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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: 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

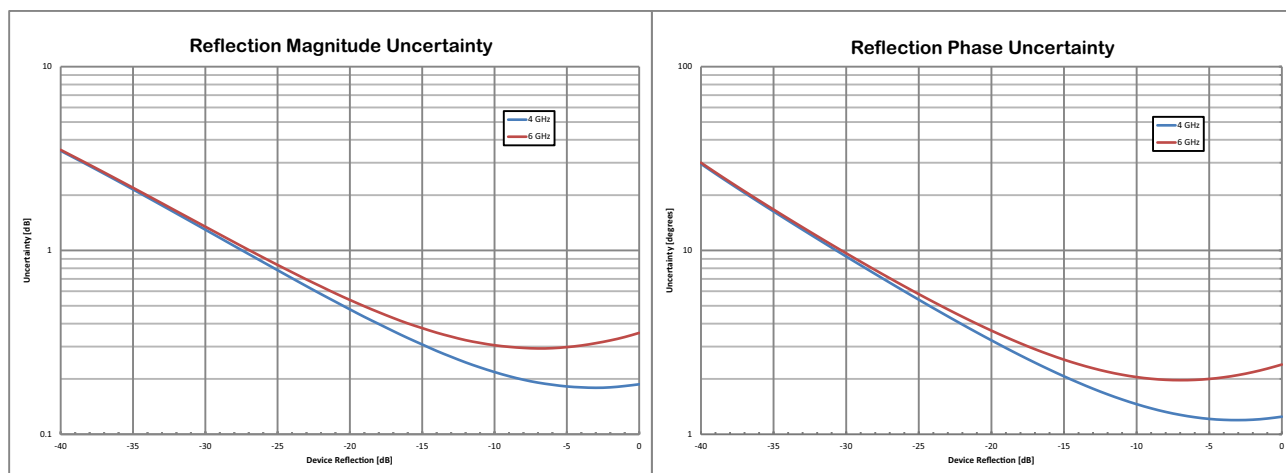
Error-Corrected Specifications

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

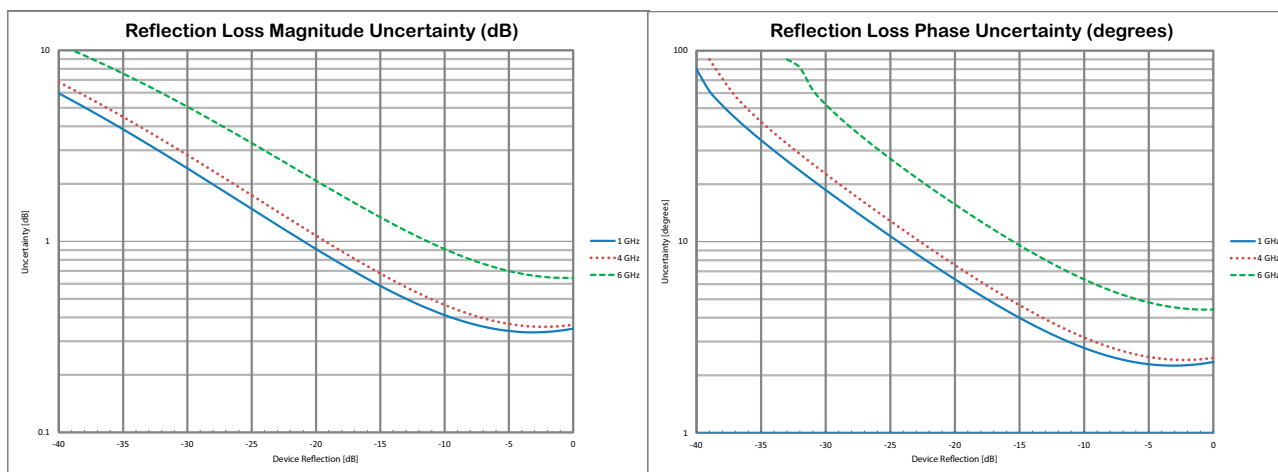
Error-Corrected Specifications

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-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 μ U |
| Phase | 0.01° |
| Time | 0.0001 ps |
| Distance | 0.1 μ m |
| SWR | 10 μ 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

| | | |
|---|--|---|
| 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-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 | 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 |

Training at Anritsu

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