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# ShockLine™ 1-Port USB Vector Network Analyzers

## MS46121B

150 kHz to 6 GHz



## Introduction

The MS46121B is part of the ShockLine™ family of Vector Network Analyzers from Anritsu. It is available with a frequency range of 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

One Frequency Option

- 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: <a href="http://www.anritsu.com">www.anritsu.com</a>

**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 <sup>a</sup>	± 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 <sup>a</sup>	10 dB <sup>b</sup>

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

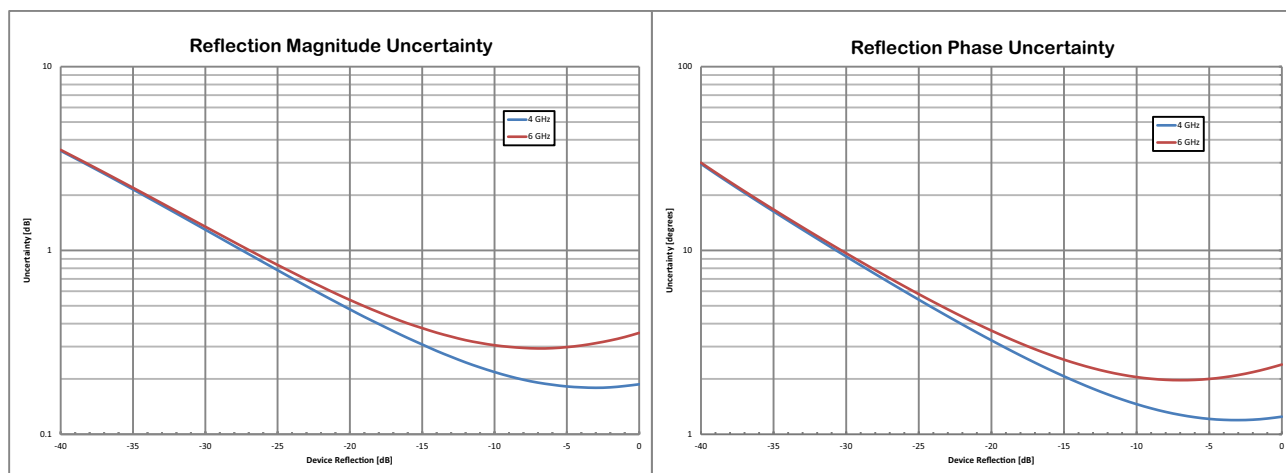
**Error-Corrected Specifications**

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](http://www.anritsu.com).



VNA System Performance

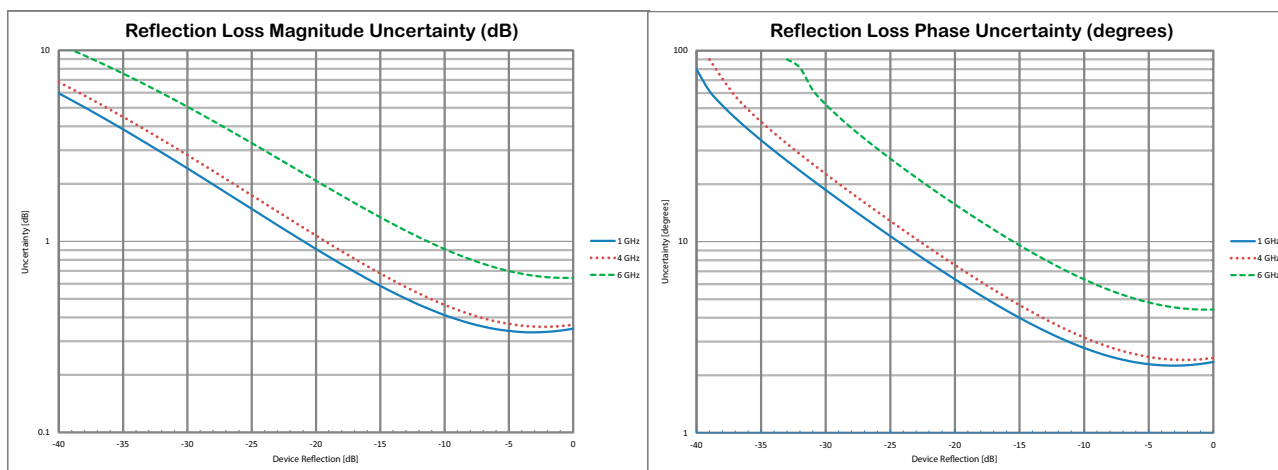
**Error-Corrected Specifications**

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](http://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**

<b>Operating Frequencies</b>	
MS46121B-006	150 kHz to 6 GHz
<b>Measurement Parameters</b>	
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)
<b>Sweeps</b>	
Frequency Sweep Types	Linear, Log, or Segmented
<b>Display Graphs</b>	
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
<b>Measurements Data Points</b>	
Maximum Data Points	2 to 20,001 points
<b>Limit Lines</b>	
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.
<b>Ripple Limit Lines</b>	
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.
<b>Averaging</b>	
Point-by-Point	Point-by-point (default), maximum number of averages = 4096
Sweep-by-Sweep	Sweep-by-sweep, maximum number of averages = 4096
<b>IF Bandwidth</b> (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
<b>Reference Plane</b>	
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.
<b>Measurement Frequency Range</b>	
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 $\mu$ U
Phase	0.01°
Time	0.0001 ps
Distance	0.1 $\mu$ m
SWR	10 $\mu$ U
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
Marker Search and Tracking	Per trace or over a marker region
	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**

<b>Calibration Methods</b>		Open Short Load (OSL) Offset Short (SSL) Triple Offset Short (SSS) SmartCal™ AutoCal™
<b>Correction Models</b>		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
<b>Coefficients for Calibration Standards</b>		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.
<b>Interpolation</b>		Allows interpolation between calibration frequency points.
<b>Dispersion Compensation</b>		Selectable as Coaxial, other non-dispersive (e.g., for coplanar waveguide), Waveguide, or Microstrip
<b>Embedding/De-embedding</b>		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 <sub>pp</sub> , 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

<b>Dimensions</b>	W x H x D	52 mm x 148 mm x 36 mm
<b>Weight</b>		< 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 <sub>n</sub>
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

<b>Instrument Models</b>	
Base Model	MS46121B, ShockLine™ 1-Port USB VNA
Required Option	MS46121B-006, 150 kHz to 6 GHz, type N(m) port
<b>Included Accessories</b>	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.
<b>Main VNA Option</b>	
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 <sup>1</sup>	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 $\Omega$
1091-27-R	Adapter, SMA(f) to N(m), DC to 18 GHz, 50 $\Omega$
1091-80-R	Adapter, SMA(m) to N(f), DC to 18 GHz, 50 $\Omega$
1091-81-R	Adapter, SMA(f) to N(f), DC to 18 GHz, 50 $\Omega$
71693-R	Ruggedized adapter, K(f) to N(f), DC to 18 GHz, 50 $\Omega$
34NK50	Precision Adapter, N(m) to K(m), DC to 18 GHz, 50 $\Omega$
34NKF50	Precision Adapter, N(m) to K(f), DC to 18 GHz, 50 $\Omega$
34NFK50	Precision Adapter, N(f) to K(m), DC to 18 GHz, 50 $\Omega$
34NFKF50	Precision Adapter, N(f) to K(f), DC to 18 GHz, 50 $\Omega$
K220B	Precision Adapter, DC to 40 GHz, K(m) to K(m), 50 $\Omega$
K222B	Precision Adapter, DC to 40 GHz, K(f) to K(f), 50 $\Omega$
K224B	Precision Adapter, DC to 40 GHz, K(m) to K(f), 50 $\Omega$

**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 $\Omega$
15NNF50-1.5B	1.5 m (59"), DC to 18 GHz, Test Port Cable, Flexible, Phase Stable, N(f) to N(m), 50 $\Omega$
15NN50-1.0B	1.0 m (39"), DC to 18 GHz, Test Port Cable, Flexible, Phase Stable, N(m) to N(m), 50 $\Omega$
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 $\Omega$
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 $\Omega$
15KK50-1.0A	1.0 m (39"), DC to 20 GHz, Test Port Cable, Armored, Phase Stable, K(m) to K(m), 50 $\Omega$
15KKF50-1.0A	1.0 m (39"), DC to 20 GHz, Test Port Cable, Armored, Phase Stable, K(m) to K(f), 50 $\Omega$

**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 <a href="http://www.anritsu.com">www.anritsu.com</a> . For more information and product support, please contact <a href="mailto:ShockLineVNA.support@Anritsu.com">ShockLineVNA.support@Anritsu.com</a> .
10100-00067	ShockLine Product Information, Compliance, and Safety
10410-00344	MS46121A/B Series VNA Operation Manual
10410-00337	MS46121A/B, MS46122A/B, and MS46322A/B Series VNA User Interface Reference Manual
10410-00746	ShockLine Programming Manual

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### • United States

**Anritsu Americas Sales Company**  
450 Century Parkway, Suite 190  
Allen, TX 75013, U.S.A.  
Phone: +1-800-Anritsu (1-800-267-4878)

### • Canada

**Anritsu Electronics Ltd.**  
700 Silver Seven Road, Suite 120  
Kanata, Ontario K2V 1C3, Canada  
Phone: +1-613-591-2003  
Fax: +1-613-591-1006

### • Brazil

**Anritsu Eletronica Ltda.**  
Praça Amadeu Amaral, 27 - 1 Andar  
01327-010 - Bela Vista - Sao Paulo - SP  
Brazil  
Phone: +55-11-3283-2511  
Fax: +55-11-3288-6940

### • Mexico

**Anritsu Company, S.A. de C.V.**  
Blvd Miguel de Cervantes Saavedra #169 Piso 1,  
Col. Granada  
Mexico, Ciudad de Mexico, 11520, MEXICO  
Phone: +52-55-4169-7104

### • United Kingdom

**Anritsu EMEA L td.**  
200 Capability Green  
Luton, Bedfordshire, LU1 3LU, U.K.  
Phone: +44-1582-433200  
Fax: +44-1582-731303

### • France

**Anritsu S.A.**  
12 avenue du Québec, Bâtiment Iris 1- Silic 612,  
91140 Villebon-sur-Yvette, France  
Phone: +33-1-60-92-15-50  
Fax: +33-1-64-46-10-65

### • Germany

**Anritsu GmbH**  
Nemetschek Haus, Konrad-Zuse-Platz 1  
81829 München, Germany  
Phone: +49-89-442308-0  
Fax: +49-89-442308-55

### • Italy

**Anritsu S.r.l.**  
Via Elio Vittorini 129, 00144 Roma, Italy  
Phone: +39-6-509-9711  
Fax: +39-6-502-2425

List Revision Date: 20191126

### • Sweden

**Anritsu AB**  
Isafjordsgatan 32C  
164 40 Kista, Sweden  
Phone: +46-8-534-707-00

### • Finland

**Anritsu AB**  
Teknobulevardi 3-5  
FI-01530 Vantaa, Finland  
Phone: +358-20-741-8100  
Fax: +358-20-741-8111

### • Denmark

**Anritsu A/S**  
c/o Regus Fairway, Arne Jacobsens Allé 7, 5th floor,  
2300 Copenhagen S, Denmark  
Phone: +45-7211-2200

### • Russia

**Anritsu EMEA Ltd.**  
**Representation Office in Russia**  
Tverskaya str. 16/2, bld. 1, 7th floor  
Moscow 125009, Russia  
Phone: +7-495-363-1694  
Fax: +7-495-935-8962

### • Spain

**Anritsu EMEA Ltd.**  
**Representation Office in Spain**  
Paseo de la Castellana, 141.  
Planta 5, Edificio Cuzco IV  
28046, Madrid, Spain  
Phone: +34-91-572-6761

### • United Arab Emirates

**Anritsu EMEA Ltd.**  
**Dubai Liaison Office**  
902 Aurora Tower  
P O Box: 500311- Dubai Internet City  
Dubai, United Arab Emirates  
Phone: +971-4-3758479  
Fax: +971-4-4249036

### • India

**Anritsu India Private Limited**  
6th Floor, Indiqube ETA, No.38/4  
Adjacent to EMC2, Doddanekundi, Outer Ring Road  
Bengaluru 560048, India  
Phone: +91-80-6728-1300  
Fax: +91-80-6728-1301

### • Singapore

**Anritsu Pte. Ltd.**  
11 Chang Charn Road, #04-01, Shriro House  
Singapore 159640  
Phone: +65-6282-2400  
Fax: +65-6282-2533

### • P.R. China (Shanghai)

**Anritsu (China) Co., Ltd.**  
Room 2701-2705, Tower A  
New Caohejing International Business Center  
No. 391 Gui Ping Road  
Shanghai 200233, P.R. China  
Phone: +86-21-6237-0898  
Fax: +86-21-6237-0899

### • P.R. China (Hong Kong)

**Anritsu Company Ltd.**  
Unit 1006-7, 10/F.  
Greenfield Tower, Concordia Plaza  
No. 1 Science Museum Road  
Tsim Sha Tsui East, Kowloon  
Hong Kong, P.R. China  
Phone: +852-2301-4980  
Fax: +852-2301-3545

### • Japan

**Anritsu Corporation**  
8-5, Tamura-cho, Atsugi-shi, Kanagawa, 243-0016  
Japan  
Phone: +81-46-296-6509  
Fax: +81-46-225-8352

### • South Korea

**Anritsu Corporation, Ltd.**  
5FL, 235 Pangyoeyeok-ro  
Bundang-gu, Seongnam-si  
Gyeonggi-do 13494, South Korea  
Phone: +82-31-696-7750  
Fax: +82-31-696-7751

### • Australia

**Anritsu Pty. Ltd.**  
Unit 20, 21-35 Ricketts Road  
Mount Waverley, Victoria 3149, Australia  
Phone: +61-3-9558-8177  
Fax: +61-3-9558-8255

### • Taiwan

**Anritsu Company Inc.**  
7F, No. 316, Sec. 1, NeiHu Rd. Taipei 114, Taiwan  
Phone: +886-2-8751-1816  
Fax: +886-2-8751-1817