S21 Magnitude (2 of 2) with Serial Numbers $\geq 2404xxx$

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-21. High Level Noise – S21 Phase (1 of 2) with Serial Numbers $\geq 2404xxx$

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.15	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.00066	0.05	
10000		0.00066	0.05	
11000		0.00066	0.05	

Table A-21. High Level Noise – S21 Phase (2 of 2) with Serial Numbers $\geq 2404xxx$

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-22. High Level Noise – S12 Magnitude with Serial Numbers $\geq 2404xxx$ (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.02	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	

Table A-22. High Level Noise – S12 Magnitude with Serial Numbers $\geq 2404xxx$ (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-23. High Level Noise – S12 Phase (1 of 2) with Serial Numbers $\geq 2404xxx$

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.15	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	

Table A-23. High Level Noise – S12 Phase (2 of 2) with Serial Numbers $\geq 2404xxx$

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Frequency Accuracy (Operational Test)

Table A-24. Frequency Accuracy – Port 1

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)
1		32

Instrument Information

Model: MS46522B	Serial Number:	Operator:
Options: 082	Software Revision:	Date:

A-5 ShockLine MS46522B Performance – Units with Opt. 82

System Dynamic Range

Table A-25. S21 System Dynamic Range of MS46522B-082 REV 1

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 67	109		2.0	
> 67 to 87	113		2.0	
> 87 to 90	101		2.0	

Table A-26. S12 System Dynamic Range of MS46522B-082 REV 1

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 67	109		2.0	
> 67 to 87	113		2.0	
> 87 to 90	101		2.0	

Table A-27. S21 System Dynamic Range of MS46522B-082 with Serial Numbers $\geq 2324xxx$

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 62	103		2.0	
> 62 to 67	106		2.0	
> 67 to 87	110		2.0	
> 87 to 90	98		2.0	

Table A-28. S12 System Dynamic Range of MS46522B-082 with Serial Numbers $\geq 2324xxx$

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 62	103		2.0	
> 62 to 67	106		2.0	
> 67 to 87	110		2.0	
> 87 to 90	98		2.0	

Table A-29. S21 System Dynamic Range of MS46522B-082 REV 2, REV 3, and REV 5 with Serial Numbers < 2324xxx

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 67	106		2.0	
> 67 to 87	110		2.0	
> 87 to 90	98		2.0	

Table A-30. S12 System Dynamic Range of MS46522B-082 REV 2 or REV 3 with Serial Numbers < 2324xxx

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 67	106		2.0	
> 67 to 87	110		2.0	
> 87 to 90	98		2.0	

Instrument Information

Model: MS46522B	Serial Number:	Operator:
Options: 083	Software Revision:	Date:

A-6 ShockLine MS46522B Performance – Units with Opt. 83

System Dynamic Range

Table A-31. S21 System Dynamic Range of MS46522B-083

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 67	106		2.0	
> 67 to 83	110		2.0	
> 83 to 87	98		2.0	
> 87 to 90	98		2.0	

Table A-32. S12 System Dynamic Range of MS46522B-083

Frequency Range (GHz)	Specification (dB)	Calculated rms (dB)	Measurement Uncertainty (dB)	Pass/Fail
60 to 67	106		2.0	
> 67 to 83	110		2.0	
> 83 to 87	98		2.0	
> 87 to 90	98		2.0	

Instrument Information

Model:	Serial Number:	Operator:
Options:	Software Revision:	Date:

A-7 ShockLine MS46524B Performance – Units with Opt. 10, 20, or 40 Rev 4 and below

Output Power Accuracy (Operational Test)

(Output Power = 0 dBm)

Table A-33. 0 dBm Output Power Accuracy (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Port 3 Measured Power (dBm)	Port 4 Measured Power (dBm)	Measurement Uncertainty (dB)
0.3					0.37
1					0.37
10					0.37
100					0.37
1000					0.37
2000					0.37
3000					0.37
4000					0.37
5000					0.37
6000					0.37
7000					0.37
8000					0.37
8500					0.37
9000					0.50
10000					0.50
11000					0.50
12000					0.50
13000					0.50
14000					0.50
15000					0.50
16000					0.50
17000					0.50
18000					0.50
19000					0.50
20000					0.50

Table A-33. 0 dBm Output Power Accuracy (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Port 3 Measured Power (dBm)	Port 4 Measured Power (dBm)	Measurement Uncertainty (dB)
21000					0.84
22000					0.84
23000					0.84
24000					0.84
25000					0.84
26000					0.84
27000					0.84
28000					0.84
29000					0.84
30000					0.84
31000					0.84
32000					0.84
33000					0.84
34000					0.84
35000					0.84
36000					0.84
37000					0.84
38000					0.84
39000					0.84
40000					0.84

Maximum Power (Operational Test)

Table A-34. Maximum Power (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Port 3 Measured Power (dBm)	Port 4 Measured Power (dBm)	Measurement Uncertainty (dB)
0.3					
1					
10					
100					
1000					
2000					
3000					
4000					
5000					
6000					
7000					
8000					
8100					
8200					
8300					
8400					
8500					
9000					
10000					
11000					
12000					
13000					
14000					
15000					
16000					
17000					
18000					
19000					
20000					
21000					
22000					
23000					
24000					
25000					
26000					
27000					

Table A-34. Maximum Power (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Port 3 Measured Power (dBm)	Port 4 Measured Power (dBm)	Measurement Uncertainty (dB)
28000					
29000					
30000					
31000					
32000					
33000					
34000					
35000					
36000					
37000					
38000					
39000					
40000					

System Dynamic Range*(High Power, 10 Hz IFBW, RMS)***Table A-35.** S12 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			137	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			120 118 (Opt. 10 Rev 4) 118 (Opt. 20/40 Rev 4)	
> 8.5 to 12			117 114 (Opt. 20/40 Rev 4)	
> 12 to 25			117	
> 25 to 40			120 119 (Opt. 20/40 Rev 4)	

Table A-36. S21 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			120 118 (Opt. 10 Rev 4) 118 (Opt. 20/40 Rev 4)	
> 8.5 to 12			117 114 (Opt. 20/40 Rev 4)	
> 12 to 25			117	
> 25 to 40			120 119 (Opt. 20/40 Rev 4)	

Table A-37. S43 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			120 118 (Opt. 10 Rev 4) 118 (Opt. 20/40 Rev 4)	
> 8.5 to 12			117 114 (Opt. 20/40 Rev 4)	
> 12 to 25			117	
> 25 to 40			120 119 (Opt. 20/40 Rev 4)	

Table A-38. S34 System Dynamic Range

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 4 to 6			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/40)	
> 8 to 8.5			120 118 (Opt. 10 Rev 4) 118 (Opt. 20/40 Rev 4)	
> 8.5 to 12			117 114 (Opt. 20/40 Rev 4)	
> 12 to 25			117	
> 25 to 40			120 119 (Opt. 20/40 Rev 4)	

High Level Noise*(100 Hz IFBW, RMS)***Table A-39.** High Level Noise – S21 Magnitude (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
3000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
4001		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
5000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
6000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
7000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8500		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
9000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
10000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
11000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
12000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
13000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	

Table A-39. High Level Noise – S21 Magnitude (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
14000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
15000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
16000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
17000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
18000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
19000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
20000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
21000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
22000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
23000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
24000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
25000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	

Table A-40. High Level Noise – S21 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	

Table A-40. High Level Noise – S21 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	

Table A-41. High Level Noise – S12 Magnitude (1 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
3000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
4001		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
5000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
6000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
7000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	

Table A-41. High Level Noise – S12 Magnitude (2 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
8000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8500		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
9000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
10000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
11000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
12000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
13000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
14000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
15000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
16000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
17000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
18000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
19000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
20000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
21000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
22000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
23000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
24000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
25000		0.00070	0.003 0.004 (Opt. 20/40 Rev 4)	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	

Table A-41. High Level Noise – S12 Magnitude (3 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	

Table A-42. High Level Noise – S12 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	

Table A-42. High Level Noise – S12 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	

Table A-43. High Level Noise – S43 Magnitude (1 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	

Table A-43. High Level Noise – S43 Magnitude (2 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
3000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
4001		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
5000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
6000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
7000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8500		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
9000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
10000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
11000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
12000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
13000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
14000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
15000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
16000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
17000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	

Table A-43. High Level Noise – S43 Magnitude (3 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
18000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
19000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
20000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
21000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
22000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
23000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
24000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
25000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	

Table A-44. High Level Noise – S43 Phase (1 of 3)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	

Table A-44. High Level Noise – S43 Phase (2 of 3)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	

Table A-44. High Level Noise – S43 Phase (3 of 3)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	

Table A-45. High Level Noise – S34 Magnitude (1 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
3000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
4001		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
5000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
6000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
7000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
8000		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	

Table A-45. High Level Noise – S34 Magnitude (2 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
8500		0.00031	0.003 0.004 (Opt. 10 Rev 4) 0.004 (Opt. 20/40 Rev 4)	
9000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
10000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
11000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
12000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
13000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
14000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
15000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
16000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
17000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
18000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
19000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
20000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
21000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
22000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
23000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
24000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
25000		0.000070	0.003 0.004 (Opt. 20/40 Rev 4)	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	

Table A-45. High Level Noise – S34 Magnitude (3 of 3)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	

Table A-46. High Level Noise – S34 Phase (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	

Table A-46. High Level Noise – S34 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	

Frequency Accuracy (Operational Test)

Table A-47. Frequency Accuracy – Port 1

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)
1		32 Hz

Table A-48. Frequency Accuracy – Port 3

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)
1		32 Hz

Instrument Information

Model: MS46524B	Serial Number:	Operator:
Options:	Software Revision:	Date:

A-8 ShockLine MS46524B Performance – Units with Opt. 10 Rev 5, Opt. 20 rev 5, or Opt. 43 Rev 1

Output Power Accuracy (Operational Test)

(Output Power = 0 dBm)

Table A-49. 0 dBm Output Power Accuracy (1 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
0.3			0.37	±1.5	
1			0.37	±1.5	
10			0.37	±1.5	
100			0.37	±1.5	
1000			0.37	±1.5	
2000			0.37	±1.5	
3000			0.37	±1.5	
4000			0.37	±1.5	
5000			0.37	±1.5	
6000			0.37	±1.5	
7000			0.37	±1.5	
8000			0.37	±1.5	
8500			0.37	±1.5	
9000			0.50	±2.0	
10000			0.50	±2.0	
11000			0.50	±2.0	
12000			0.50	±2.0	
13000			0.50	±2.0	
14000			0.50	±2.0	
15000			0.50	±2.0	
16000			0.50	±2.0	
17000			0.50	±2.0	
18000			0.50	±2.0	
19000			0.50	±2.0	
20000			0.50	±2.0	

Table A-49. 0 dBm Output Power Accuracy (2 of 2)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
21000			0.84	±2.0	
22000			0.84	±2.0	
23000			0.84	±2.0	
24000			0.84	±2.0	
25000			0.84	±2.0	
26000			0.84	±2.5	
27000			0.84	±2.5	
28000			0.84	±2.5	
29000			0.84	±2.5	
30000			0.84	±2.5	
31000			0.84	±2.5	
32000			0.84	±2.5	
33000			0.84	±2.5	
34000			0.84	±2.5	
35000			0.84	±2.5	
36000			0.84	±2.5	
37000			0.84	±2.5	
38000			0.84	±2.5	
39000			0.84	±2.5	
40000			0.84	±2.5	
41000			1.2	±3.0	
42000			1.2	±3.0	
43000			1.2	±3.0	
43500			1.2	±3.0	

Maximum Power (Operational Test)

Table A-50. Maximum Power (1 of 3)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
0.3				+15	
1				+15	
10				+15	
100				+15	
1000				+15	
2000				+15	

Table A-50. Maximum Power (2 of 3)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
3000				+15	
4000				+15	
5000				+15	
6000				+15	
7000				+12 (Opt 10) + 10 (Opt 20/43)	
8000				+12 (Opt 10) + 10 (Opt 20/43)	
8100				+10	
8200				+10	
8300				+10	
8400				+10	
8500				+10	
9000				+6	
10000				+6	
11000				+6	
12000				+6	
13000				+6	
14000				+6	
15000				+6	
16000				+6	
17000				+6	
18000				+6	
19000				+6	
20000				+6	
21000				+6	
22000				+6	
23000				+6	
24000				+6	
25000				+6	
26000				+6	
27000				+6	
28000				+6	
29000				+6	
30000				+6	
31000				+6	
32000				+6	

Table A-50. Maximum Power (3 of 3)

Frequency (MHz)	Port 1 Measured Power (dBm)	Port 2 Measured Power (dBm)	Measurement Uncertainty (dB)	Specification (dB)	Pass/Fail
33000				+6	
34000				+6	
35000				+6	
36000				+6	
37000				+6	
38000				+6	
39000				+6	
40000				+6	
41000				+2	
42000				+2	
43000				+2	
43500				+2	

System Dynamic Range

(High Power, 10 Hz IFBW, RMS)

Table A-51. S12 System Dynamic Range with Serial Numbers < 2324xxx

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-52. S21 System Dynamic Range with Serial Numbers < 2324xxx

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-53. S43 System Dynamic Range with Serial Numbers < 2324xxx

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-54. S34 System Dynamic Range with Serial Numbers < 2324xxx

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 2 GHz			140	
> 2 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-55. S12 System Dynamic Range with Serial Numbers $\geq 2324xx$

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 1.8 GHz			140	
> 1.8 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-56. S21 System Dynamic Range with Serial Numbers $\geq 2324xx$

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 1.8 GHz			140	
> 1.8 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-57. S43 System Dynamic Range with Serial Numbers $\geq 2324xxx$

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 1.8 GHz			140	
> 1.8 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

Table A-58. S34 System Dynamic Range with Serial Numbers $\geq 2324xx$

Frequency (GHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
300 kHz to 1 MHz			90	
> 1 MHz to 50 MHz			100	
> 50 MHz to 1.8 GHz			140	
> 1.8 to 4			137	
> 4 to 6			130	
> 6 to 8			128 (Opt. 10) 122 (Opt. 20/43)	
> 8 to 8.5			118	
> 8.5 to 12			114	
> 12 to 25			117	
> 25 to 40			119	
> 40 to 43.5			100	

High Level Noise*(100 Hz IFBW, RMS)***Table A-59.** High Level Noise – S21 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	

Table A-59. High Level Noise – S21 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
28000		0.000090	0.004	
29000		0.000090	0.004	
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-60. High Level Noise – S21 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	

Table A-60. High Level Noise – S21 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
8500		0.0015	0.05	
9000		0.00066	0.05	
10000		0.00066	0.05	
11000		0.00066	0.05	
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-61. High Level Noise – S12 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-61. High Level Noise – S12 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-62. High Level Noise – S12 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	

Table A-62. High Level Noise – S12 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-63. High Level Noise – S43 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-63. High Level Noise – S43 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-64. High Level Noise – S43 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.00066	0.05	

Table A-64. High Level Noise – S43 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.00066	0.05	
11000		0.00066	0.05	
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-65. High Level Noise – S34 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.004	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-65. High Level Noise – S34 Magnitude with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-66. High Level Noise – S34 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.04	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	

Table A-66. High Level Noise – S34 Phase with Serial Number < 2404xxx (Excluding 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-67. High Level Noise – S21 Magnitude with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.02	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-67. High Level Noise – S21 Magnitude with Serial Number $\geq$ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-68. High Level Noise – S21 Phase with Serial Number $\geq$ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.15	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.00066	0.05	

Table A-68. High Level Noise – S21 Phase with Serial Number $\geq$ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.00066	0.05	
11000		0.00066	0.05	
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-69. High Level Noise – S12 Magnitude with Serial Number $\geq$ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.02	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-69. High Level Noise – S12 Magnitude with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-70. High Level Noise – S12 Phase with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.15	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	

Table A-70. High Level Noise – S12 Phase with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-71. High Level Noise – S43 Magnitude with Serial Number ≥ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.02	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-71. High Level Noise – S43 Magnitude with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-72. High Level Noise – S43 Phase with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.15	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.00066	0.05	

Table A-72. High Level Noise – S43 Phase with Serial Number $\geq$ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.00066	0.05	
11000		0.00066	0.05	
12000		0.00066	0.05	
13000		0.00066	0.05	
14000		0.00066	0.05	
15000		0.00066	0.05	
16000		0.00066	0.05	
17000		0.00066	0.05	
18000		0.00066	0.05	
19000		0.00066	0.05	
20000		0.00066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Table A-73. High Level Noise – S34 Magnitude with Serial Number $\geq$ 2404xxx (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
0.3		0.00015	0.02	
1		0.00015	0.004	
10		0.00015	0.004	
50		0.00015	0.004	
100		0.00015	0.004	
501		0.00015	0.004	
1000		0.00015	0.004	
2000		0.00031	0.004	
3000		0.00031	0.004	
4001		0.00031	0.004	
5000		0.00031	0.004	
6000		0.00031	0.004	
7000		0.00031	0.004	
8000		0.00031	0.004	
8500		0.00031	0.004	
9000		0.000070	0.004	
10000		0.000070	0.004	
11000		0.000070	0.004	
12000		0.000070	0.004	
13000		0.000070	0.004	
14000		0.000070	0.004	
15000		0.000070	0.004	
16000		0.000070	0.004	
17000		0.000070	0.004	
18000		0.000070	0.004	
19000		0.000070	0.004	
20000		0.000070	0.004	
21000		0.000070	0.004	
22000		0.000070	0.004	
23000		0.000070	0.004	
24000		0.000070	0.004	
25000		0.000070	0.004	
26000		0.000090	0.004	
27000		0.000090	0.004	
28000		0.000090	0.004	
29000		0.000090	0.004	

Table A-73. High Level Noise – S34 Magnitude with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)	Specification (dB rms)	Pass/Fail
30000		0.000090	0.004	
31000		0.000090	0.004	
32000		0.000090	0.004	
33000		0.000090	0.004	
34000		0.000090	0.004	
35000		0.000090	0.004	
36000		0.000090	0.004	
37000		0.000090	0.004	
38000		0.000090	0.004	
39000		0.000090	0.004	
40000		0.000090	0.004	
41000		0.000060	0.004	
42000		0.000060	0.004	
43000		0.000060	0.004	
43500		0.000060	0.004	

Table A-74. High Level Noise – S34 Phase with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (1 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
0.3		0.0011	0.15	
1		0.0011	0.04	
10		0.0011	0.04	
50		0.0011	0.04	
100		0.0011	0.04	
501		0.0011	0.04	
1000		0.0011	0.04	
2000		0.0015	0.05	
3000		0.0015	0.05	
4001		0.0015	0.05	
5000		0.0015	0.05	
6000		0.0015	0.05	
7000		0.0015	0.05	
8000		0.0015	0.05	
8500		0.0015	0.05	
9000		0.000066	0.05	

Table A-74. High Level Noise – S34 Phase with Serial Number $\geq 2404xxx$ (Including 2341204, 2345204, 2346201, 2349203, 2351202, 2403201) (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)	Specification (Deg rms)	Pass/Fail
10000		0.000066	0.05	
11000		0.000066	0.05	
12000		0.000066	0.05	
13000		0.000066	0.05	
14000		0.000066	0.05	
15000		0.000066	0.05	
16000		0.000066	0.05	
17000		0.000066	0.05	
18000		0.000066	0.05	
19000		0.000066	0.05	
20000		0.000066	0.05	
21000		0.00065	0.05	
22000		0.00065	0.05	
23000		0.00065	0.05	
24000		0.00065	0.05	
25000		0.00065	0.05	
26000		0.00079	0.05	
27000		0.00079	0.05	
28000		0.00079	0.05	
29000		0.00079	0.05	
30000		0.00079	0.05	
31000		0.00079	0.05	
32000		0.00079	0.05	
33000		0.00079	0.05	
34000		0.00079	0.05	
35000		0.00079	0.05	
36000		0.00079	0.05	
37000		0.00079	0.05	
38000		0.00079	0.05	
39000		0.00079	0.05	
40000		0.00079	0.05	
41000		0.00077	0.05	
42000		0.00077	0.05	
43000		0.00077	0.05	
43500		0.00077	0.05	

Frequency Accuracy (Operational Test)

Table A-75. Frequency Accuracy – Port 1

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)
1		32

Table A-76. Frequency Accuracy – Port 3

Frequency (GHz)	Measured Value (Hz)	Measurement Uncertainty (Hz)
1		32

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