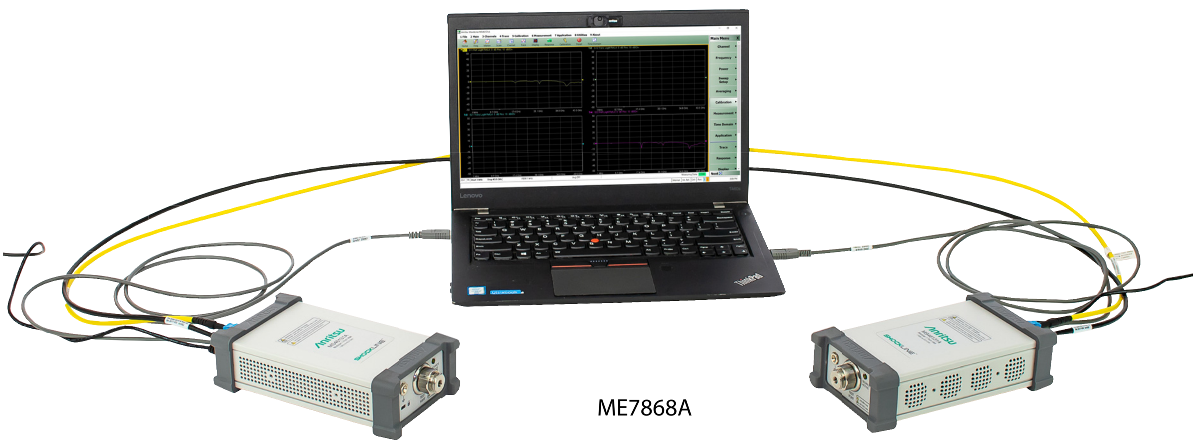
Maintenance Manual

ShockLine™
Modular
Vector Network Analyzer

MS46131A-010, 1 MHz to 8 GHz
MS46131A-020, 1 MHz to 20 GHz
MS46131A-043, 1 MHz to 43.5 GHz
ME7868A, 1 MHz to 43.5 GHz, 2-Port



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NOTICE

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 MS46131A Vector Network Analyzer. The information includes product description, performance verification procedures, parts removal and replacement procedures, and troubleshooting information.

The ME7868A is a modular 2-port VNA consisting of two ShockLine MS46131A 1-port VNAs, a frequency option, and a PhaseLync™ Synchronization option.

1-2 Description

The ShockLine MS46131A Vector Network Analyzer is a 1-port USB Vector Network Analyzer that is controlled from an external PC running ShockLine software. It is based on patented ShockLine VNA-on-chip technology, which simplifies the internal VNA architecture at high frequencies, reduces instrument cost, and enhances accuracy and measurement repeatability. The combination of low cost and good performance make MS46131A Vector Network Analyzer ideal candidates for testing RF and Microwave passive devices to 43.5 GHz.

The PhaseLync option enables two MS46131A Vector Network Analyzers to phase synchronize, enabling vector 2-port S-parameter measurements. The two ShockLine MS46131A VNAs determine the instrument performance of the ME7868A, as they become the test ports and provide the source and measurement capabilities for the 2-port VNA. The PhaseLync option supports synchronization between two MS46131A Vector Network Analyzers up to a distance of 100 meters. For simplicity purposes, the ME7868A and MS46131A-012 will be used interchangeably when referring to 2-port measurements or verifications, as two MS46131A-012 VNAs enable the ME7868A system.

Standard Accessories

Each instrument includes:

- Power Cord
- AC/DC Adapter
- USB Type A to Micro-B Cable

Available Options

The main system options for MS46131A are:

- MS46131A-002 – Time Domain with Time Gating
- MS46131A-012 – PhaseLync Synchronization
- MS46131A-024 – Universal Fixture Extraction
- MS46131A-010 – Frequency Option, 1 MHz to 8 GHz, type N(f) test port
- MS46131A-020 – Frequency Option, 1 MHz to 20 GHz, type K(m) test port
- MS46131A-043 – Frequency Option, 1 MHz to 43.5 GHz, type K(m) test port

The main system options for ME7868A are:

- ME7868A-010-2 – 8 GHz, 2 meter system
- ME7868A-010-5 – 8 GHz, 5 meter system
- ME7868A-010-25 – 8 GHz, 25 meter system
- ME7868A-020-2 – 20 GHz, 2 meter system

- ME7868A-020-5 – 20 GHz, 5 meter system
- ME7868A-020-25 – 20 GHz, 25 meter system
- ME7868A-043-2 – 43.5 GHz, 2 meter system
- ME7868A-043-5 – 43.5 GHz, 5 meter system
- ME7868A-043-25 – 43.5 GHz, 25 meter system

Identification Number

All Anritsu MS46131A instruments are assigned a seven-digit ID number (Serial Number), such as “1934003”. 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, installed options, and serial number. For example, MS46131A, Option 2, Option 10, Serial Number 1934007.Related Documents

Other documents are available for the MS46131A at the Anritsu web site at: www.anritsu.com

- ShockLine Product Information, Compliance, and Safety (PICS) – 10100-00067
- ShockLine MS46131A Series VNA Technical Data Sheet – 11410-01146
- ShockLine MS46131A VNA Operation Manual – 10410-00780
- ShockLine MS46121AB, MS46122AB, MS46131A, MS46322AB Software User Interface Reference Manual – 10410-00337
- ShockLine Programming Manual – 10410-00746
- ShockLine MS46131A Modular VNA Technical Data Sheet – 11410-01146
- ShockLine ME7868A Modular VNA Technical Data Sheet – 11410-02824

1-3 Basic Maintenance

Calibration/Certification

Test instruments are often put on a calibration cycle for performance verification in order to provide a quality check or assurance. The details of the performance verification procedures are included in Chapter 2 — Performance Verification.

Repair Service

In the event that the MS46131A VNA requires repair, contact your local Anritsu Service Center. See Section 1-4 “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

1-4 Anritsu Customer Service Centers

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

http://www.anritsu.com/contact.asp

Choose a country for regional contact information.

1-5 Recommended Test Equipment

The following test equipment is recommended for use in testing and maintaining the ShockLine MS46131A without Option 12.

Table 1-1. Recommended Test Equipment for MS46131A without Option 12 (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes[a]
Airline (For Opt. 10)	Impedance: 50 Ohm Connector: N(m)	Anritsu Model SC3833	P
Short (For Opt. 10)	Connector: GPC-7	Anritsu Model 22A50	P
Offset Termination (For Opt. 10)	Frequency: DC to 8 GHz Return Loss: 20 dB Connector: GPC-7	Anritsu Model SC8408	P
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8	P
Torque Wrench (For Opt. 10)	3/4 in. Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200	P
Airline (For Opt. 20 or 43)	Impedance: 50 Ohm Connector: K(f)	Anritsu Model SC7760	P
Short (For Opt. 20 or 43)	Connector: K(f)	Anritsu Model 23KF50	P
Offset Termination (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Return Loss: 20 dB Connector: K(f)	Anritsu Model SC7888	P
Calibration Kit (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSLKF50A-43.5	P
Torque Wrench (For Opt. 20 or 43)	5/16 in. Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201	P
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	Impedance: 50 ohm Connector: BNC(m) to BNC(m)	Anritsu Part Number 2000-1627-R	P, A
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50	P, A
Adapter	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50	P, A
RF Coaxial Cable	Frequency: DC to 20 GHz Connector: K(m) to K(f)	Anritsu Model 15KKF50-1.0A	P, A
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A	A
Power Sensor	Frequency: 100 kHz to 40 GHz Connector Type: K(m)	Anritsu Model SC7413	A
Fixed Attenuator	Frequency: 100 kHz to 40 GHz Attenuation: 10 dB Connector: K(m) to K(f)	Anritsu Model 41KC-10	A

Table 1-1. Recommended Test Equipment for MS46131A without Option 12 (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes[a]
PC Controller	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any	A
GPIB Adapter	USB to GPIB	National Instruments Model GPIB-USB-HS or GPIB-USB-HS+	A

a.P= Performance Verification; A = Adjustment

The following test equipment is recommended for use in testing and maintaining the ShockLineMS46131A with Option 12.

Table 1-2. Recommended Test Equipment for MS46131A with Option 12 (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes[a]
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8	P
Calibration Kit (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(f)	Anritsu Model OSLNF50A-8 or TOSLNF50A-8	P
Verification Kit (For Opt. 10)	Connector: N Type	Anritsu Model 3663-3 (Verification Software included)	P
Torque Wrench (For Opt. 10)	3/4 in. Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200	P
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to N(m)	Anritsu Model 33NN50B	P
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to N(f)	Anritsu Model 33NNF50B	P
Calibration Kit(For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(m)	Anritsu Model TOSLK50A-43.5	P
Calibration Kit (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSLKF50A-43.5	P
Verification Kit (For Opt. 20 or 43)	Connector: K Type	Anritsu Model 3668-4 (Verification Software included)	P
Adapter (For Opt. 20 or 43)	Connector: K(m) to K(f)	Anritsu Model 33KKF50C	P
Adapter (For Opt. 20 or 43)	Connector: K(f) to K(f)	Anritsu Model 33KFKF50C	P
Torque Wrench (For Opt. 20 or 43)	5/16 in. Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201	P
Torque Wrench (For Opt. 20 or 43)	13/16 in. Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-203	P
PC Controller	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any	P, A
Interface Cable	USB Type A to Micro-B Cable	Anritsu Part Number 2000-1816-R (Qty 2)	P

Table 1-2. Recommended Test Equipment for MS46131A with Option 12 (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model	Use Codes[a]
Interface Cable	PhaseLync Sync Cable Length: 1 m	Anritsu Part Number 2000-1947-R	P
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	Impedance: 50 ohm Connector: BNC(m) to BNC(m)	Anritsu Part Number 2000-1627-R	P, A
RF Coaxial Cable	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 3670K50-2	P, A
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A	P, A
Power Sensor	Frequency: 100 kHz to 40 GHz Connector Type: K(m)	Anritsu Model SC7413	P, A
Fixed Attenuator	Frequency: 100 kHz to 40 GHz Attenuation: 10 dB Connector: K(m) to K(f)	Anritsu Model 41KC-10	P, A
Adapter	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50	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
GPIB Adapter	USB to GPIB	National Instruments Model GPIB-USB-HS or GPIB-USB-HS+	A

a.P= Performance Verification; A = Adjustment

1-6 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 MS46131A. They can also be viewed in the ShockLine Application About box display (Select 9 Help | 1. ShockLine Info.).

Table 1-3 summarizes the available replaceable parts and assemblies.

Table 1-3. Replaceable Parts and Assemblies

Part Number	Description
3-ND85131-RFB	VNA Assembly of MS46131A instruments with Option 10
3-ND85132-RFB	VNA Assembly of MS46131A instruments with Options 10 and 12
3-ND85133-RFB	VNA Assembly of MS46131A instruments with Option 20
3-ND85134-RFB	VNA Assembly of MS46131A instruments with Options 20 and 12
3-ND85135-RFB	VNA Assembly of MS46131A instruments with Option 43
3-ND85136-RFB	VNA Assembly of MS46131A instruments with Options 43 and 12
3-513-149	N female Test Port Adapter
3-83829	Semi-rigid Coaxial Cable Assembly, SMA(m) to SMA(m) – For instruments with Option 10 – Linking between N female Test Port Adapter and VNA Assembly
3-83773	Ruggedized K male Test Port Adapter – For instruments with Options 20 and 43
3-ND85129	Fan Assembly
3-ND85130	Fan PCB Assembly
3-ND85171	Test Port Connector Plate with LED indicator
3-83515	Plastic End Cap
40-187-R	AC/DC Adapter
2000-1816-R	USB Type A to Micro-B Cable, 6 ft

Chapter 2 — Performance Verification

2-1 Introduction to Performance Verification

This chapter provides procedures to be used to verify the performance of ShockLine MS46131A.

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 residual specifications (corrected directivity, source match, load match, and tracking) which are measured using traceable airlines (absolute 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 a 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.

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

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.

Figure 2-1 below shows the VNA Traceability by means of Verification Kit.

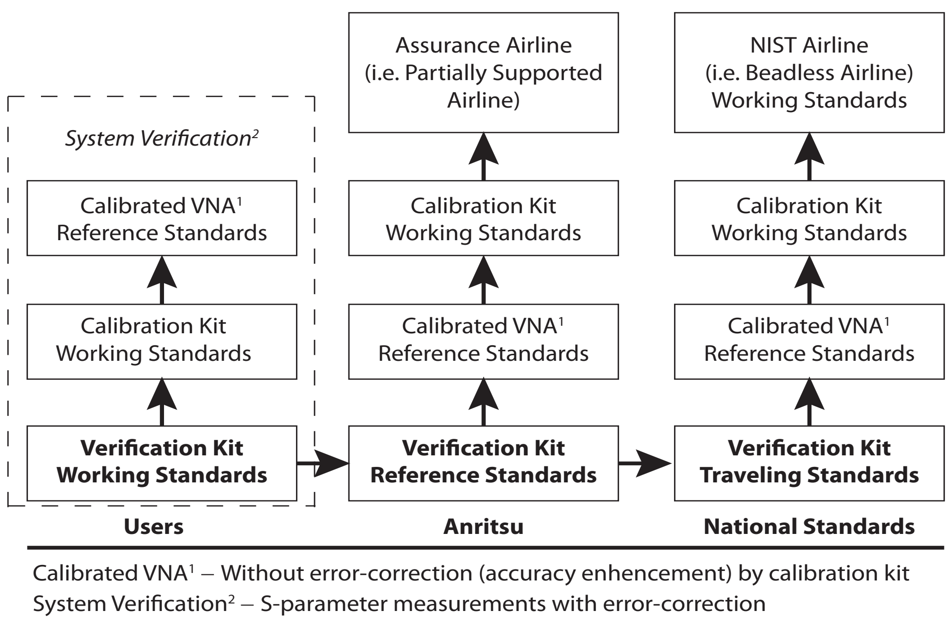


Figure 2-1. VNA Traceability

2-3 Electrostatic Discharge Prevention

A Vector Network Analyzer is a precision electronic instrument consists 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 the instrument 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 condition and stability of the test port connectors, through-cable, calibration kit and adapters (if used), and the surrounding environmental conditions determine system measurement integrity to a large extent.

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

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

- Warm-up Time:
    - 60 minutes
- Environmental Conditions
    - Temperature
        - For System Verification, 23 °C ± 3 °C, with < 1 °C variation from calibration temperature
        - For other tests, 25 °C ± 5 °C
    - Relative Humidity
        - 20-50% recommended

2-5 PASS/FAIL Determination

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

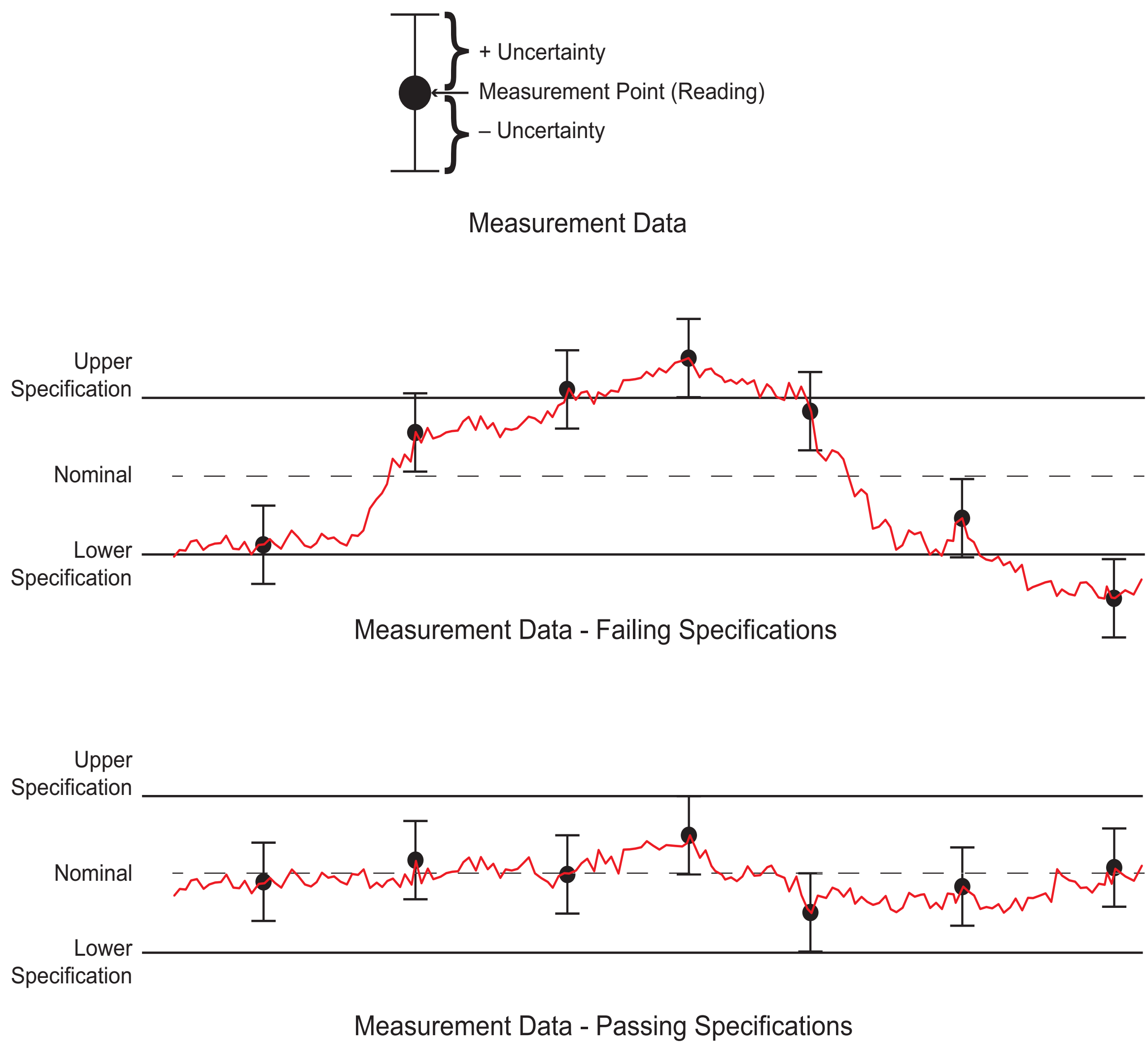


Figure 2-2. Pass/Fail Determination

Measurement Uncertainty

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 test procedure. Most of the uncertainties are type-B per ISO/IEC Guide 98-3, Guide to the Expression of Uncertainty in Measurement (GUM).

2-6 System Verification – MS46131A without Option 12

This section provides specific procedures to be used to verify the system performance of a single MS46131A without Option 12.

The procedures verify the calibration residuals such as corrected directivity and corrected port match after calibrating the MS46131A with a specified Calibration Kit.

Equipment Required

Table 2-1. Equipment Required

Equipment	Critical Specification	Recommended Manufacturer/Model
Airline (For Opt. 10)	Impedance: 50 Ohm Connector: N(m)	Anritsu Model SC3833
Short (For Opt. 10)	Connector: GPC-7	Anritsu Model 22A50
Offset Termination (For Opt. 10)	Frequency: DC to 8 GHz Return Loss: 20 dB Connector: GPC-7	Anritsu Model SC8408
Calibration Tee (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Torque Wrench (For Opt. 10)	3/4 in. Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Airline (For Opt. 20 or 43)	Impedance: 50 Ohm Connector: K(f)	Anritsu Model SC7760
Short (For Opt. 20 or 43)	Connector: K(f)	Anritsu Model 23KF50
Offset Termination (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Return Loss: 20 dB Connector: K(f)	Anritsu Model SC7888
Calibration Tee (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSLKF50A-43.5
Torque Wrench (For Opt. 20 or 43)	5/16 in. Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Interface Cable	USB Type A to Micro-B Cable	Anritsu Part Number 2000-1816-R
Personal Computer	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any

Procedure

1. Power on the Personal Computer.
2. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
3. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.

4. Run the ShockLine software on the Personal Computer.
5. Allow the instrument to warm up for 60 minutes.
6. On the ShockLine Software graphic user interface (GUI), click on the Preset icon and then the OK button.
   a. Ensure that only S11 Log Mag is displayed on the PC monitor.
7. Click on the Freq icon and then change # of Points to 401.
8. Click on the Calibration icon and then select:
   Calibrate | Manual Cal | Reflection Only | Modify Cal Setup | Edit Cal Params
9. On the Cal Kit drop-down menu on the One Port Cal Setup (SOL, Coax) dialog box, select:
   - TOSLN50A for MS46131A with Option 10
   - TOSLKF50A for MS46131A with Option 20 or 43
10. Select Back.
11. Select Port 1 Reflective Devices.
12. Install the Open standard to the test port of MS46131A. Use torque wrench to tighten the connection.
13. Select Open to start the measurement. Once the measurement is complete, disconnect the Open standard from the test port of MS46131A.
14. Install the Short standard to the test port of MS46131A. Use torque wrench to tighten the connection.
15. Select Short to start the measurement. Once the measurement is complete, disconnect the Short standard from the test port of MS46131A.
16. Install the Load standard to the test port of MS46131A. Use torque wrench to tighten the connection.
17. Select Load to start the measurement. Once the measurement is complete, disconnect the Load standard from the test port of MS46131A.
18. Click OK on the displayed dialog and then select Done.

Corrected Directivity Measurement

19. Connect the Airline to the test port of the MS46131A and then terminate the Airline with the Offset Termination.

Caution	Finger tighten only. Do not use torque wrench to tighten the connector connection beginning with this step.

20. Click on the Scale icon and then select Auto Scale Active Trace.
21. Click on the Marker icon and then select Marker 1, Marker 2 and Marker 3 to turn these markers On.
22. Use the mouse to move Marker 1 and Marker 3 to adjacent peaks of the ripple with the greatest negative trough (or adjacent troughs if the ripple has the greatest positive peak) in the frequency band of interest. For frequency band information, refer to the following applicable table in "ShockLine MS46131A without Option 12 Test Record" on page A-2:
   - Table A-1, "Corrected Directivity of MS46131A with Option 10
   - Table A-2, "Corrected Directivity of MS46131A with Option 20 or 43
   - Table A-3, "Corrected Port Match of MS46131A with Option 10
   - Table A-4, "Corrected Port Match of MS46131A with Option 20 or 43
23. Position Marker 2 to the bottom of the trough (or to the top of the peak if the ripple has the greatest positive peak).

24. Sum the magnitude values of Marker 1 and Marker 3 at the peaks (or troughs) and divide the result by two. This is the average value of the two peaks or (troughs).

For example, Marker 1 = –15.9634 dB and Marker 3 = –15.641 dB, then:

Average Value = (Marker 1 + Marker 3)/2 = (–15.9634 dB) + (–15.641 dB)/2 = –15.8022 dB

25. Calculate the peak-to-peak ripple value (absolute difference between Marker 2 value and the Average Value calculated in Step 24).

For example, Marker 2 = –17.452 dB, then:

dB_{p-p} = |Marker 2 value| – |Average Value| = 17.452 dB – 15.8022 dB = 1.6498 dB

26. Use the RF Measurement Chart in Figure 2-3 on page 2-8 to find the corresponding return loss value of the peak-to-peak ripple value calculated in Step 25.

For example, the corresponding return loss value of 1.6498 dB_{p-p} is approximately 20 dB

27. Also find the corresponding Ref + X or Ref – X value from the RF Measurement Chart.

28. Use the following formula to calculate the corrected directivity:

- For ripple with a negative trough:

  Directivity = Return Loss value + |Marker 2 value| – |Ref – X value|

- For ripple with a positive peak:

  Directivity = Return Loss value + |Marker 2 value| – |Ref + X value|

- Example:

  Directivity = 20 dB + 17.452 dB – 0.9151 dB = 36.5369 dB

29. Record the calculated directivity value into the Measured column of the following applicable table in "ShockLine MS46131A without Option 12 Test Record" on page A-2:

- Table A-1, "Corrected Directivity of MS46131A with Option 10
- Table A-2, "Corrected Directivity of MS46131A with Option 20 or 43

30. Repeat Step 22 to Step 29 for other frequency bands in the applicable table listed in Step 29.

Corrected Port Match Measurement

31. Disconnect the Offset Termination from the Airline and connect a short.

32. Click on the Scale icon and then select Auto Scale Active Trace.

33. Repeat Step 22 to Step 26. Record the calculated Return Loss value to the Measured column of the following table in "ShockLine MS46131A without Option 12 Test Record" on page A-2:

- Table A-3, "Corrected Port Match of MS46131A with Option 10
- Table A-4, "Corrected Port Match of MS46131A with Option 20 or 43

34. Repeat Step 33 for other frequency bands listed in the applicable table listed in Step 33.

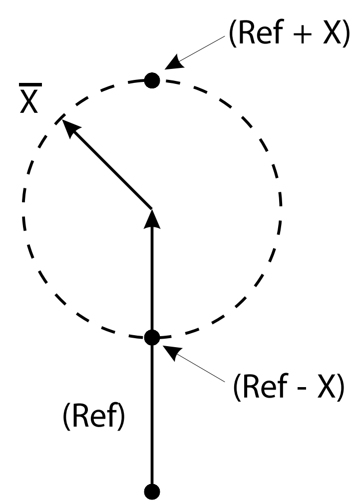
The first three columns are conversion tables for return loss, reflection coefficient, and SWR.

The last four columns are values for interactions of a small phasor X with a large phasor (unity reference) expressed in dB related to the reference.

The RF Measurement Chart can be used to determine the uncertainty due to bridge/autotester VNA directivity. The "X dB Below Reference" column represents the difference between the directivity and the measured reflection (return loss). The "Ref + X dB" and "Ref – X dB" values are 360°. Therefore, the peak-to-peak ripple (1 ± X) is the total measurement uncertainty caused by the error signal.

For example, if a 30 dB return loss is measured with a 40 dB directivity autotester, the X dB Below Reference value is 10 dB. The Ref + X dB value is 2.3866 dB and the Ref – X dB value is 3.3018 dB.

The actual return loss is between 27.6134 dB (– 30 + 2.3866) and 33.3018 dB (– 30 – 3.3018). The peak-to-peak ripple on a swept measurement will be 5.6884 dB. If the error and directivity signals are equal, the Ref + X dB value equals 6 dB (voltage doubling causes a 6 dB change) and the Ref – X dB value becomes infinite, since the two signals are equal in amplitude and 180° out of phase (zero voltage).



Phasor Interaction

SWR	Reflection Coefficient	Return Loss (dB)	Relative to Unity Reference			
			X dB Below Reference	Ref + X (dB)	Ref - X (dB)	Ref ± X Pk to Pk Ripple (dB)
17.3910	0.8913	1	1	5.5350	-19.2715	24.8065
8.7242	0.7943	2	2	5.0780	-13.7365	18.8145
5.8480	0.7079	3	3	4.6495	-10.6907	15.3402
4.4194	0.6310	4	4	4.2489	-8.6585	12.9073
3.5698	0.5623	5	5	3.8755	-7.1773	11.0528
3.0095	0.5012	6	6	3.5287	-6.0412	9.5699
2.6146	0.4467	7	7	3.2075	-5.1405	8.3480
2.3229	0.3981	8	8	2.9108	-4.4096	7.3204
2.0999	0.3548	9	9	2.6376	-3.8063	6.4439
1.9250	0.3162	10	10	2.3866	-3.3018	5.6884
1.7849	0.2818	11	11	2.1567	-2.8756	5.0322
1.6709	0.2512	12	12	1.9465	-2.5126	4.4590
1.5769	0.2239	13	13	1.7547	-2.2013	3.9561
1.4985	0.1995	14	14	1.5802	-1.9331	3.5133
1.4326	0.1778	15	15	1.4216	-1.7007	3.1224
1.3767	0.1585	16	16	1.2778	-1.4988	2.7766
1.3290	0.1413	17	17	1.1476	-1.3227	2.4703
1.2880	0.1259	18	18	1.0299	-1.1687	2.1986
1.2528	0.1122	19	19	0.9237	-1.0337	1.9574
1.2222	0.1000	20	20	0.8279	-0.9151	1.7430
1.1957	0.0891	21	21	0.7416	-0.8108	1.5524
1.1726	0.0794	22	22	0.6639	-0.7189	1.3828
1.1524	0.0708	23	23	0.5941	-0.6378	1.2319
1.1347	0.0631	24	24	0.5314	-0.5661	1.0975
1.1192	0.0562	25	25	0.4752	-0.5027	0.9779
1.1055	0.0501	26	26	0.4248	-0.4466	0.8714
1.0935	0.0447	27	27	0.3796	-0.3969	0.7765
1.0829	0.0398	28	28	0.3391	-0.3529	0.6919
1.0736	0.0355	29	29	0.3028	-0.3138	0.6166
1.0653	0.0316	30	30	0.2704	-0.2791	0.5495
1.0580	0.0282	31	31	0.2414	-0.2483	0.4897
1.0515	0.0251	32	32	0.2155	-0.2210	0.4365
1.0458	0.0224	33	33	0.1923	-0.1967	0.3890
1.0407	0.0200	34	34	0.1716	-0.1751	0.3467
1.0362	0.0178	35	35	0.1531	-0.1558	0.3090
1.0322	0.0158	36	36	0.1366	-0.1388	0.2753
1.0287	0.0141	37	37	0.1218	-0.1236	0.2454
1.0255	0.0126	38	38	0.1087	-0.1100	0.2187
1.0227	0.0112	39	39	0.0969	-0.0980	0.1949
1.0202	0.0100	40	40	0.0864	-0.0873	0.1737
1.0180	0.0089	41	41	0.0771	-0.0778	0.1548
1.0160	0.0079	42	42	0.0687	-0.0693	0.1380
1.0143	0.0071	43	43	0.0613	-0.0617	0.1230
1.0127	0.0063	44	44	0.0546	-0.0550	0.1096
1.0113	0.0056	45	45	0.0487	-0.0490	0.0977
1.0101	0.0050	46	46	0.0434	-0.0436	0.0871
1.0090	0.0045	47	47	0.0387	-0.0389	0.0776
1.0080	0.0040	48	48	0.0345	-0.0346	0.0692
1.0071	0.0035	49	49	0.0308	-0.0309	0.0616
1.0063	0.0032	50	50	0.0274	-0.0275	0.0549
1.0057	0.0028	51	51	0.0244	-0.0245	0.0490
1.0050	0.0025	52	52	0.0218	-0.0218	0.0436
1.0045	0.0022	53	53	0.0194	-0.0195	0.0389
1.0040	0.0020	54	54	0.0173	-0.0173	0.0347
1.0036	0.0018	55	55	0.0154	-0.0155	0.0309
1.0032	0.0016	56	56	0.0138	-0.0138	0.0275
1.0028	0.0014	57	57	0.0123	-0.0123	0.0245
1.0025	0.0013	58	58	0.0109	-0.0109	0.0219
1.0022	0.0011	59	59	0.0097	-0.0098	0.0195
1.0020	0.0010	60	60	0.0087	-0.0087	0.0174

Figure 2-3. RF Measurement Chart

2-7 System Verification – MS46131A with Option 12

This section provides specific procedures to be used to verify that two MS46131A VNAs with Option 12 are making accurate 2-port S-parameter measurements.

The procedures verify the measurement capabilities of the VNAs, calibration kit, and any required adapters as a system by analyzing the measurement of artifacts that are traceable to International System of Units (SI) via national metrology institutes. The procedures are automated by using the ME7868A ShockLine System Verification Software, in conjunction with the appropriate Anritsu Calibration and Verification Kits listed in Table 2-2.

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

Table 2-2. Equipment Required (1 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model
Calibration Tee (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Calibration Tee (For Opt. 10)	Frequency: DC to 8 GHz Connector: N(f)	Anritsu Model OSLNF50A-8 or TOSLNF50A-8
Verification Kit (For Opt. 10)	Connector: N Type	Anritsu Model 3663-3 (Verification Software included)
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to N(m)	Anritsu Model 33NN50B
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to N(f)	Anritsu Model 33NNF50B
Torque Wrench (For Opt. 10)	3/4 in. Open End Wrench 12 lbf·in (1.35 N·m)	Anritsu Model 01-200
Calibration Tee (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(m)	Anritsu Model TOSLK50A-43
Calibration Tee (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSLKF50A-43
Verification Kit (For Opt. 20 or 43)	Connector: K Type	Anritsu Model 3668-4 (Verification Software included)
Adapter (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C
Adapter (For Opt. 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C
Torque Wrench (For Opt. 20 or 43)	5/16 in. Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-201
Torque Wrench (For Opt. 20 or 43)	13/16 in. Open End Wrench 8 lbf·in (0.90 N·m)	Anritsu Model 01-203
Interface Cable	USB Type A to Micro-B Cable	Anritsu Part Number 2000-1816-R (Qty 2)
Interface Cable	PhaseLync Sync Cable Length: 1 m	Anritsu Part Number 2000-1947-R

Table 2-2. Equipment Required (2 of 2)

Equipment	Critical Specification	Recommended Manufacturer/Model
Personal Computer	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any

The System Performance Verification Software guides the user to perform a full 12-term calibration on the two MS46131A Vector Network Analyzers using the appropriate calibration kit, measure the S-parameters of the impedance transfer standards in the verification kit, and verify that the measured values are within the specified measurement uncertainty limits.

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

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

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

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

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.
- The uncertainties can be found from the USB memory stick included with the respective verification kit.

These uncertainties are calculated based on the VNA, the calibration kit, and repeatability. If this quantity *En* 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 adapter connectors.
- 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, and attached components.
- Clean and check the pin depth and condition of all adapters, calibration components, and impedance transfer standards.

Procedure

The System Verification procedure assumes that both ShockLine software (Graphical User Interface) and ShockLine System Performance Verification software have been installed on the same External Personal Computer.

1. Power on the external personal computer.
2. Connect a USB Type A to Micro-B cable between each of the ShockLineMS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
3. Connect the DC connector from the AC/DC Adapter to each of ShockLineMS46131A and connect the AC power cords of AC/DC adapters to AC power source.
4. Allow both instruments to warm up for 45 minutes.
5. When verify a MS46131A with Option 10, do the following:
   - **b.** Install the 33NNF50B Adapter to the test port of the MS46131A that is designated to be Port 1 and install the 33NN50B Adapter to the test port of the MS46131A that is designated to be Port 2. Use torque wrench to tighten the N male connector to insure that the connection does not work itself loose during the test.
6. When verify a MS46131A with Option 20 or 43, do the following:
   - **a.** Install the 33KFKF50C Adapter to the test port of theMS46131A that is designated to be Port 1.
   - **b.** Install the 33KKF50C Adapter on the test port of theMS46131A that is designated to be Port 2.
7. Run the ShockLine MS46131A System Verification software on the external Personal Computer.
8. Insert the USB flash drive that is supplied with the 366x-x verification kit to an available USB port on the personal computer. Follow the instructions in Section 6 of the ShockLine Series Vector Network Analyzers Verification Kits and Performance Verification Quick Start Guide, PN 10410-00766, to add the four impedance transfer standards to the verification tools database.
9. Follow the instructions in Section 6 of the Quick Start Guide to add the calibration kits to the verification tools database.
10. On the System Performance Verification software graphic user interface (GUI) displayed on the personal computer, locate the Select Interface field and then select TcpipSocket using the drop-down menu.

11. Enter the local Host address 127.0.0.1 to the Address field and enter 5001 to the Port field. See Figure 2-4.

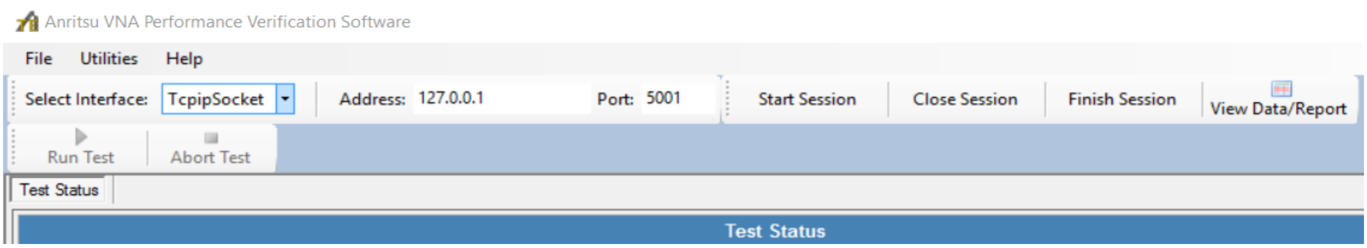


Figure 2-4. TCP/IP IP Address and Port Number

12. On the ShockLine Software graphic user interface (GUI), select:
    2 Main | System | Network Interface.
13. Enter 127.0.0.1 to the IP Address.
14. Follow the instructions in Section 7 of the Quick Start Guide to start the performance verification testing.

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

15. After all tests have been completed, print the test results and attach the printouts to the test record, "ShockLine MS46131A with Option 12 Test Record" on page A-3.

If Verification Fails

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

- The VNA test port connectors
- The calibration tee
- The impedance transfer standards
- The adapter connectors
- The PhaseLync Sync Cable connectors

These are the most common causes for verification failures.

2-8 Instrument Key Parameter Performance Test

The Instrument Key Parameter test verifies the key performance parameter of the MS46131A Vector Network Analyzer as an independent instrument.

The Instrument Key Performance Test consists of the following test, as appropriate:

- Frequency Accuracy
- MS46131A High-level Noise
- MS46131A-012 High Level Noise
- MS46131A-012 or ME7868A System Dynamic Range

2-9 Frequency Accuracy

This test verifies the internal time base of the MS46131A.

Equipment Required

Table 2-3. Equipment Required for Frequency Accuracy Verification

Equipment	Critical Specification	Recommended Manufacturer/Model
Frequency Counter	Frequency: 10 MHz to 20 GHz	Anritsu Model MF2412B or MF2412C with Option 3
Frequency Reference	Frequency: 10 MHz	Symmetricom Model RubiSource T&M
RF Coaxial Cable	Impedance: 50 ohm Connector: BNC(m) to BNC(m)	Anritsu Part Number 2000-1627-R
Adapter (For Opt. 10)	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 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 3670K50A-2
Interface Cable	USB Type A to Micro-B Cable	Anritsu Part Number 2000-1816-R
Personal Computer	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any

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 34NKF50 Adapter to Input 1 N(f) connector of the Frequency Counter.
3. Install the 15KKF50-1.0A Cable to the 34NKF50 Adapter.
4. Power on both the external Time Base Reference and Frequency Counter.
5. Setup the Frequency Counter as follows:
   a. Press the Preset key to restore the factory setting.
   b. Set the Resolution to 0.1 Hz.
   c. Set the Sample rate to 11 ms.
6. Power on the external Personal Computer.
7. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
8. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
9. Run the ShockLine software on the external Personal Computer.
10. Allow the MS46131A to warm up for at least 60 minutes.
11. On the ShockLine Software graphic user interface (GUI), click on the Preset icon and then the OK button.

a. Ensure that only S11 Log Mag is displayed on the PC monitor.

12. Click on the Freq icon and then turn CW Mode to ON.
13. Change # of Points to 801.
14. Change Start Frequency to 1 GHz. (This changes the CW Frequency to 1 GHz.)
15. Connect the open end of the 15KKF50-1.0A Cable from the Frequency Counter to the test port of the MS46131A.
16. Record the Frequency Counter reading in Table A-5, "Frequency Accuracy" on page A-4.

2-10 MS46131A High-level Noise

This test verifies the High-level Noise performance of the MS46131A.

Equipment Required

Table 2-4. Equipment Required for High-level Noise Test

Equipment	Critical Specification	Recommended Manufacturer/Model
Calibration Tee (For Opt 10)	Frequency: DC to 8 GHz Connector: N(m)	Anritsu Model OSLN50A-8 or TOSLN50A-8
Calibration Tee (For Opt 20 or 43)	Frequency: DC to 43.5 GHz Connector: K(f)	Anritsu Model TOSKF50A-20 Anritsu Model TOSKF50A-43.5

Procedure

1. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, (10410-00780), for setup procedure.
2. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC Adapter to AC power source.
3. Run the ShockLine software on the external Personal Computer.
4. Allow the MS46131A to warm up at least 60 minutes.
5. On the ShockLine software user interface (GUI), select Preset button on the Icon Bar and then the OK button.
6. Set up the VNA display as follows:
    a. Ensure that only S11 Log Mag is displayed.
    b. Select Display icon and then change Trace Format to Linear And Phase.
    c. Select Scale icon and then change Log Mag Resolution to 0.01.
    d. Select 8 Utilities, System, and Utility; and then turn Factory RF Cal to OFF.
7. 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 from the next row of Table 2-5 into the VNA.

f. Repeat Step d through Step e until F2 = 8000 MHz for Option 10 unit, F2 = 20000 MHz for Option 20 unit, or F2 = 43500 MHz for Option 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 High-level Noise Test

F1	F2	# of Pts	IFBW	Src Pwr	Avg
1 MHz	10 MHz	10	100 Hz	0	1
15 MHz	20 MHz	2	100 Hz	0	1
20.1 MHz	30 MHz	2	100 Hz	0	1
40 MHz	100 MHz	7	100 Hz	0	1
150 MHz	250 MHz	3	100 Hz	0	1
301 MHz	350 MHz	2	100 Hz	0	1
401 MHz	450 MHz	2	100 Hz	0	1
475 MHz	501 MHz	2	100 Hz	0	1
550 MHz	601 MHz	2	100 Hz	0	1
650 MHz	701 MHz	2	100 Hz	0	1
750 MHz	801 MHz	2	100 Hz	0	1
850 MHz	901 MHz	2	100 Hz	0	1
950 MHz	1000 MHz	2	100 Hz	0	1
1001 MHz	1050 MHz	2	100 Hz	0	1
1101 MHz	1150 MHz	2	100 Hz	0	1
1201 MHz	1250 MHz	2	100 Hz	0	1
1301 MHz	1350 MHz	2	100 Hz	0	1
1401 MHz	1450 MHz	2	100 Hz	0	1
1501 MHz	1550 MHz	2	100 Hz	0	1
1600 MHz	2450 MHz	18	100 Hz	0	1
2499.99 MHz	2500.01 MHz	2	100 Hz	0	1
2600 MHz	3900 MHz	14	100 Hz	0	1
3950 MHz	3975 MHz	2	100 Hz	0	1
4001 MHz	4100 MHz	2	100 Hz	0	1
4200 MHz	8000 MHz	39	100 Hz	0	1
8000.1 MHz	8100 MHz	2	100 Hz	0	1
8200 MHz	8500 MHz	4	100 Hz	0	1
8525 MHz	10000 MHz	60	100 Hz	0	1
10050 MHz	20000 MHz	200	100 Hz	0	1
20000.1 MHz	20050 MHz	2	100 Hz	0	1
20100 MHz	35000 MHz	299	100 Hz	0	1
35100 MHz	40000 MHz	50	100 Hz	0	1
40125 MHz	43500 MHz	136	100 Hz	0	1

8. Connect a short to the test port of the MS46131A.
9. On the ShockLine Software GUI, select Display and then View Trace.
10. Select Store Data to Memory.
11. Select Data, Memory Math. Ensure that Data Mem. Op. is set to [Data/Mem1.].
12. Select Sweep and then Hold Functions. Select Single Sweep & Hold.
13. Select File and then Save Data.
14. Change the Type of File to Active Channel TXT File (`*.txt`).
15. Change the file name to `HLN#1` and then click the Save button. Note the location the data file is being saved to.
16. Repeat Step 12 through Step 15 thirty-nine (39) more times. When saving the data, increment the number at the end of the file name by one. (e.g. `HLN#2`, `HLN#3` and etc.).
17. Import the saved data from the `HLN#n` files into Microsoft Excel so the RMS values can be calculated.
18. There are many ways one can set up Microsoft Excel to calculate the RMS values. Below is an example:
    a. Assume the data are in an Excel worksheet as follows:
        i. Row 1 is the header: Freq, Data1 through Data40, RMS Linear Mag, RMS Log Mag (or RMS Deg)
        ii. Column A: Freq (Imported from the `HLN#n` file)
        iii. Column B through Column AO: Data1 through Data40 (Imported from the HLN#n file)
    b. Set up Cell AP2 to calculate the RMS value in Linear Mag by entering the following formula into the cell:

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

           = 20*LOG(AP2+1,10)
        ii. Copy the formula to the next cell in Column AQ until it reaches the last frequency point.
    e. Assume Sheet 1 is set up for Magnitude measurements, rename Sheet 1 to `S11 Magnitude` by right-clicking on the Sheet 1 tab, selecting Rename and typing in the new name.
    f. Rename Sheet 2 to `S11 Phase`.
    g. Import the Magnitude and Phase data to the appropriate worksheet for RMS value calculation as required.
19. Record the calculated RMS value of each frequency point listed in Table A-6, “MS46131A High-level Noise - S11 Magnitude” on page A-4 and Table A-7, “MS46131A High Level Noise - S11 Phase” on page A-6.

2-11 MS46131A-012 High Level Noise

This test checks the High Level Noise performance of the MS46131A-012.

Equipment Required

Equipment required for MS46131A-012 High Level Noise test is listed in Table 2-6.

Table 2-6. Equipment Required for MS46131A-012 High Level Noise Test

Equipment	Critical Specification	Recommended Manufacturer/Model
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(m)	Anritsu Model 34NK50
Adapter (For Opt. 10)	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50B
Adapter (For Opt. 20 or 40)	Frequency: DC to 40 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50B
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(m) to K(f)	Anritsu Model 33KKF50C
Adapter (For Opt. 43)	Frequency: DC to 43.5 GHz Connector: K(f) to K(f)	Anritsu Model 33KFKF50C
Torque Wrench (For Opt. 10)	3/4 in. (0.75 in.) Open End 12 lbf · in (1.35 N · m)	Anritsu Model 01-200
Torque Wrench (For Opt. 20, 40, or 43)	5/16 in. (0.3125 in.) Open End 8 lbf · in (0.90 N · m)	Anritsu Model 01-201
Torque Wrench (For Opt. 20, 40, or 43)	13/16 in. (0.8125 in.) Open End 8 lbf · in (0.90 N · m)	Anritsu Model 01-203
RF Coaxial Cable (For Opt. 10, 20, or 40)	Frequency: DC to 40 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50-2
RF Coaxial Cable (For Opt. 43)	Frequency: DC to 43.5 GHz Impedance: 50 ohm Connector: K(f) to K(m)	Anritsu Model 3670K50A-2

Procedure

1. Power on the MS46131A-012 VNAs and allow the instruments to warm up for 30 minutes.
2. Preset the VNAs as follows:
   a. Select Preset button on the Icon Bar and then the OK button.
3. Prepare the Through Cable or MS46131A-012 VNAs as follows:
   a. For ShockLine MS46131A-012 VNAs with Option 10:
   Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Through Cable. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.
   b. For ShockLine MS46131A-012 VNAs with Option 20, 40, or 43:
   Install the 33KFKF50x Adapter to the VNA Port 1. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.

4. Install the Through Cable to Port 2.
5. Set up the VNA for segmented sweep as follows:
   a. Select Sweep Setup.
   b. Select Freq-based Seg. Sweep Setup.
   c. Enter the data from the first row of Table 2-7 into the setup table on the bottom of the VNA display.
   d. Select Add.
   e. Enter the data in the next row of Table 2-7. into the VNA
   f. Repeat Step d through Step e until F2 = 8000 MHz for Option 10 unit, F2 = 20000 MHz for Option 20 unit, or F2 = 43500 MHz for Option 40 or 43 unit.
   g. Select Back.
   h. Select Sweep type and then Segmented Sweep (Freq-based).
   i. Select Back.
   j. This completes the Segmented Sweep setup.

Table 2-7. VNA Segmented Sweep Setup for MS46131A-012 High Level Noise Test

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

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

h. Select Done.

i. This completes the 2-port Transmission Response calibration.

j. Leave the Through Cable connected between Port 1 and Port 2.

7. Set up the VNA display as follows:

   a. Select Trace and then set # of Traces to 2.

   b. Select Response and then S12. Verify that Tr1 is displaying S12 response.

   c. Select Display and set Trace Format to Linear Mag And Phase.

   d. Click on Tr2 on the top of the S21 trace on the screen and then set Trace Format to Linear Mag And Phase.

8. Select Sweep and then Hold Functions. Select Single Sweep & Hold

9. Select File and then Save Data

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

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

12. Repeat Step 8 through Step 11 thirty-nine (39) more times. When saving the data, increment the number at the end of the file name by one (e.g. HLN#2, HLN#3 and etc.).

13. Import the saved data from the HLN#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 worksheet as follows:

      - Row 1 is the header – Freq, Data1 through Data40, RMS Linear Mag, RMS Log Mag (or RMS Deg)
      - Column A – Freq (Imported from the HLN#n files)
      - Column B through Column AO – Data1 through Data40 (Imported from the HLN#n files)

   b. Set up Cell AP2 to calculate the RMS value in Linear Mag by entering the following Formula into the Cell:
      = STDEV.P(B2:AO2)

   c. Copy the formula to the next cell on Column AP until it reaches the last frequency point.

   d. For magnitude measurements only,

      a. Set up Cell AQ2 to calculate the RMS value in Log Mag by entering the following Formula into the Cell:
         = 20*LOG(AP2+1,10)

      b. Copy the formula to the next cell on Column AQ until it reaches the last frequency point.

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

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

   g. Rename the new sheet as 'S21 Magnitude'.

   h. Use Move or Copy... in Excel to create as many new sheets as required for both magnitude and phase measurements. Rename the sheets as necessary to indicate which measurement is being computed on the worksheet (e.g. S12 Phase, and etc.).

   i. Import the Magnitude and Phase data to the appropriate worksheet for RMS value calculation as required.

15. Record the calculated RMS value of each frequency point listed in Table A-10, "MS46131A-012 High Level Noise – S21 Magnitude through Table A-11, "MS46131A-012 High Level Noise – S21 Phase.

2-12 MS46131A-012 or ME7868A System Dynamic Range

This section provides the procedure to measure the System Dynamic Range of the MS46131A-012 VNAs or ME7868A system.

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

Procedure

1. Power on the MS46131A-012 VNAs and allow the instrument to warm up for 30 minutes.
2. Preset the VNAs as follows:
   a. Select Preset button on the Icon Bar and then the OK button.
3. Prepare the Through Cable or MS46131A-012 VNAs as follows:
   a. For ShockLine MS46131A-012 VNAs with Option 10:
   Install the 34NK50 and 34NKF50 Adapters to the 3670K50-2 Through Cable. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.
   b. For ShockLine MS46131A-012 VNAs with Option 20, 40, or 43:
   Install the 33KFKF50x Adapter to the VNA Port 1. Use torque wrench to tighten the K connectors to ensure that the connections do not work themselves loose during the test.
4. Install the Through Cable to Port 2.
5. Set up the VNA for segmented sweep as follows:
   a. Select Sweep Setup.
   b. Select Freq-based Seg. Sweep Setup.
   c. Enter the data in Table 2-9 into the first row of 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 = 8000 MHz for Option 10 unit, F2 = 20000 MHz for Option 20 unit, F2 = 40000 MHz for Option 40 unit, or F2 = 43500 MHz for Option 43 unit.
   g. Select Back.
   h. Select Sweep type and then Segmented Sweep (Freq-based).
   i. Select Back.
   j. This completes the Segmented Sweep setup.

Table 2-9. VNA Segmented Sweep Setup for System Dynamic Range Test

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

6. Perform a Transmission Response calibration as follows:
   a. Select Calibration.
   b. Select Calibrate and then Manual Cal.

c. Select Transmission Freq. Response.

d. Select Thru/Recip.

e. Connect the Through 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 Through Cable from Port 1.

i. Select Isolation (Optional).

j. Install Loads to Port 1 and Port 2 (at the end of the Through Cable).

k. Select Isolation 1-2 and then allow the VNA to complete the measurements.

l. Select Back.

m. Select Done.

n. This completes the 2-port Transmission Response calibration.

o. Leave the Loads connected to both Port 1 and Port 2.

7. Set up the VNA display as follows:

   a. Select Trace and then set # of Traces to 2.

   b. Select Response and then S12. Verify that Tr1 is displaying S12 response.

   c. Select Display and set Trace Format to Linear Mag.

   d. Click on Tr2 on the top of the S21 trace on the screen and then set Trace Format to Linear Mag.

8. Select Sweep, select Hold Functions and then select Single Sweep & Hold.

9. Select File and then Save Data.

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

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

12. Repeat Step 8 through Step 11 seven (7) more times. When saving the data, increment the number at the end of the file name by one (e.g. SDR#2.txt, SDR#3.txt and etc.).

13. Import the saved data from the SDR#n.txt into Microsoft Excel so the RMS values can be calculated.

14. There are many ways one can set up Microsoft Excel for calculating the System Dynamic Range in dB RMS values. Below is an example:

   a. Assume the data are in an Excel worksheet as follows:

      - Row 1 is the header – Freq, Data1 through Data8, RMS Linear Mag, RMS Log Mag, SDR
      - Column A – Freq (Imported from the SDR#n.txt files)
      - Column B through Column I – Data1 through Data8 (Imported from the SDR#n.txt files)
      - Column J – Calculated Linear Mag RMS values
      - Column K – Calculating Log Mag RMS values
      - Column L – Calculated Noise Floor values
      - Column M – High Power values. This power will be + 0 dBm.
      - Column N – Calculated System Dynamic Range values

   b. Import the frequency data from the SDR#n.txt file.

   c. Set up Cell J2 to calculate the RMS value in Linear Mag by entering the following Formula into the Cell:
      = 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*LOG(J2,10)

f. Copy the formula to the next cell on Column K until it reaches the last frequency point.

g. Set up Cell L2 to calculate Noise Floor in dBm by entering the following formula into the cell:
   = –K2

h. Copy the formula to the next cell on Column L until it reaches the last frequency point.

i. Set up Cell N2 to calculate the System Dynamic Range by entering the following formula in the cell:
   = M2 – L2

j. 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 the Create a copy checkbox, and then clicking OK.

m. Rename the new sheet as ‘S21 Magnitude’.

n. Import the S12 data and S21 data to appropriate Excel worksheet for System Dynamic Range calculation.

15. Record the worst case calculated SDR value of each frequency band in Table A-12, “MS46131A-012 or ME7868A S12 System Dynamic Range and Table A-13, “MS46131A-012 or ME7868A S12 S21 System Dynamic Range.

Chapter 3 — Adjustment

3-1 Introduction

This chapter contains procedures that are used to restore and optimize the operation of the MS46131A Vector Network Analyzer.

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. Power on the external Personal Computer.
2. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
3. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
4. Run the ShockLine software on the external Personal Computer.
5. On the ShockLine Software graphic user interface (GUI), click on the System button on the right-side menu and then click on the Diagnostics button.
6. The Diagnostics Access dialog box appears providing an entry field to enter the diagnostics access password as shown below in Figure 3-1.

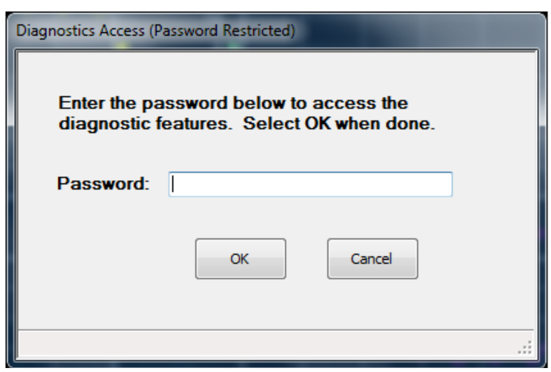


Figure 3-1. DIAGNOSTICS ACCESS Dialog Box

7. Enter the password ModVna in the Password field and click the OK button.

8. The Diagnostics menu appears as shown in Figure 3-2.

Figure 3-2. Diagnostics Menu

9. Click on the Hardware Cal button to access the Hardware Cal menu as shown in Figure 3-3.

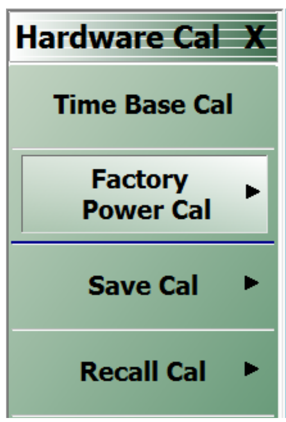


Figure 3-3. Hardware Cal Menu

3-3 Time Base Adjustment

This section provides the procedure to adjust internal Time Base of the MS46131A. Perform this procedure to restore or optimize the operation of MS46131A related to the frequency accuracy of VNA Test Port stimulus signal.

Note	Performing Time Base adjustment procedure is normally not required after the VNA Assembly has been replaced. Each replacement VNA Assembly has its time base pre-adjusted prior to shipping from the factory.

Equipment Required

Table 3-1. Equipment Required for Time Base Adjustment

Equipment	Critical Specification	Recommended Manufacturer/Model
Frequency Counter	Frequency: 10 MHz to 20 GHz	Anritsu Model MF2412B or MF2412C with Option 3
Frequency Reference	Frequency: 10 MHz	Symmetricom Model RubiSource T&M
RF Coaxial Cable	Impedance: 50 ohm Connector: BNC(m) to BNC(m)	Anritsu Part Number 2000-1627-R
Adapter (For Opt. 10)	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 20 GHz Connector: K(m) to K(f)	Anritsu Model 15KKF50-1.0A
Interface Cable	USB Type A to Micro-B Cable	Anritsu Part Number 2000-1816-R
Personal Computer	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any

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 34NKF50 Adapter to Input 1 N(f) connector of the Frequency Counter.
3. Install the 15KKF50-1.0A Cable to the 34NKF50 Adapter.
4. Power on both the external Time Base Reference and Frequency Counter.
5. Setup the Frequency Counter as follows:
   a. Press the Preset key to restore the factory setting.
   b. Set the Resolution to 0.1 Hz.
   c. Set the Sample rate to 11 ms.
6. Power on the external Personal Computer.
7. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.

8. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
9. Run the ShockLine software on the external Personal Computer.
10. Allow the MS46131A to warm up for at least 60 minutes.
11. On the ShockLine Software graphic user interface (GUI), access the Hardware Cal menu. Refer to "Adjustment Menu Access" on page 3-1.
12. Click on the Time Base Cal button and then follow the instructions on the Time Base Calibration dialog box.

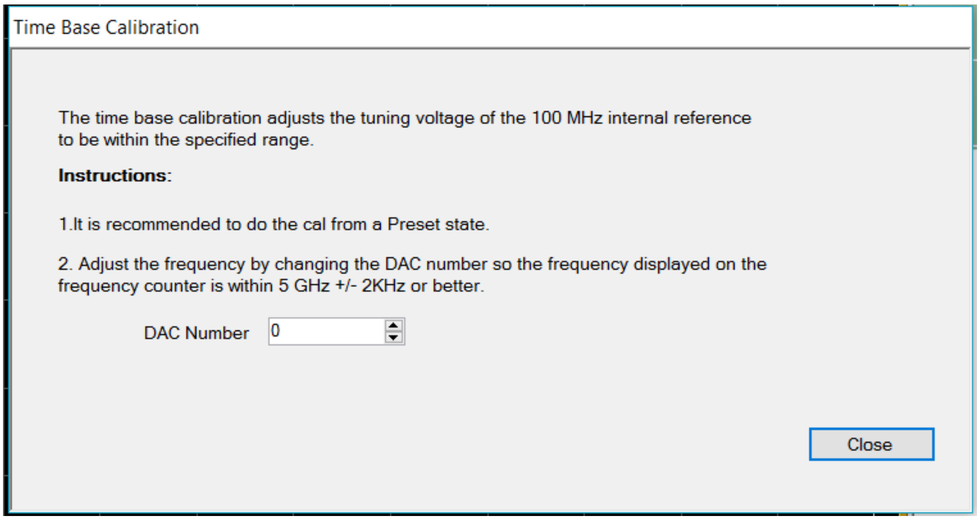


Figure 3-4. Time Base Calibration Dialog

13. Adjust the DAC Number until the frequency displayed on the Frequency Counter is within the required range.
14. Click on the Close button when the adjustment is complete.

3-4 Factory Power Adjustment

This section provides the procedure to restore or optimize the operation of MS46131A related to the RF leveling at the VNA Test Port. Perform this procedure after test port adapter or VNA Assembly have been replaced.

Equipment Required

Table 3-2. Equipment Required for Factory Power Adjustment

Equipment	Critical Specification	Recommended Manufacturer/Model
Power Meter	Power Range: -70 to +20 dBm	Anritsu Model ML2438A
Power Sensor	Frequency: 100 kHz to 40 GHz Connector Type: K(m)	Anritsu Model SC7413
Fixed Attenuator	Frequency: 100 kHz to 40 GHz Attenuation: 10 dB Connector: K(m) to K(f)	Anritsu Model 41KC-10
Adapter	Frequency: DC to 18 GHz Connector: N(m) to K(f)	Anritsu Model 34NKF50
Interface Cable	USB Type A to Micro-B Cable	Anritsu Part Number 2000-1816-R
Personal Computer	Configuration: – Intel Core i5-6300U Processor – 4 GB RAM – 120 GB Disk – Direct X Version 9 – Windows 10, 32 bit or 64 bit OS	Any
GPIB Adapter	USB to GPIB	National Instruments Model GPIB-USB-HS or GPIB-USB-HS+

Procedure

1. Power on the external Personal Computer.

Note	Software and driver should already been installed to the Personal Computer for the National Instruments USB to GPIB adapter. The USB to GPIB Adapter should also been plugged into a USB Type A port on the Personal computer.

2. Connect the GPIB end of the USB to GPIB Adapter to the GPIB port on the rear panel of the ML2438A Power Meter.
3. Install the Power Sensor to the Power Meter and then power on the Power Meter.
4. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
5. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
6. Run the ShockLine software on the external Personal Computer.
7. Allow both instruments to warm up for at least 60 minutes.
8. On the Power Meter, zero and calibrate the Power Sensor.
9. Disconnect the Power Sensor from the Calibrator port of the Power Meter.
10. Install the 10 dB Fixed Attenuator to the input of the Power Sensor.
11. On the Power Meter, press Sensor key, More soft key and then Offset soft key.

12. Press Type soft key until Offset TYPE is Fixed as shown on the display.
13. Press Value soft key.
14. Use the numeric keypad to enter 10.
15. Press Enter soft key to accept the value.
16. Press the Sensor key.
17. On the ShockLine Software graphic user interface (GUI), access the Hardware Cal menu. Refer to "Adjustment Menu Access" on page 3-1.
18. Click on the Hardware Cal button to access the Hardware Cal menu as shown in Figure 3-3
19. Click on the Factory Power Cal button and then click on the Perform Cal button; the Power Calibration dialog box appears. See Figure 3-5.

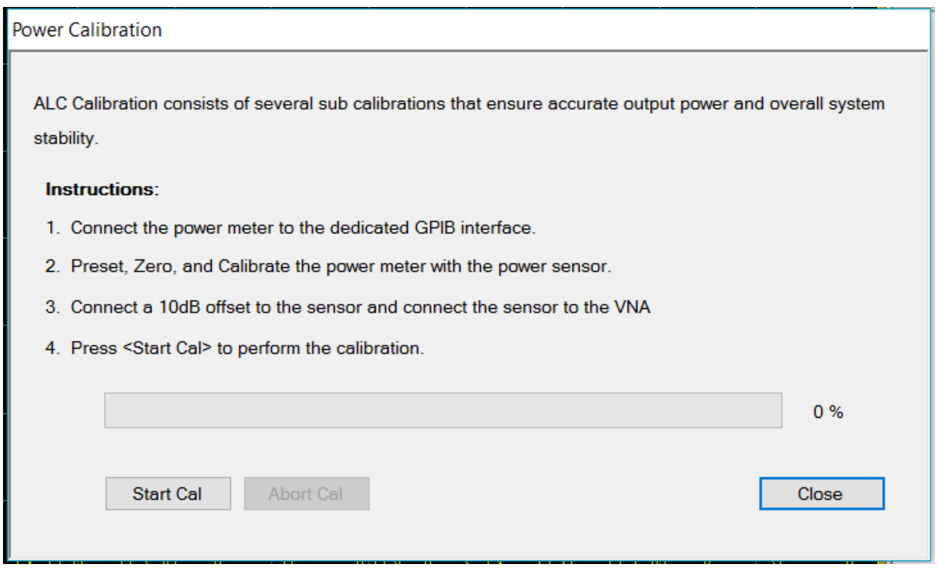


Figure 3-5. Power Calibration Dialog Box

20. For MS46131A with Option 10, install the 34NKF50 Adapter to the open end of the Fixed Attenuator at the Power Sensor Input.
21. Connect the power sensor to VNA Test Port.
22. Click on the Start Cal button to begin the calibration (adjustment).
23. When the calibration is complete, click on the Close button and disconnect the power sensor from VNA Test Port.

3-5 IF Adjustment

This section provides the procedure to restore or optimize the operation of MS46131A related to the IF level in the VNA Receivers.

Equipment Required

- For units with N(f) test ports:
    - Anritsu Model OSLN50A-8 or TOSLN50A-8 Calibration Kit
- For units with K(m) test ports:
    - Anritsu Model TOSLKF50A-43.5 Calibration Kit

Procedure

1. Power on the external Personal Computer.
2. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
3. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
4. Run the ShockLine software on the external Personal Computer.
5. Allow the MS46131A to warm up for at least 60 minutes.
6. Connect the Short standard of to the MS46131A VNA Test Port.
7. Select the Calibration button on the right side menu.
8. Select IF Cal button and follow the prompt to perform the calibration.
9. Select File | Exit to shut down the ShockLine Application software.
10. Launch the ShockLine Application software from the Windows desktop. The new calibration coefficients will take effect afterward.

3-6 Factory RF Calibration (RF Cal)

The Factory RF Calibration represents a subset of a 6-term error correction so that simple reflection and transmission standards will read somewhat close to their true value, even without a User Measurement Calibration.

Equipment Required

- For units with N(f) test ports:
  - Anritsu Model OSLN50A-8 or TOSLN50A-8 Calibration Kit
- For units with K(m) test ports:
  - Anritsu Model TOSLKF50A-43.5 Calibration Kit

Procedure

1. Power on the external Personal Computer.
2. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual,* PN 10410-00780, for setup procedures.
3. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
4. Run the ShockLine software on the external Personal Computer.
5. Allow the MS46131A to warm up for at least 60 minutes.
6. On the ShockLine Software graphic user interface (GUI), access the Diagnostics menu. Refer to "Adjustment Menu Access" on page 3-1.
7. Click on the Factory Cal button.
8. Click on the Calibrate button to display the Factory RF Cal dialog box.
9. Connect each calibration standard from the calibration kit in sequence to the test port. Click the appropriate button when ready.
10. When all calibration standards have been measured, click the Done button to complete the procedure.

Chapter 4 — Troubleshooting

4-1 Introduction

This chapter provides information about troubleshooting tests that can be used to check the MS46131A Vector Network Analyzer and two MS46131A VNAs configured as an ME7868A distributed VNA system 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 MS46131A and MS46131A-012 VNAs.

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.

Caution	Many assemblies and modules in the MS46131A 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 — Non-Ratio Power Level Check

The Non-Ratio Power Level Check is very useful to verify if the VNA Module Assembly is faulty. This test assumes that only one MS46131A is connected to the Personal Computer running the ShockLine Software.

Equipment Required

- For units with N(f) test ports:
  - Anritsu Model TOSLN50A-8 Calibration Kit
- For units with K(m) test ports:
  - Anritsu Model TOSLKF50A-43.5 Calibration Kit

Procedure

1. Power on the external Personal Computer.
2. Connect a USB Type A to Micro-B cable between the MS46131A and a USB Type A port of the Personal Computer. Refer to the *MS46131A Operation Manual*, PN 10410-00780, for setup procedures.
3. Connect the DC connector from the AC/DC Adapter to the MS46131A and connect the AC power cord of AC/DC adapter to AC power source.
4. Run the ShockLine software on the external Personal Computer.
5. Install the Short of the Calibration to the VNA Test Port.
6. Click on the Trace icon and then change the # of Traces to 2.
7. Click on the Trace Layout button and select the third button from the top. See Figure 4-1.

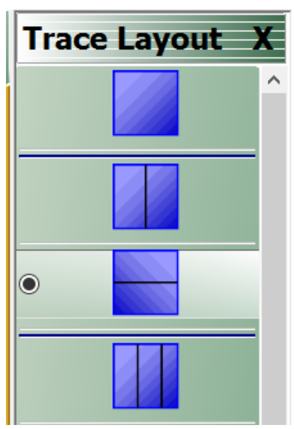


Figure 4-1. Trace Layout Menu

8. Click on Tr1.
9. Click on the Response icon and then click on the User-defined button. The User-defined menu appears.
10. Set Numerator to A1, Denominator to 1, and Driver Port to Port 1.
11. Use a mouse to move the Reference Line to one graticule below top scale.
12. Repeat Step 8 thru Step 10 for Tr2, setting Numerator to B1, Denominator to 1, and Driver Port to Port 1.
13. Observe whether any portions of these traces show any abnormality (e.g. very low power level).

4-4 Troubleshooting Turn-on Problems

ShockLine Application Cannot Launch

If the ShockLine Application does not launch for the MS46131A the Personal Computer, do the following:

1. ShockLine Application Software update may not have completed. Re-install software.
2. If the problem still exists, verify that the Personal Computer USB port is functioning properly or verify that the MS46131A is working properly with another Personal Computer.
3. If the MS46131A is not working with another Personal Computer, replace VNA Assembly.
4. If the MS46131A is working with another Personal Computer, Windows dependencies files on the non-operating Personal Computer might have been corrupted or changed. Verify that Microsoft Visual C++ 2015 Redistributable version 14.0.24212 is installed on the Personal Computer using Program and Features in Windows Control Panel. If necessary, download the 'Redistributable' from the following link and then re-install.

   https://www.microsoft.com/en-us/download/confirmation.aspx?id=52685
5. If the problem still exists, replace the VNA Assembly.

If the ShockLine application does not launch with two MS46131A VNAs with Option 012 and display ME7868A on the Personal Computer, or only launches a single VNA, do the following:

1. Check the display port PLE cable between the RX-TX connections. A disconnection will result in a long start-up with a flatline response across all S-parameters and a display where the VNAs do not sweep.
2. Check the fiber optic cable as a bad connection or dirty fiber optical cable. Device Manager will show both VNAs but only one VNA will be displayed.
3. Check the USB connection between the MS46131A-012 and the PC. Device Manager will show only one VNA and only one VNA will be displayed.

ShockLine Application Displays 'No Hardware Detected'

1. Open Device Manager on the Personal Computer and check if Anritsu Programmed USB is present under Universal Serial Bus controllers. See Figure 4-2.

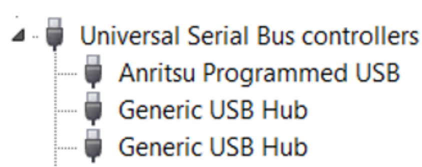


Figure 4-2. Windows Device Manager

2. If it is displayed as Anritsu Programmed USB with an exclamation mark (!) on it, right-click on it and then select Uninstall. On the next dialog box, check Delete the driver software for this device and the click the OK button. You may have to do this step several times.
3. After uninstalling the driver, the instrument will appear in the Device Manager as Other Device.
4. If ShockLine Application Software is not installed, install the latest ShockLine Software and it will automatically install the driver.
5. If latest ShockLine Application Software has already been installed, right-click on the Other Device in Device Manager and select Update Driver Software. On the next dialog box, browse to `C:\Program Files (x86)\Anritsu Company\ShockLine\Application` and then click the Next button.
6. If the problem still exists, replace the VNA Assembly.

ShockLine Application Displays ‘Anritsu hardware is unavailable’

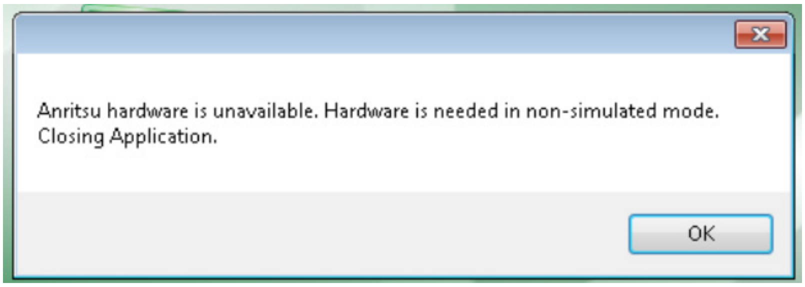


Figure 4-3. Anritsu hardware is unavailable message

If the ShockLine Application displays the ‘Anritsu hardware is unavailable’ message, do the following:

1. Wait until the IVI client finishes its task and re-try after 15 minutes.

Note	ShockLine Application Software and IVI client cannot be run simultaneously. If ShockLine Application software is running and an IVI client is being started, then ShockLine Application software will be automatically stopped. If an IVI client is running, ShockLine Application Software will not be able to start and the ‘Anritsu hardware is unavailable’ message will be displayed.

2. If the problem still exists, the IVI client might not be properly closed. Try manually restarting the IVI Server to release the hardware using the following steps:

   a. Right-click on the ShockLine Tray Daemon icon on the lower right hand corner of the display. Select Stop IVI Server and then select Start IVI Server. See Figure 4-4.

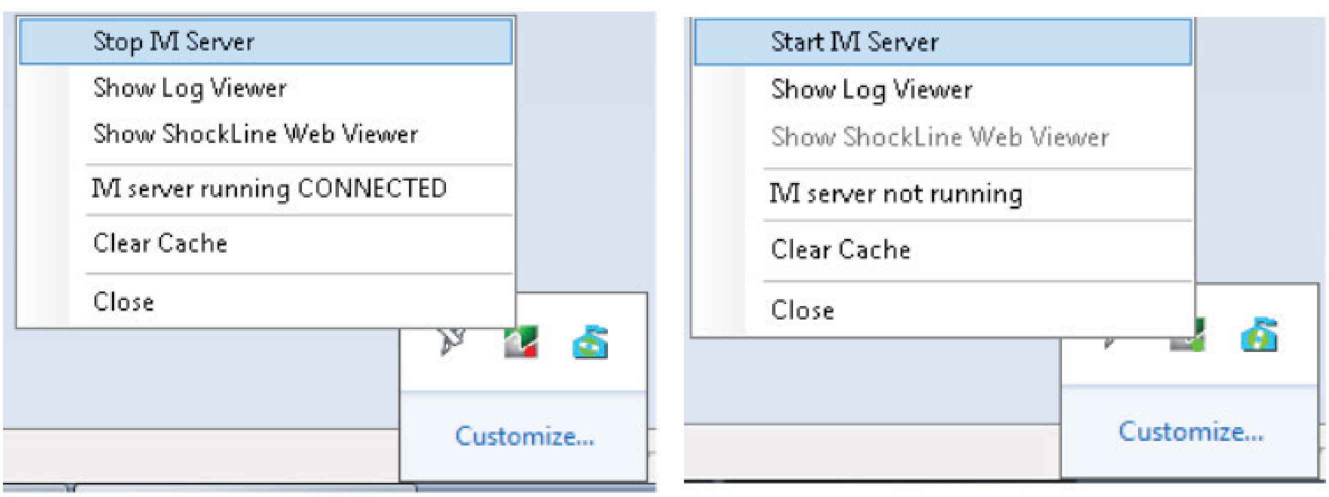


Figure 4-4. IVI Server Control

   b. Check the color of the indicator on the ShockLine Tray Daemon to verify if it is in conditions that allows the ShockLine Application software to run.

ShockLine Tray Daemon Indicator Color Definitions

- **Green**
  The IVI Server is not running and no IVI connections are available. Only ShockLine Application Software can be run.
- **Yellow**
  The IVI Server is running. The IVI Clients or ShockLine Application Software can be run.

- **Red**
  The tray menu provides two status states when Red.
    - If the state is CONNECTED, an IVI Client is connected and the hardware is busy so ShockLine Application Software could not be used.
    - If the state is WAITING, the server is waiting for an IVI client but the hardware is not busy so the ShockLine Application Software or an IVI Client can be run.

4-5 Troubleshooting Operating Problems

Frequency-Related Problems

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

1. Apply external 10 MHz Reference to the front panel 10 MHz Ref In.
2. If the problem does not show with the external reference, the problem is in the internal reference oscillator. Replace the VNA Assembly.

RF Power-Related Problems

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

1. Perform "Troubleshooting Test — Non-Ratio Power Level Check" on page 4-2.
2. If the power level shows any abnormality, do the following:
    a. Verify that the connection between test port adapter and VNA Assembly. Re-torque if necessary.
    b. Verify that the test port adapter is worn or damaged. Replace the test port adapter if necessary.
    c. Replace VNA Assembly.

4-6 Troubleshooting Measurement Problems

If the MS46131A measurement quality is suspect, the following paragraphs provide guidelines and hints for determining possible quality problems.

VNA Measurement Quality

The quality of MS46131A VNA measurements is determined by the following test conditions and variable:

- The condition of the MS46131A.
- The quality and condition of the interface connections and connectors.
- The quality and condition of the calibration components, 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 proper calibration was done for the device being measured:
        - For 2-port 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.
    - **b.** Check the condition of DUT mating connectors and their pin depth.
    - **c.** If possible, measure an alternate known good DUT.
    - **d.** 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 condition and pin depth of calibration kit components. Replace with known good components, if necessary.
    - **b.** 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 — Assembly Removal and Replacement

5-1 Introduction

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

5-2 Electrostatic Discharge Prevention

An ESD safe work area and proper ESD handling procedures that conform to ANSI/ESD S20.20-2014 is mandatory to avoid ESD damage when handling subassemblies or components found in the MS46131A Vector Network Analyzer.

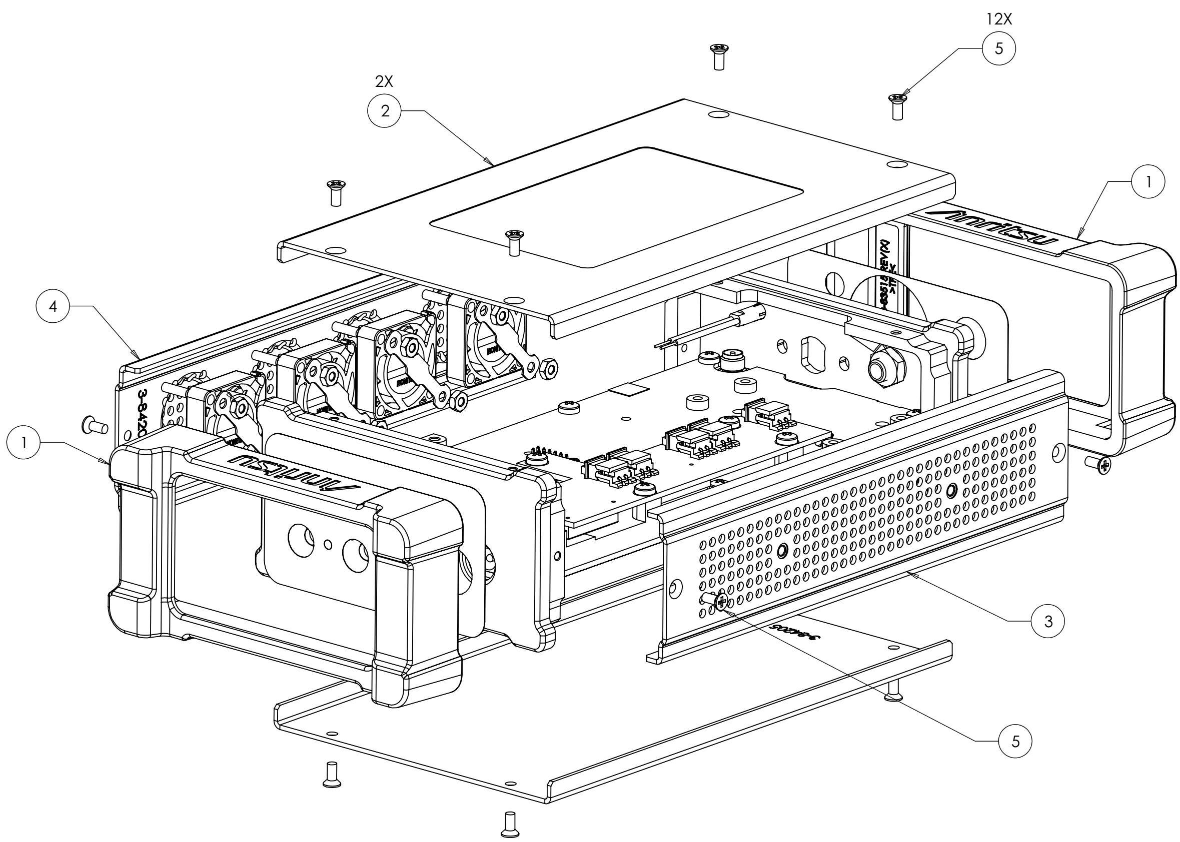
Warning	All electronic devices, components, and instruments can be damaged by electrostatic discharge. It is important to take preventative measures to protect the instrument and its internal subassemblies from electrostatic discharge.

5-3 Disassembly Procedure

Use this procedure to prepare the MS46131A for removal and replacement procedures for all of its replaceable components. All replacement components require this common disassembly procedure.

Reference Figures

- Figure 5-1, “MS46131A Instrument Enclosure” on page 5-2
- Figure 5-2, “Top View of MS46131A Enclosure” on page 5-3



1 – End Cap

2 – Top/Bottom Covers

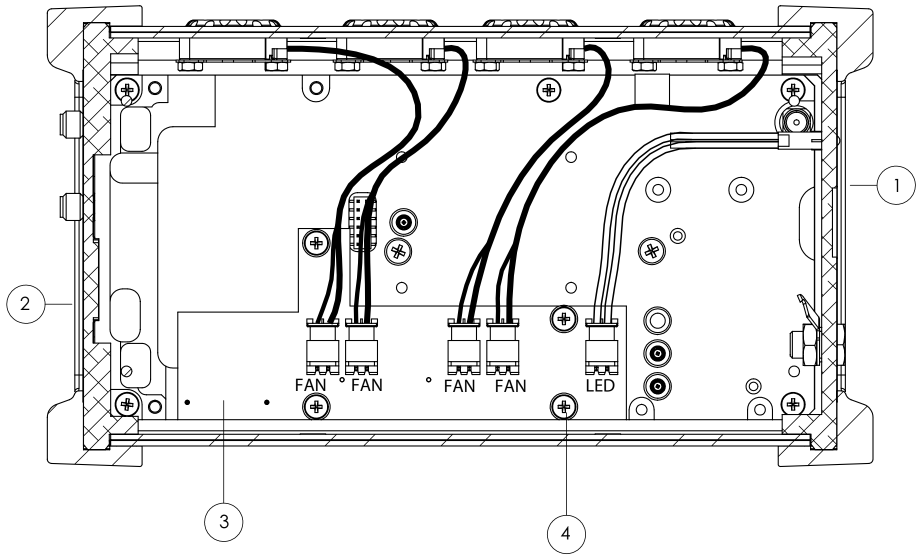
3 – Vent Side Cover

4 – Fan Side Cover

5 – M2.5 x 4 Flat Head Phillips Screws (Qty 12)

Figure 5-1. MS46131A Instrument Enclosure

.



1 – Test Port Connector Panel

2 – Face Panel

3 – Fan PCB Assembly

4 – M3 x 6 Pan Head Phillips Screws (Qty 4)

Figure 5-2. Top View of MS46131A Enclosure

Common Disassembly Procedures

1. Prepare a clean and static free work area. Make sure that the work area is well grounded. Cover the work surface with a soft, clean anti-static mat.
2. Provide all personnel with appropriate anti-static grounding wrist straps and similar equipment.
3. Remove both End Caps from the MS46131A and place the instrument on the anti-static mat with the Model ID label side facing upward.

Top Cover Removal

4. Remove the Top Cover as follows:
   a. Remove the four M2.5 x 4 Flat Head Phillips screws that secure the Top Cover.
   b. Remove the Top Cover.

Vent Side Cover Removal

5. Remove the Vent Side Cover as follows:
   a. Remove the two M2.5 x 4 Flat Head Phillips screws that secure the Vent Side Cover.
   b. Remove the Vent Side cover.

Fan Side Cover Removal

6. Remove the Fan Side Cover as follows:

a. Unplug the four Fan Wiring Harnesses from the Fan PCB Assembly. Refer to Figure 5-2.

b. Remove the two M2.5 x 4 Flat Head Phillips screws that secure the Fan Side Cover.

c. Remove the Fan Side Cover.

Bottom Cover Removal

7. Remove the Bottom Cover as follows:

a. Flip the instrument so that the Bottom Cover is facing upward.

b. Remove four M2.5 x 4 Flat Head Phillips screws that secure the Bottom Cover.

c. Remove the Bottom Cover.

Test Port Connector Panel Removal

8. Remove the Test Port Connector Panel as follows:

a. Flip the instrument so that the Fan PCB Assembly is facing upward.

b. Unplug the LED Wiring Harness from the Fan PCB Assembly.

c. Flip the instrument so that the Fan PCB Assembly is facing downward.

d. Remove the two M3 x 6 Flat Head Phillips Screws that secure the Test Port Connector Panel to the VNA Assembly.

e. For instruments with Option 10, disconnect the connection between the RF Coaxial Cable Assembly from the VNA Assembly and the Test Port Adapter.

f. For instruments with Option 20 or 43, disconnect the connection between the Test Port Adapter and the Sampler Module of the VNA Assembly.

g. Slide the Test Port Connector Panel off the VNA Assembly.

Face Panel Removal

9. Remove the Face Panel as follows:

a. Remove the two M3 x 6 Flat Head Phillips Screws that secure the Face Panel to the VNA Assembly.

b. Carefully slide the Face Panel off the VNA Assembly.

5-4 Fan PCB Assembly

Use this procedure to replace the Fan PCB Assembly.

Replacement Parts

- Fan PCB Assembly – 3-ND85130

Reference Figures

- Figure 5-2, “Top View of MS46131A Enclosure” on page 5-3

Replacement Procedure

1. Refer to the “Common Disassembly Procedures” on page 5-3 when performing this replacement procedure.
2. Remove the End Caps and Top Cover.
3. Unplug the Fan Wiring Harnesses from the Fan PCB Assembly
4. Unplug the LED Wiring Harness from the Fan PCB Assembly.
5. Remove the Four M3 x 6 Pan Head Phillips screws that secure the Fan PCB Assembly to the VNA Assembly.
6. Carefully unplug the Fan PCB Assembly from the VNA Assembly.
7. Install the replacement Fan PCB Assembly to the VNA Assembly.
8. Secure the Fan PCB Assembly with screws that were removed in Step 4.
9. Re-connect the Fan Wiring Harnesses and LED Wiring Harness to the Fan PCB Assembly.
10. Install the Top Cover.
11. Install the End Caps.

5-5 Fan Assembly

Use this procedure to replace the Fan Assembly.

Replacement Parts

- Fan Assembly – 3-ND85129

Reference Figures

- Figure 5-1, “MS46131A Instrument Enclosure” on page 5-2
- Figure 5-2, “Top View of MS46131A Enclosure” on page 5-3

Replacement Procedure

1. Refer to the “Common Disassembly Procedures” on page 5-3 when performing this replacement procedure.
2. Remove the End Caps and Top Cover.
3. Unplug the Fan Wiring Harnesses from the Fan PCB Assembly.
4. Remove the Fan Side Cover.
5. Lay the Fan Side Cover with Fan Assemblies facing upward on a flat working surface.
6. Remove the two M2.5 Stainless Steel Hex Nuts that secure the Fan Assembly to the Fan Side Cover.
7. Carefully slide the Fan Assembly from the studs of the Fan Side Cover.
8. Install the replacement Fan Assembly to the Fan Side Cover.
9. Apply threadlocker (Loctite 242 or equivalent) to the threads of the studs on the Fan Side Cover.
10. Secure the Fan Assembly with Hex Nuts that were removed in Step 6.
11. Install the Fan Side Cover.
12. Re-connect the Fan Wiring Harnesses to the Fan PCB Assembly.
13. Install the Top Cover.
14. Install the End Caps.

5-6 VNA Assembly

Use this procedure to replace the VNA Assembly.

Replacement Part

- VNA Assembly of MS46131A with Option 10 – 3-ND85131-RFB
- VNA Assembly of MS46131A with Options 10 and 12 – 3-ND85132-RFB
- VNA Assembly of MS46131A with Option 20 – 3-ND85133-RFB
- VNA Assembly of MS46131A with Options 20 and 12 – 3-ND85134-RFB
- VNA Assembly of MS46131A with Option 43 – 3-ND85135-RFB
- VNA Assembly of MS46131A with Options 43 and 12 – 3-ND85136-RFB

Reference Figure

- Figure 5-1, “MS46131A Instrument Enclosure” on page 5-2

Replacement Procedure

1. Refer to the “Common Disassembly Procedures” on page 5-3 when performing this replacement procedure.
2. Remove the Top Cover.
3. Unplug the Fan Wiring Harnesses and LED Wiring Harness from the Fan PCB Assembly.
4. Remove both the Fan Side Cover and Vent Side Cover.
5. Remove the Bottom Cover.
6. Remove the two M3 x 6 Flat Head Phillips Screws that secure the Test Port Connector Panel to the VNA Assembly.
7. For instruments with Option 10, disconnect the connection between the RF Coaxial Cable Assembly from the VNA Assembly and the Test Port Adapter.
8. For instruments with Option 20 or 43, disconnect the connection between the Test Port Adapter and the VNA Assembly.
9. Remove the Test Port Connector Panel.
10. Remove the Face Panel.
11. Remove the Fan PCB Assembly from the VNA Assembly and install it onto the replacement VNA Assembly.
12. Install the Face Panel to the replacement VNA Assembly.
13. For instruments with Option 10:
    a. Slide the Test Port Connector Panel onto the VNA Assembly.
    b. Connect the RF Coaxial Cable Assembly from the VNA Assembly to the Test Port Adapter.
    c. Secure the Test Port Connector Panel to the VNA Assembly with the two M3 x 6 Flat Head Phillips Screws and then tighten the cable connection to the Test Port Adapter with an 8 in·lb torque wrench.
14. For instruments with Option 20 or 43:
    a. Loosen the Hex Nut that secures the Test Port Adapter to the Test Port Connector Panel slightly.
    b. Slide the Test Port Connector Panel onto the VNA Assembly and check for alignment. Make adjustment if necessary and then tighten Hex Nut to secure the Test Port Adapter to the panel.
    c. Connect the Test Port Adapter to the Sampler Module of the VNA Assembly.

d. Secure the Test Port Connector Panel to the VNA Assembly with the two M3 x 6 Flat Head Phillips Screws and then tighten the connection between the Test Port Adapter and the Sampler Module of the VNA Assembly with an 8 in·lb torque wrench.

15. Install the Fan Side Cover and the Vent Side Cover.
16. Install the Bottom Cover.
17. Re-connect the Fan Wiring Harnesses and LED Wiring Harness from the Fan PCB Assembly.
18. Install the Top Cover.
19. Install both End Caps.

5-7 Test Port Adapter

Use this procedure to replace the Test Port Adapters.

Replacement Part

- Test Port Adapter of MS46131A with Option 10 – 3-513-149
- Test Port Adapter of MS46131A with Option 20 or Option 43 – 3-83773

Reference Figure

- Figure 5-1, “MS46131A Instrument Enclosure” on page 5-2
- Figure 5-3, “Test Port Adapters” on page 5-9

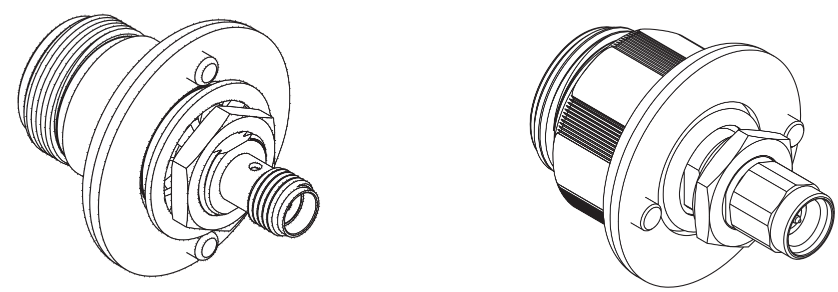


Figure 5-3. Test Port Adapters

Replacement Procedure

1. Refer to the “Common Disassembly Procedures” on page 5-3 when performing this replacement procedure.
2. Remove the Top Cover.
3. Unplug the Fan Wiring Harnesses and LED Wiring Harness from the Fan PCB Assembly.
4. Remove both the Fan Side Cover and Vent Side Cover.
5. Remove the Bottom Cover.
6. Remove the two M3 x 6 Flat Head Phillips Screws that secure the Test Port Connector Panel to the VNA Assembly.
7. For instruments with Option 10, disconnect the connection between the RF Coaxial Cable Assembly from the VNA Assembly and the Test Port Adapter.
8. For instruments with Option 20 or 43, disconnect the connection between the Test Port Adapter and the Sampler Module of the VNA Assembly.
9. Remove the Test Port Connector Panel.
10. Remove the Hex Nut and Washer.
11. Remove the Test Port Adapter from the Test Port Connector Panel.
12. For instruments with Option 10:
    a. Install the replacement Test Port Adapter to the Test Port Connector Panel.

b. Secure the adapter to the Test Port Connector Panel with the Hex Nut and Washer supplied with the replacement adapter.

c. Connect the RF Coaxial Cable Assembly from the VNA Assembly to the Test Port Adapter.

d. Secure the Test Port Connector Panel to the VNA Assembly with the two M3 x 6 Flat Head Phillips Screws and then tighten the cable connection to the Test Port Adapter with an 8 in·lb torque wrench.

13. For instruments with Option 20 or 43:

a. Install the replacement Test Port Adapter to the Test Port Connector Panel.

b. Secure the adapter to the Test Port Connector Panel with the Hex Nut and Washer supplied with the replacement adapter but do not tighten.

c. Slide the Test Port Connector Panel onto the VNA Assembly and check for alignment. Make adjustment if necessary and then tighten Hex Nut to secure the Test Port Adapter to the panel.

d. Connect the Test Port Adapter to the Sampler Module of the VNA Assembly.

e. Secure the Test Port Connector Panel to the VNA Assembly with the two M3 x 6 Flat Head Phillips Screws and then tighten the connection between the Test Port Adapter and the Sampler Module of the VNA Assembly with an 8 in·lb torque wrench.

14. Install the Fan Side Cover and the Vent Side Cover.

15. Install the Bottom Cover.

16. Re-connect the Fan Wiring Harnesses and LED Wiring Harness from the Fan PCB Assembly.

17. Install the Top Cover.

18. Install both End Caps.

5-8 RF Coaxial Cable Assembly (For Instruments with Option 10)

Use this procedure to replace the RF Coaxial Cable Assembly linking between the Test Port Adapter and the VNA Assembly of MS46131A with Option 10.

Replacement Part

RF Coaxial Cable Assembly – 3-83829

Replacement Procedure

1. Refer to the "Common Disassembly Procedures" on page 5-3 when performing this replacement procedure.
2. Remove the Top Cover.
3. Unplug the Fan Wiring Harnesses and LED Wiring Harness from the Fan PCB Assembly.
4. Remove both the Fan Side Cover and Vent Side Cover.
5. Remove the Bottom Cover.
6. Remove the two M3 x 6 Flat Head Phillips Screws that secure the Test Port Connector Panel to the VNA Assembly.
7. Disconnect the connection between the RF Coaxial Cable Assembly and the Test Port Adapter.
8. Remove the Test Port Connector Panel.
9. Disconnect the RF Coaxial Cable Assembly from the VNA Assembly.
10. Install the replacement RF Coaxial Cable Assembly to the VNA Assembly.
11. Slide the Test Port Connector Panel onto the VNA Assembly and connect the RF Coaxial Cable Assembly to the Test Port Adapter.
12. Secure the Test Port Connector Panel to the VNA Assembly with the two M3 x 6 Flat Head Phillips Screws.
13. Tighten the connections at both ends of the RF Coaxial Cable Assembly with with an 8 in·lb torque wrench.
14. Install the Fan Side Cover and the Vent Side Cover.
15. Install the Bottom Cover.
16. Re-connect the Fan Wiring Harnesses and LED Wiring Harness from the Fan PCB Assembly.
17. Install the Top Cover.
18. Install both End Caps.

Appendix A — Test Records

A-1 Introduction

This appendix provides test record that can be used to record the performance of the ShockLine MS46131A.

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 MS46131A without Option 12 Test Record” on page A-2
- “ShockLine MS46131A with Option 12 Test Record” on page A-3
- “ShockLine MS46131A Instrument Key Parameter Test Record” on page A-4

Instrument Information

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

A-2 ShockLine MS46131A without Option 12 Test Record

Corrected Directivity

Table A-1. Corrected Directivity of MS46131A with Option 10

Frequency (GHz)	Specification (dB)	Measured (dB)	Uncertainty (dB)	Pass/Fail
0.001 to 6	≥ 42		2.2	
>6 to 8	≥ 37		2.2	

Table A-2. Corrected Directivity of MS46131A with Option 20 or 43

Frequency (GHz)	Specification (dB)	Measured (dB)	Uncertainty (dB)	Pass/Fail
0.001 to 6	≥ 42		2.2	
>6 to 20	≥ 36		1.4	
>20 to 30 (Opt 43)	≥ 32		1.1	
>30 to 40 (Opt 43)	≥ 30		1.0	
>40 to 43.5 (Opt 43)	≥ 28		1.0	

Corrected Port Match

Table A-3. Corrected Port Match of MS46131A with Option 10

Frequency (GHz)	Specification (dB)	Measured (dB)	Uncertainty (dB)	Pass/Fail
0.001 to 6	≥ 33		1.3	
>6 to 8	≥ 33		1.3	

Table A-4. Corrected Port Match of MS46131A with Option 20 or 43

Frequency (GHz)	Specification (dB)	Measured (dB)	Uncertainty (dB)	Pass/Fail
0.001 to 6	≥ 33		1.3	
>6 to 20	≥ 26		0.8	
>20 to 30 (Opt 43)	≥ 22		0.7	
>30 to 40 (Opt 43)	≥ 20		0.7	
>40 to 43.5 (Opt 43)	≥ 20		0.7	

Instrument Information

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

A-3 ShockLine MS46131A with Option 12 Test Record

This test is automated using the System Performance Verification software that is included with 3663-3 amd 3668-4 Verification Kit.

Note	Pass/Fail criteria is determined from EnR. EnR $\leq$1 = PASS, EnR >1 = FAIL Where EnR = $\lvert M_a - M_b \rvert / sqrt(U_a^2 + U_b^2)$

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

Instrument Information

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

A-4 ShockLine MS46131A Instrument Key Parameter Test Record

Frequency Accuracy

Table A-5. Frequency Accuracy

Frequency	Specification (See Note below)	Measured Value	Uncertainty	Pass/Fail
1 GHz	Hz	Hz	32 Hz	

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

MS46131A High Level Noise (100 Hz IFBW, RMS)

Table A-6. MS46131A High-level Noise - S11 Magnitude (1 of 2)

Frequency (MHz)	Measured Value (dB RMS)	Specification (dB)	Measurement Uncertainty (dB RMS)	Pass/Fail
1		0.009	0.00095	
10		0.009	0.00095	
50		0.009	0.00095	
100		0.009	0.00095	
501		0.009	0.00095	
1000		0.009	0.00095	
2000		0.009	0.00095	
3000		0.009	0.00095	
4001		0.009	0.00095	
5000		0.009	0.00095	
6000		0.009	0.00095	
7000		0.009	0.00095	
8000		0.009	0.00095	
8500		0.006	0.00029	
9000		0.006	0.00029	
10000		0.006	0.00029	
11000		0.006	0.00029	

Table A-6. MS46131A High-level Noise - S11 Magnitude (2 of 2)

Frequency (MHz)	Measured Value (dB RMS)	Specification (dB)	Measurement Uncertainty (dB RMS)	Pass/Fail
12000		0.006	0.00029	
13000		0.006	0.00029	
14000		0.006	0.00029	
15000		0.006	0.00029	
16000		0.006	0.00029	
17000		0.006	0.00029	
18000		0.006	0.00029	
19000		0.006	0.00029	
20000		0.006	0.00029	
20000.1		0.006	0.00030	
21000		0.006	0.00030	
22000		0.006	0.00030	
23000		0.006	0.00030	
24000		0.006	0.00030	
25000		0.006	0.00030	
26000		0.006	0.00030	
27000		0.006	0.00030	
28000		0.006	0.00030	
29000		0.006	0.00030	
30000		0.006	0.00030	
31000		0.006	0.00030	
32000		0.006	0.00030	
33000		0.006	0.00030	
34000		0.006	0.00030	
35000		0.006	0.00030	
36000		0.006	0.00030	
37000		0.006	0.00030	
38000		0.006	0.00030	
39000		0.006	0.00030	
40000		0.006	0.00030	
40000.1		0.009	0.00039	
41000		0.009	0.00039	
42000		0.009	0.00039	
43000		0.009	0.00039	
43500		0.009	0.00039	

Table A-7. MS46131A High Level Noise - S11 Phase (1 of 2)

Frequency (MHz)	Measured Value (deg RMS)	Specification (deg)	Measurement Uncertainty (deg RMS)	Pass/Fail
1		0.12	0.0032	
10		0.12	0.0032	
50		0.12	0.0059	
100		0.12	0.0059	
501		0.12	0.0059	
1000		0.12	0.0059	
2000		0.12	0.0059	
3000		0.12	0.0059	
4001		0.12	0.0059	
5000		0.12	0.0059	
6000		0.12	0.0059	
7000		0.12	0.0059	
8000		0.12	0.0059	
8500		0.1	0.0021	
9000		0.1	0.0021	
10000		0.1	0.0021	
11000		0.1	0.0021	
12000		0.1	0.0021	
13000		0.1	0.0021	
14000		0.1	0.0021	
15000		0.1	0.0021	
16000		0.1	0.0021	
17000		0.1	0.0021	
18000		0.1	0.0021	
19000		0.1	0.0021	
20000		0.1	0.0021	
20000.1		0.1	0.0019	
21000		0.1	0.0019	
22000		0.1	0.0019	
23000		0.1	0.0019	
24000		0.1	0.0019	
25000		0.1	0.0019	
26000		0.1	0.0019	
27000		0.1	0.0019	
28000		0.1	0.0019	
29000		0.1	0.0019	
30000		0.1	0.0019	

Table A-7. MS46131A High Level Noise - S11 Phase (2 of 2)

Frequency (MHz)	Measured Value (deg RMS)	Specification (deg)	Measurement Uncertainty (deg RMS)	Pass/Fail
31000		0.1	0.0019	
32000		0.1	0.0019	
33000		0.1	0.0019	
34000		0.1	0.0019	
35000		0.1	0.0019	
36000		0.1	0.0019	
37000		0.1	0.0019	
38000		0.1	0.0019	
39000		0.1	0.0019	
40000		0.1	0.0019	
40000.1		0.12	0.0025	
41000		0.12	0.0025	
42000		0.12	0.0025	
43000		0.12	0.0025	
43500		0.12	0.0025	

MS46131A-012 High-level Noise (100 Hz IFBW, RMS)

Table A-8. MS46131A-012 High Level Noise - S11 Phase (1 of 2)

Frequency (MHz)	Measured Value (deg RMS)	Specification (deg)	Measurement Uncertainty (deg RMS)	Pass/Fail
1		0.21	0.0014	
10		0.21	0.0014	
50		0.21	0.0014	
100		0.21	0.0014	
500		0.21	0.0014	
1000		0.21	0.0014	
2000		0.21	0.0014	
3000		0.21	0.0014	
4001		0.21	0.0014	
5000		0.41	0.0014	
6000		0.41	0.0014	
7000		0.41	0.0014	
8000		0.41	0.0014	
8001		0.41	0.0024	
9000		0.41	0.0024	
10000		0.41	0.0024	
11000		0.41	0.0024	
12000		0.41	0.0024	
13000		0.41	0.0024	
14000		0.41	0.0024	
15000		0.41	0.0024	
16000		0.41	0.0024	
17000		0.41	0.0024	
18000		0.41	0.0024	
19000		0.41	0.0024	
20000		0.41	0.0024	
20001		0.41	0.0024	
21000		0.56	0.0034	
22000		0.56	0.0034	
23000		0.56	0.0034	
24000		0.56	0.0034	
25000		0.56	0.0034	
26000		0.56	0.0034	
27000		0.56	0.0034	
28000		0.56	0.0034	
29000		0.56	0.0034	
30000		0.56	0.0034	

Table A-8. MS46131A-012 High Level Noise - S11 Phase (2 of 2)

Frequency (MHz)	Measured Value (deg RMS)	Specification (deg)	Measurement Uncertainty (deg RMS)	Pass/Fail
31000		0.56	0.0034	
32000		0.56	0.0034	
33000		0.56	0.0034	
34000		0.56	0.0034	
35000		0.56	0.0034	
36000		0.56	0.0034	
37000		0.56	0.0034	
38000		0.56	0.0034	
39000		0.56	0.0034	
40000		0.56	0.0034	
40001		0.56	0.0034	
41000		0.56	0.0038	
42000		0.56	0.0038	
43000		0.56	0.0038	
43500		0.56	0.0038	

Table A-9. MS46131A-012 High Level Noise – S12 Phase (1 of 2)

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

Table A-9. MS46131A-012 High Level Noise – S12 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)
12000		0.0018
13000		0.0018
14000		0.0018
15000		0.0018
16000		0.0018
17000		0.0018
18000		0.0018
19000		0.0018
20000		0.0018
21000		0.0018
22000		0.0018
23000		0.0018
24000		0.0018
25000		0.0018
26000		0.0018
27000		0.0018
28000		0.0018
29000		0.0018
30000		0.0018
31000		0.0018
32000		0.0018
33000		0.0018
34000		0.0018
35000		0.0018
36000		0.0018
37000		0.0018
38000		0.0018
39000		0.0018
40000		0.0018
41000		0.0013
42000		0.0013
43000		0.0013
43500		0.0013

Table A-10. MS46131A-012 High Level Noise – S21 Magnitude (1 of 2)

Frequency (MHz)	Measured Value (dB rms)	Measurement Uncertainty (dB rms)
1		0.00059
10		0.00059
50		0.0029
100		0.0029
501		0.0029
1000		0.0029
2000		0.0029
3000		0.0029
4001		0.0029
5000		0.0029
6000		0.0029
7000		0.0029
8000		0.0029
8500		0.0029
9000		0.0029
10000		0.0029
11000		0.0029
12000		0.0029
13000		0.0029
14000		0.0029
15000		0.0029
16000		0.0029
17000		0.0029
18000		0.0029
19000		0.0029
20000		0.0029
21000		0.0029
22000		0.0029
23000		0.0029
24000		0.0029
25000		0.0029
26000		0.0029
27000		0.0029
28000		0.0029
29000		0.0029
30000		0.0029
31000		0.0029

Table A-10. MS46131A-012 High Level Noise – S21 Magnitude (2 of 2)

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

Table A-11. MS46131A-012 High Level Noise – S21 Phase (1 of 2)

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

Table A-11. MS46131A-012 High Level Noise – S21 Phase (2 of 2)

Frequency (MHz)	Measured Value (Deg rms)	Measurement Uncertainty (Deg rms)
14000		0.0018
15000		0.0018
16000		0.0018
17000		0.0018
18000		0.0018
19000		0.0018
20000		0.0018
21000		0.0018
22000		0.0018
23000		0.0018
24000		0.0018
25000		0.0018
26000		0.0018
27000		0.0018
28000		0.0018
29000		0.0018
30000		0.0018
31000		0.0018
32000		0.0018
33000		0.0018
34000		0.0018
35000		0.0018
36000		0.0018
37000		0.0018
38000		0.0018
39000		0.0018
40000		0.0018
41000		0.0013
42000		0.0013
43000		0.0013
43500		0.0013

MS46131A-012 or ME7868A System Dynamic Range

(High Power, 10 Hz IFBW, RMS)

Table A-12. MS46131A-012 or ME7868A S12 System Dynamic Range

Frequency	Measured Value	Measurement Uncertainty	Specification	Pass/Fail
1 MHz to 5 GHz	dB rms	0.91 dB rms	97 dB rms	
>5 GHz to 7 GHz	dB rms	0.91 dB rms	97 dB rms	
>7 GHz to 7.5 GHz	dB rms	0.91 dB rms	97 dB rms	
>7.5 GHz to 8.5 GHz	dB rms	0.91 dB rms	94 dB rms	
>8.5 GHz to 20 GHz	dB rms	0.91 dB rms	98 dB rms	
>20 GHz to 40 GHz	dB rms	1.14 dB rms	102 dB rms	
>40 GHz to 43.5 GHz	dB rms	0.71 dB rms	99 dB rms	

Table A-13. MS46131A-012 or ME7868A S12 S21 System Dynamic Range

Frequency	Measured Value	Measurement Uncertainty	Specification	Pass/Fail
1 MHz to 5 GHz	dB rms	0.91 dB rms	97 dB rms	
>5 GHz to 7 GHz	dB rms	0.91 dB rms	89 dB rms	
>7 GHz to 7.5 GHz	dB rms	0.91 dB rms	97 dB rms	
>7.5 GHz to 8.5 GHz	dB rms	0.91 dB rms	94 dB rms	
>8.5 GHz to 20 GHz	dB rms	0.91 dB rms	98 dB rms	
>20 GHz to 40 GHz	dB rms	1.14 dB rms	102 dB rms	
>40 GHz to 43.5 GHz	dB rms	0.71 dB rms	99 dB rms	

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