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ShockLine™ 1-Port USB Vector Network Analyzers

MS46121B

150 kHz to 6 GHz

SHOCKLINE™

Introduction

The MS46121B is part of the ShockLine™ family of Vector Network Analyzers from Anritsu. It is available in two frequency ranges of 40 MHz to 4 GHz and 150 kHz to 6 GHz, and is capable of 1-port S-parameter and band pass time domain (distance to fault) measurements.

The MS46121B Vector Network Analyzer (VNA) is controlled through USB from an external PC. The MS46121B runs the same software as the rest of the ShockLine family, providing a powerful graphical user interface for testing of passive devices. Up to 16 MS46121B VNAs can be controlled from one computer, making it ideal for testing multiple 1-port devices in parallel for improved test productivity and throughput.

The MS46121B with Option 2 provides a Time Domain Reflectometry (TDR) like display that enables real impedance measurements over frequency. With Option 21, scalar transmission measurements between MS46121B instruments can be performed in various configurations.

This document provides detailed specifications for the MS46121B series Vector Network Analyzer and related options.

Instrument Models and Operating Frequencies

Base Model

- MS46121B, 1-Port ShockLine VNA

Requires one Frequency Option

- MS46121B-004, 40 MHz to 4 GHz, 1-Port
- MS46121B-006, 150 kHz to 6 GHz, 1-Port

Principal Options

- MS46121B-002, Time Domain
- MS46121B-021, Scalar Transmission Measurement

MS46121B ShockLine 1-Port USB VNA

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Definitions

All specifications and characteristics apply to instruments under the following conditions, unless otherwise stated:

Warm-Up Time	After 30 minutes of warm-up time, where the instrument is left in the ON state.
Temperature Range	Specifications apply over the 25 °C ± 5 °C temperature range.
Error-Corrected Specifications	Specifications are valid over 23 °C ± 3 °C, with < 1 °C variation from calibration temperature.
Frequency Bands in Tables	When a frequency is listed in two rows of the same table, the specification for the common frequency is taken from the lower frequency band.
User Cables	Specifications do not include effects of any user cables attached to the instrument.
Discrete Spurious Responses	Specifications may exclude discrete spurious responses.
Internal Reference Signal	All specifications apply with internal 10 MHz Crystal Oscillator Reference Signal.
Interpolation Mode	All specifications are with Interpolation Mode Off.
Standard	Refers to instruments without Options.
Typical Performance	Typical performance indicates the measured performance of an average unit. It does not include guard-bands and is not covered by the product warranty.
Characteristic Performance	Characteristic performance indicates a performance designed-in and verified during the design phase. It does include guard-bands and is not covered by the product warranty.
Uncertainty	A coverage factor of x1 is applied to the measurement uncertainties to facilitate comparison to other industry analyzers.
Recommended Calibration Cycle	12 months (Residual specifications also require calibration kit calibration cycle adherence.)
Specifications Subject to Change	All specifications are typical unless otherwise noted and are subject to change without notice. For the most current data sheet, please visit the Anritsu web site: www.anritsu.com

High Level Noise

Measured at 100 Hz IF bandwidth and at default power level, RMS.

Frequency	Magnitude (dB)	Phase Noise (deg RMS)
150 kHz to 6 GHz	0.02	0.2

Output Power

Frequency	Power Setting	Standard (dBm)
150 kHz to 46 MHz	Default	–5
>46 MHz to 4 GHz	Default	+3
>4 GHz to 6 GHz	Default	–5

Measurement Stability

Ratio measurement, with ports shorted. Typical.

Frequency	Magnitude (dB/°C)	Phase (deg/°C)
150 kHz to 1 MHz	0.1	0.1
>1 MHz to 4 GHz	0.01	0.1
>4 GHz to 6 GHz	0.05	0.2

Frequency Resolution, Accuracy, and Stability

Resolution	Accuracy	Stability	Aging
1 Hz[a]	±0.5 ppm (at time of calibration)	±1.0 ppm from -10 °C to +55 °C	±1.0 ppm/year

a. Frequency resolution is 10 kHz when using an external reference.

Uncorrected (Raw) Port Characteristics

User and System Correction Off.

Frequency	Directivity (dB)	Port Match (dB)
150 kHz to 6 GHz	10 dB[a]	10 dB[b]

a. Raw directivity specification degrades by 2 dB above 4 GHz.

b. Raw port match specification degrades by 5 dB above 4 GHz.

Scalar Transmission Measurement Accuracy

Measurement accuracy is specified @ 50 Hz IFBW with external reference, scalar normalization On, and from 0 dB to –50 dB insertion loss levels. Scalar transmission is functional to 6 GHz.

Frequency	Accuracy (dB)
>150 kHz to 6 GHz	±1.0

Dynamic Range for Scalar Transmission

Dynamic range is specified @ 30 Hz IFBW with external reference, scalar normalization On, and using a USB hub with two MS46121B instruments connected.

Frequency	Dynamic Range (dB, typical)
150 kHz to 6 GHz	80

VNA System Performance

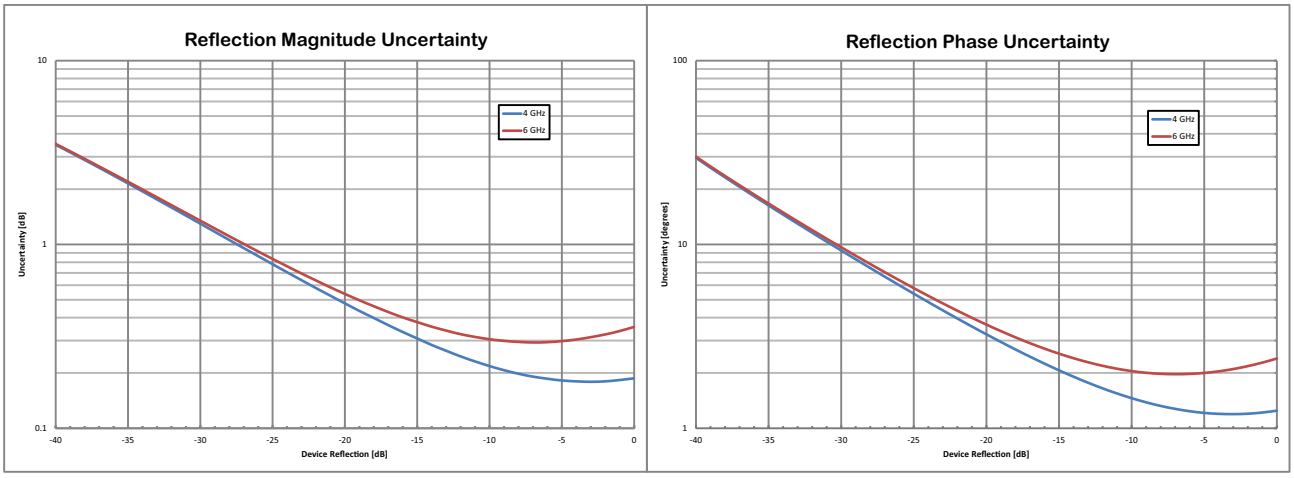
Error-Corrected Specifications

With calibration using TOSLN50A-8 or TOSLNF50A-8 N-type connector manual calibration kits or the MN25208A SmartCal™ automatic calibration kit with connector options MN25208A-001, -002, and -003.

Frequency Range	Directivity (dB)	Source Match (dB)	Reflection Tracking (dB)
150 kHz to 4 GHz	42	35	±0.1
> 4 GHz to 6 GHz	42	35	±0.2

Measurement Uncertainties

The graphs give measurement uncertainties after the above error-corrected calibration. The errors are a worst-case contribution of residual directivity, load and source match, frequency response and isolation, network analyzer dynamic accuracy, and connector repeatability. 10 Hz IF Bandwidth is used. All calibrations and measurements were performed at default port power. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



VNA System Performance

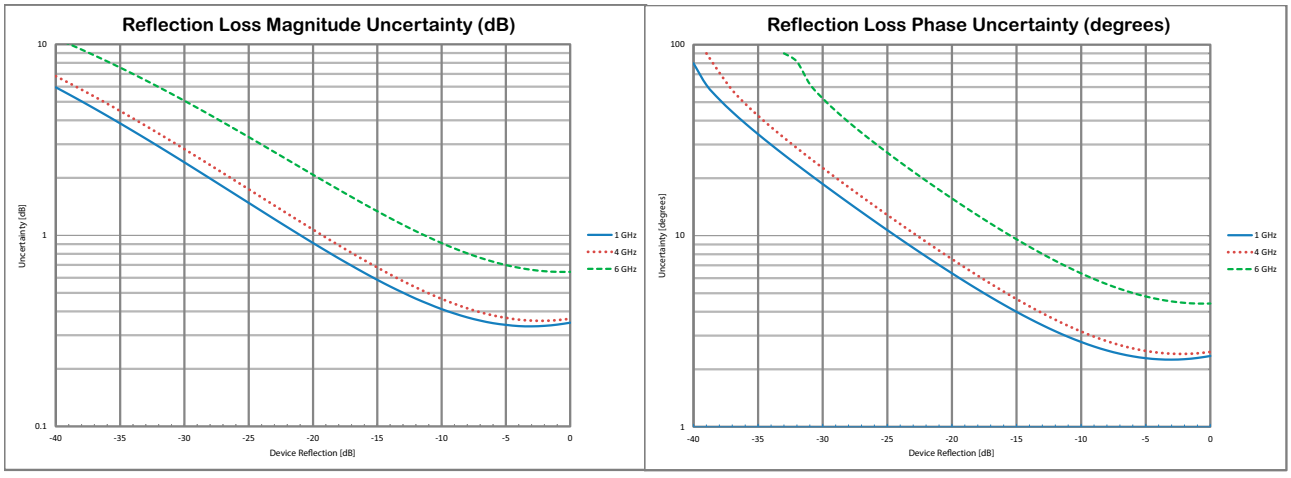
Error-Corrected Specifications

With calibration using the MN25408A SmartCal™ automatic calibration kit with connector options MN25408A-001, -002, and -003.

Frequency Range	Directivity (dB)	Source Match (dB)	Reflection Tracking (dB)
150 kHz to 1 GHz	42	35	±0.15
> 1 GHz to 5 GHz	40	35	±0.2
> 5 GHz to 6 GHz	33	32	±0.2

Measurement Uncertainties

The graphs give measurement uncertainties after the above error-corrected calibration. The errors are a worst-case contribution of residual directivity, load and source match, frequency response and isolation, network analyzer dynamic accuracy, and connector repeatability. 10 Hz IF Bandwidth is used. All calibrations and measurements were performed at default port power. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



Measurement Throughput

Measurement Speed

120 µs/point, typical. Per point single sweep time, including placing measurement data into memory. Average of narrow, mid, and wide frequency span sweeps. 100 kHz IFBW, 1601 points, 1 port calibrated data measurement. Timing dependent on external computer configuration. Measurements taken with an Intel® Core™ i5-6300U processor running Windows 7 with 4 GB of RAM and 60 GB of free hard disk space.

Standard Capabilities

Operating Frequencies

MS46121B-004	40 MHz to 4 GHz
MS46121B-006	150 kHz to 6 GHz

Measurement Parameters

1-Port Measurements	S_{11} or any user-defined combination of a_1, b_1, 1
2-Port Measurements	$S_{\|XY\|}$ where Y is the source and X is the receiver
Domains	Frequency Domain and Band Pass Time Domain (Distance to Fault)

Sweeps

Frequency Sweep Types	Linear, Log, or Segmented

Display Graphs

Single Rectilinear Graph Types	Log Magnitude, Phase, Linear Magnitude, Real, Imaginary, SWR, and Impedance
Dual Rectilinear Graph Types	Log Mag and Phase, Linear Mag and Phase, Real and Imaginary
Circular Graph Types	Smith Chart, Polar

Measurements Data Points

Maximum Data Points	2 to 20,001 points

Limit Lines

Limit Lines	Single or segmented. 2 limit lines per trace. 50 segments per trace.
Single Limit Readouts	Uses interpolation to determine the intersection frequency.
Test Limits	Both single and segmented limits can be used for PASS/FAIL testing.

Ripple Limit Lines

Limit Lines	Single or segmented. Two limit lines per trace. 50 segments per trace.
Ripple Value	Absolute Value or Margin
Test Limits	Both single and segmented limits can be used for PASS/FAIL testing.

Averaging

Point-by-Point	Point-by-point (default), maximum number of averages = 4096
Sweep-by-Sweep	Sweep-by-sweep, maximum number of averages = 4096

IF Bandwidth (All IFBW settings applicable with Option 21 enabled.)

10, 20, 30, 50, 70, 100, 200, 300, 500, 700 Hz
1, 2, 3, 5, 7, 10, 20, 30, 50, 100 kHz

Reference Plane

Line Length or Time Delay	The reference planes of a calibration or other normalization can be changed by entering a line length or time delay.
Dielectric Constants	Dielectric constants may be entered for different media so the length entry can be physically meaningful.
Dispersion Modeling	Dispersion modeling is used in the cases of microstrip and waveguide to take into account frequency dependent phase velocities.
Attenuations	Attenuations and constant phase offsets can be entered to better describe any reference plane distortions.
De-embedding	For more complete reference plane manipulation, the full de-embedding system can also be used.

Measurement Frequency Range

Frequency Range Change	Frequency range of the measurement can be narrowed within the calibration range without recalibration.
CW Mode	CW mode permits single frequency measurements also without recalibration.
Interpolation Not Activated	If interpolation is not activated, the subset frequency range is forced to use calibration frequency points.
Interpolation Activated	If interpolation is activated, any frequency range that is a subset of the calibration frequency range can be used, but there may be some added interpolation error.

Channels, Display, and Traces

Channels	Up to 16 MS46121B VNAs can operate in parallel while controlled from a single host computer. ShockLine software dedicates one channel per MS46121B VNA with 16 channels maximum
Traces	Each channel supports up to 16 data traces.
Display Colors	Unlimited colors for data traces, memory, text, markers, graticules, and limit lines
Trace Memory and Math	A separate memory for each trace can be used to store measurement data for later display or subtraction, addition, multiplication or division with current measurement data. The trace data can be saved and recalled.
Inter-trace Math	Any two traces within a channel can be combined (via addition, subtraction, multiplication, or division) and displayed on another trace. An equation editor mode is also available that allows the combination of trace data, trace memory and S-parameter data in more complex equations. Over 30 built-in functions are available. Simple editing tools and the ability to save/recall equations are also provided.

Scale Resolution

	Minimum per division, varies with graph type.
Log Magnitude	0.001 dB
Linear Magnitude	10 μU
Phase	0.01°
Time	0.0001 ps
Distance	0.1 μm
SWR	10 μU
Power	0.01 dB

Markers

Markers	12 markers + 1 reference marker
Marker Coupling	Coupled or decoupled
Marker Overlay	Display markers on active trace only or on all traces when multiple trace responses are present on the same trace
Marker Data	Data displayed in graph area or in table form
Reference Marker	Additional marker per trace for reference
Marker Statistics	Mean, maximum, minimum, standard deviation
	Per trace or over a marker region
Marker Search and Tracking	Search and/or track for minimum, maximum, peak, or target value

Other

Filter Parameters	Display bandwidth (user-selectable loss value), corner and center frequencies, loss, Q, and shape factors.
S-Parameter Conversion	Z Reflection Impedance Z Transmission Impedance Y Reflection Admittance Y Transmission Admittance 1/S

Calibration and Correction Capabilities

Calibration Methods

Open Short Load (OSL)
Offset Short (SSL)
Triple Offset Short (SSS)
SmartCal™
AutoCal™

Correction Models

1-Port	Reflection Frequency Response (S_{11})
2-Port	Transmission Frequency Response (Scalar) ($S_{\|XY\|}$) where Y is the source and X is the receiver

Coefficients for Calibration Standards

Use the Anritsu calibration kit USB memory device to load kit coefficients and characterization files.
Enter coefficients into user-defined locations.
Use complex load models.

Interpolation

Allows interpolation between calibration frequency points.

Dispersion Compensation

Selectable as Coaxial, other non-dispersive (e.g., for coplanar waveguide), Waveguide, or Microstrip

Embedding/De-embedding

The MS46121B is equipped with an Embedding/De-embedding system.

De-embedding	De-embedding is generally used for removal of test fixture contributions, modeled networks, and other networks described by S-parameters (s2p files) from measurements.
Embedding	Similarly, the Embedding function can be used to simulate matching circuits for optimizing amplifier designs or simply adding effects of a known structure to a measurement.
Multiple Networks	Multiple networks can be embedded/de-embedded and changing the port and network orientations is handled easily.

Remote Operability

ShockLine supports several remote operability options.

Communication Type	Data Format	Performance	Description
Drivers	IVI-C drivers are available for download from the Anritsu website. The IVI-C package supports National Instruments LabVIEW and LabWindows, C#, .NET, MATLAB, and Python34 programming environments.		
Triggering	Start Trigger	Software	

Recommended External PC Configuration

CPU	Intel® Core™ i5-6300U Processor
RAM	4 GB
Disk	120 GB
DirectX	Version 9 with Windows Display Driver Model (WDDM) installed
USB	One USB 2.0 (or higher) type A port per MS46121B used
	To increase the number of USB ports available an externally powered USB hub may also be used.
	ShockLine software is compatible with Windows® 7, 8, 8.1, or 10; 32 or 64 bit operating systems

Device Connections

MS46121B

Test Port 1		
	MS46121B	N(m)
	Damage Input Levels	+23 dBm maximum, ±50 VDC maximum
External Reference In		
	Frequency Input	10 MHz (better than 10 ppm frequency accuracy is recommended)
	Connector Type	MCX(f)
	Signal	0.89 V_{pp}, minimum; 80 Ω, nominal
USB Ports		One Micro USB 2.0 port for connecting to an external PC controller. For multiple MS46121B instruments on one PC, an externally powered USB 2.0 hub is recommended

Mechanical

Dimensions	W x H x D	52 mm x 148 mm x 36 mm
Weight		< 0.4 kg (< 0.9 lb), typical weight

Regulatory Compliance

European Union	EMC 2014/30/EU, EN 61326:2013, CISPR 11/EN 55011, IEC/EN 61000-4-2/3/4/5/6/8/11 Low Voltage Directive 2014/35/EU Safety EN 61010-1:2010 RoHS Directive 2011/65/EU applies to instruments with CE marking placed on the market after July 22, 2017
Australia and New Zealand	RCM AS/NZS 4417:2012
South Korea	KCC-REM-A21-0004

Environmental

MIL-PRF-28800F Class 2

Operating Temperature Range	–10 °C to 55 °C
Storage Temperature Range	–51 °C to 71 °C
Maximum Relative Humidity	95 % RH at 30 °C, non-condensing
Vibration, Sinusoidal	5 Hz to 55 Hz
Vibration, Random	10 Hz to 500 Hz
Half Sine Shock	30 g_n
Altitude	4600 meters, operating and non-operating

Warranty

Instrument and Built-In Options	Three (3) years from the date of shipment (standard warranty)
Calibration Kits	Typically 1 year from the date of shipment
Test Port Cables	Typically 1 year from the date of shipment
Warranty Options	Additional warranty available

Ordering Information

Instrument Models

Base Model	MS46121B, ShockLine™ 1-Port USB VNA
Required Option	MS46121B-004, 40 MHz to 4 GHz, type N(m) port
(Select one frequency option only)	MS46121B-006, 150 kHz to 6 GHz, type N(m) port

Included Accessories

USB-A to Micro-B with latch cable, 2000-1816-R, 1.8 m (6 ft)
Getting Started with Anritsu Flier, provides access to all ShockLine web content and services.

Main VNA Option

MS46121B-002	Low Pass Time Domain
MS46121B-021	Scalar Transmission Measurement

Precision Automatic Calibrator Module

MN25208A	2-port USB SmartCal Module, 300 kHz to 8.5 GHz (available with connector Options -001 N(f), -002 K(f), -003 3.5 mm(f))
MN25408A	4-port USB SmartCal Module, 300 kHz to 8.5 GHz (available with connector Options -001 N(f), -002 K(f), -003 3.5 mm(f))
MN25218A[1]	2-port USB SmartCal Module, 300 kHz to 20 GHz (available with connector Option -002 K(f))
MN25418A	4-port USB SmartCal Module, 300 kHz to 20 GHz (available with connector Option -002 K(f))
36585K-2M	K Connector Precision AutoCal Module, 70 kHz to 40 GHz, K(m) to K(m)
36585K-2F	K Connector Precision AutoCal Module, 70 kHz to 40 GHz, K(f) to K(f)
36585K-2MF	K Connector Precision AutoCal Module, 70 kHz to 40 GHz, K(m) to K(f)
2000-1809-R	Serial to USB Adapter (required for use with 36585 AutoCal module if control PC does not have a serial port)

Mechanical Calibration Kits

3653A	N Connector Calibration Kit, Without Sliding Loads, DC to 18 GHz, 50 Ω
OSLN50A-8	Precision N Male Open/Short/Load Mechanical Calibration Tee, DC to 8 GHz, 50 Ω
OSLNF50A-8	Precision N Female Open/Short/Load Mechanical Calibration Tee, DC to 8 GHz, 50 Ω
TOSLN50A-8	Precision N Male Through/Open/Short/Load Mechanical Calibration Tee, DC to 8 GHz, 50 Ω
TOSLNF50A-8	Precision N Female Through/Open/Short/Load Mechanical Calibration Tee, DC to 8 GHz, 50 Ω

1. Applies to Rev 2 SmartCal Modules. MN25218A with serial numbers <1817999 operate from 1 MHz to 20 GHz.

Ordering Information (continued)

RF Cables and Adapters

1091-26-R	Adapter, SMA(m) to N(m), DC to 18 GHz, 50 Ω
1091-27-R	Adapter, SMA(f) to N(m), DC to 18 GHz, 50 Ω
1091-80-R	Adapter, SMA(m) to N(f), DC to 18 GHz, 50 Ω
1091-81-R	Adapter, SMA(f) to N(f), DC to 18 GHz, 50 Ω
71693-R	Ruggedized adapter, K(f) to N(f), DC to 18 GHz, 50 Ω
34NK50	Precision Adapter, N(m) to K(m), DC to 18 GHz, 50 Ω
34NKF50	Precision Adapter, N(m) to K(f), DC to 18 GHz, 50 Ω
34NFK50	Precision Adapter, N(f) to K(m), DC to 18 GHz, 50 Ω
34NFKF50	Precision Adapter, N(f) to K(f), DC to 18 GHz, 50 Ω
K220B	Precision Adapter, DC to 40 GHz, K(m) to K(m), 50 Ω
K222B	Precision Adapter, DC to 40 GHz, K(f) to K(f), 50 Ω
K224B	Precision Adapter, DC to 40 GHz, K(m) to K(f), 50 Ω

Test Port Cables, Flexible, Ruggedized, Phase Stable

15NNF50-1.0B	1.0 m (39”), DC to 18 GHz, Test Port Cable, Flexible, Phase Stable, N(f) to N(m), 50 Ω
15NNF50-1.5B	1.5 m (59”), DC to 18 GHz, Test Port Cable, Flexible, Phase Stable, N(f) to N(m), 50 Ω
15NN50-1.0B	1.0 m (39”), DC to 18 GHz, Test Port Cable, Flexible, Phase Stable, N(m) to N(m), 50 Ω
15LL50-1.0A	1.0 m (39”), DC to 20 GHz, Test Port Cable, Armored, Phase Stable, 3.5 mm(m) to 3.5 mm(m), 50 Ω
15LLF50-1.0A	1.0 m (39”), DC to 20 GHz, Test Port Cable, Armored, Phase Stable, 3.5 mm(m) to 3.5 mm(f), 50 Ω
15KK50-1.0A	1.0 m (39”), DC to 20 GHz, Test Port Cable, Armored, Phase Stable, K(m) to K(m), 50 Ω
15KKF50-1.0A	1.0 m (39”), DC to 20 GHz, Test Port Cable, Armored, Phase Stable, K(m) to K(f), 50 Ω

Tools

01-200	Calibrated Torque End Wrench, GPC-7 and Type N
01-201	Torque End Wrench, 5/16 in, 0.9 N·m (8 lbf·in) (for tightening male devices, for SMA, 3.5 mm, 2.4 mm, K, and V connectors)
01-203	Torque End Wrench, 13/16 in, 0.9 N.m (8 lbf.in) (for tightening ruggedized SMA, 2.4 mm, K and V test port connectors)
01-204	End Wrench, 5/16 in, Universal, Circular, Open-ended (for SMA, 3.5 mm, 2.4 mm, K, and V connectors)
More Information	Refer to our Precision RF & Microwave Components Catalog for descriptions of adapters and other components.

Documentation

User Documentation	Soft copies of the manuals as Adobe Acrobat PDF files are available for download from the instrument model web page at www.anritsu.com. For more information and product support, please contact ShockLineVNA.support@Anritsu.com.
10100-00067	Product information, compliance, and safety
10410-00344	MS46121A/B Series VNA User Guide
10410-00337	MS46121A/B, MS46122A/B, and MS46322A/B Series VNA User Interface Reference Manual
10410-00746	ShockLine Series VNA Programming Manual, for IEEE 488.2 and SCPI Commands

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