Anritsu envision : ensure

2TEST

ShockLine™ Compact Vector Network Analyzers

MS46122B

1 MHz to 43.5 GHz

SHOCKLINE™

Introduction

The MS46122B is part of the ShockLine™ family of Vector Network Analyzers from Anritsu. It is a very low-cost series of 1U high, 2-port Compact Vector Network Analyzers (VNAs). It is available in three frequency ranges: 1 MHz to 8/20/43.5 GHz, and is capable of s-parameter and time domain measurements.

The MS46122B 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 ShockLine™ VNAs ideal candidates for testing RF and Microwave passive devices to 43.5 GHz.

The MS46122B series is controlled through USB from an external PC. The MS46122B runs the same software as the rest of the ShockLine family, providing a powerful graphical user interface for debugging and manual testing of devices.

This document provides detailed specifications for the MS46122B series Vector Network Analyzers and related options.

Instrument Models and Operating Frequencies

Base Model

- MS46122B, 2-Port ShockLine VNA

Requires one Frequency Option

- MS46122B-010, 1 MHz to 8 GHz, 2-Port
- MS46122B-020, 1 MHz to 20 GHz, 2-Port
- MS46122B-040, 1 MHz to 43.5 GHz, 2-Port

Principal Options

- MS46122B-002, Time Domain

MS46122B-040 2-Port ShockLine Compact VNA

Table of Contents

Definitions

All specifications and characteristics apply 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	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. Error-corrected specifications are warranted and include guard-bands, unless otherwise stated.
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. Typical specifications are shown in parenthesis, such as (-102 dB), or noted as Typical. The MS46122B is operational to 43.5 GHz. All specifications above 40 GHz are typical.
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.
Recommended Calibration Cycle	12 months (Residual specifications also require calibration kit calibration cycle adherence.)
Specifications Subject to Change	All specifications subject to change without notice.

System Dynamic Range

System dynamic range is calculated as the difference between High source power and the noise floor (RMS) at the specified reference plane at 10 Hz IF Bandwidth with an isolation calibration.

Frequency Range	Standard (dB)	Typical (dB)
1 MHz to 10 MHz	85	105
> 10 MHz to 8 GHz[a]	100	115
> 8 GHz to 43.5 GHz[b]	100	110

a. Crosstalk may reduce dynamic range up to 20 dB (typical) at lower IF bandwidths (≤ 10 kHz) when measuring highly reflective DUT's from 4 GHz to 8 GHz. Reflection measurements are not affected.

b. Decrease specification by 5 dB between 8 GHz and 14 GHz.

Receiver Compression Levels

Performance is typical.

Frequency Range	Standard (dBm)
1 MHz to 43.5 GHz	+5 dBm

High Level Noise

Measured at 100 Hz IF bandwidth and at High power level, RMS. Performance is characteristic.

Frequency	Magnitude (dB)	Phase (deg)
1 MHz to < 20 MHz	0.03 (0.005, typical)	< 0.2 (< 0.035 typical)
20 MHz to 43.5 GHz	0.006 (0.001, typical)	< 0.1 (< 0.05 typical)[a]

a. Above 20 GHz, High Level Noise (phase only) is increased by a factor of 1.5.

Output Power Settings

Typical

Power Setting	Standard (dBm)	
High (default)	1 MHz to 8 GHz > 8 GHz to 43.5 GHz	5 dBm –3 dBm
Low	1 MHz to 43.5 GHz	–20 dBm

Measurement Stability

Ratio measurement, with ports shorted. Typical.

Frequency	Magnitude (dB/°C)	Phase (deg/°C)
10 MHz to 43.5 GHz	0.02	0.3

Frequency Resolution, Accuracy, and Stability

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

Uncorrected (Raw) Port Characteristics

User and System Correction Off. All specifications typical.

Frequency Range	Directivity (dB)	Port Match (dB)
1 MHz to 43.5 GHz	> 8 dB	> 8 dB

MS46122B-010 VNA System Performance with Manual Cal Kits

Error-Corrected Specifications

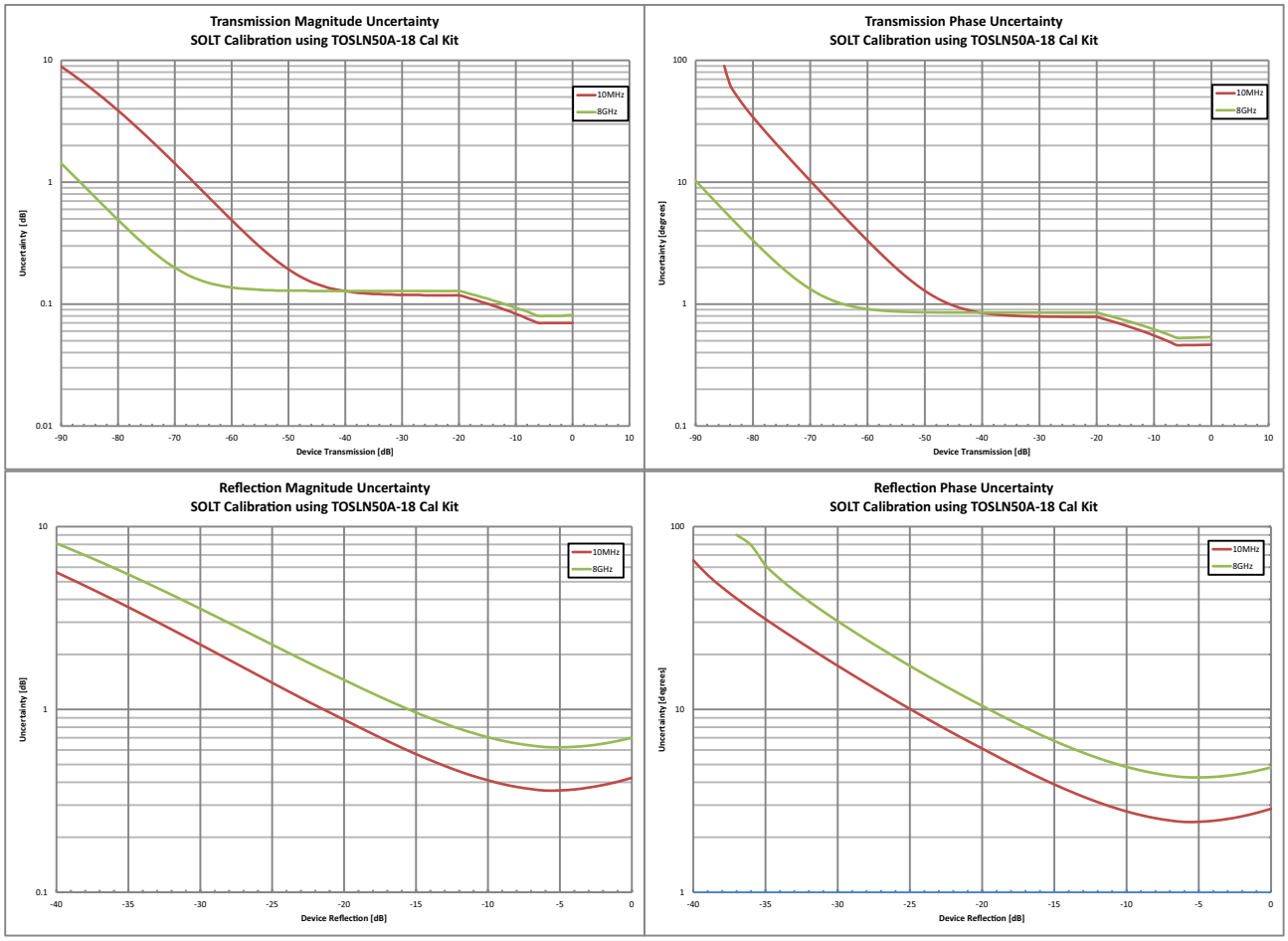
With 12-term SOLT Calibration using TOSLN50A-8 or TOSLNF50A-8 N type connector calibration kits.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
1 MHz to 6 GHz	≥ 42	≥ 33	≥ 42	±0.15	±0.06
> 6 GHz to 8 GHz	≥ 37	≥ 33	≥ 37	±0.15	±0.06

a. Characteristic performance.

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. For transmission uncertainties, it is assumed that $S_{11} = S_{22} = 0$. For reflection uncertainties, it is assumed that $S_{21} = S_{12} = 0$. All calibrations and measurements were performed at default port power.



MS46122B-020 VNA System Performance with Manual Cal Kits

Error-Corrected Specifications

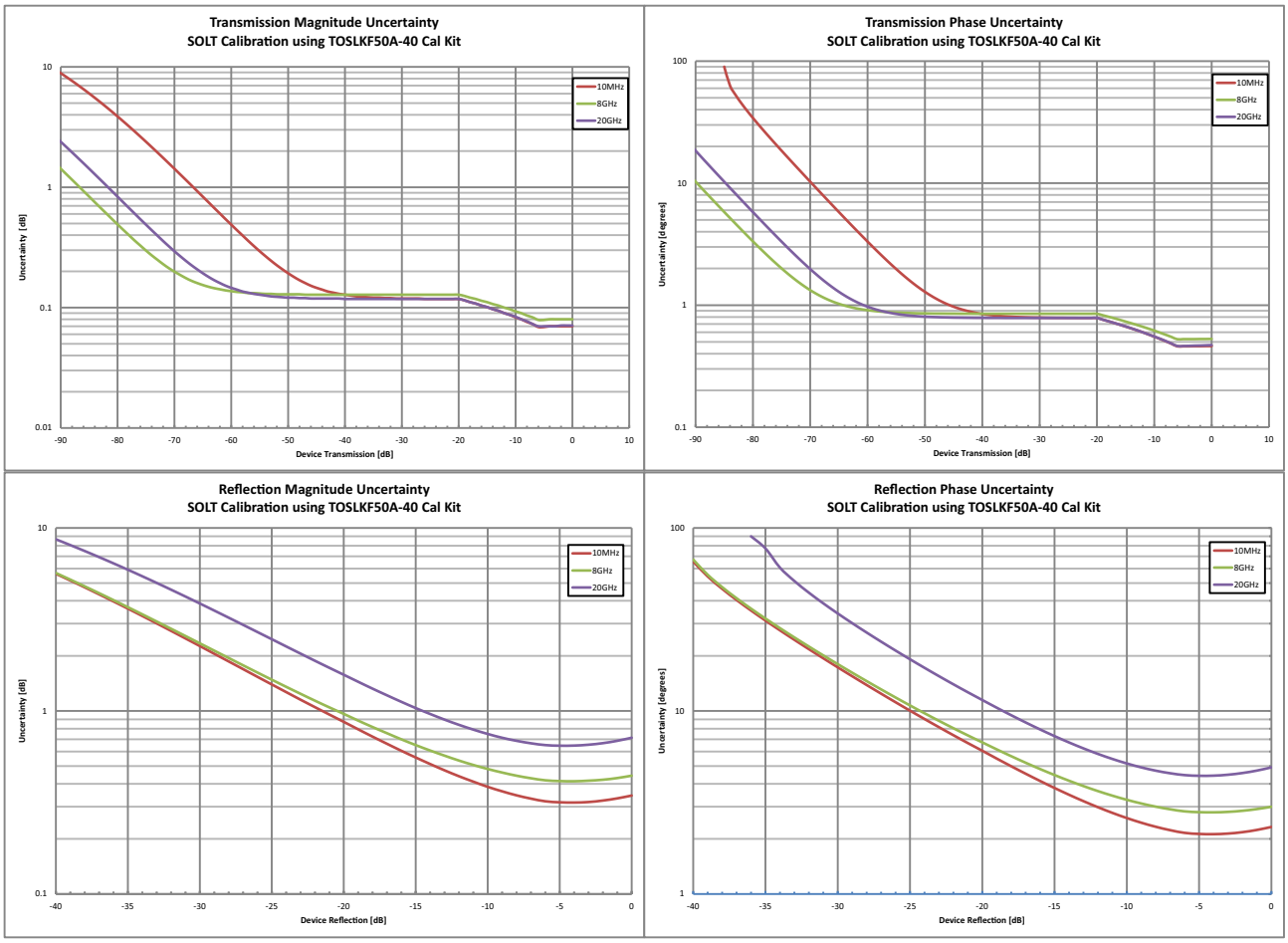
With 12-term SOLT calibration using the TOSLK50A-20 or TOSLKF50A-20 K type connector calibration kits.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
1 MHz to 10 GHz	≥ 42	≥ 33	≥ 42	±0.15	±0.06
> 10 GHz to 20 GHz	≥ 36	≥ 26	≥ 36	±0.15	±0.05

a. Characteristic performance.

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. For transmission uncertainties, it is assumed that $S_{11} = S_{22} = 0$. For reflection uncertainties, it is assumed that $S_{21} = S_{12} = 0$. All calibrations and measurements were performed at default port power.



MS46122B-040 VNA System Performance with Manual Cal Kits

Error-Corrected Specifications

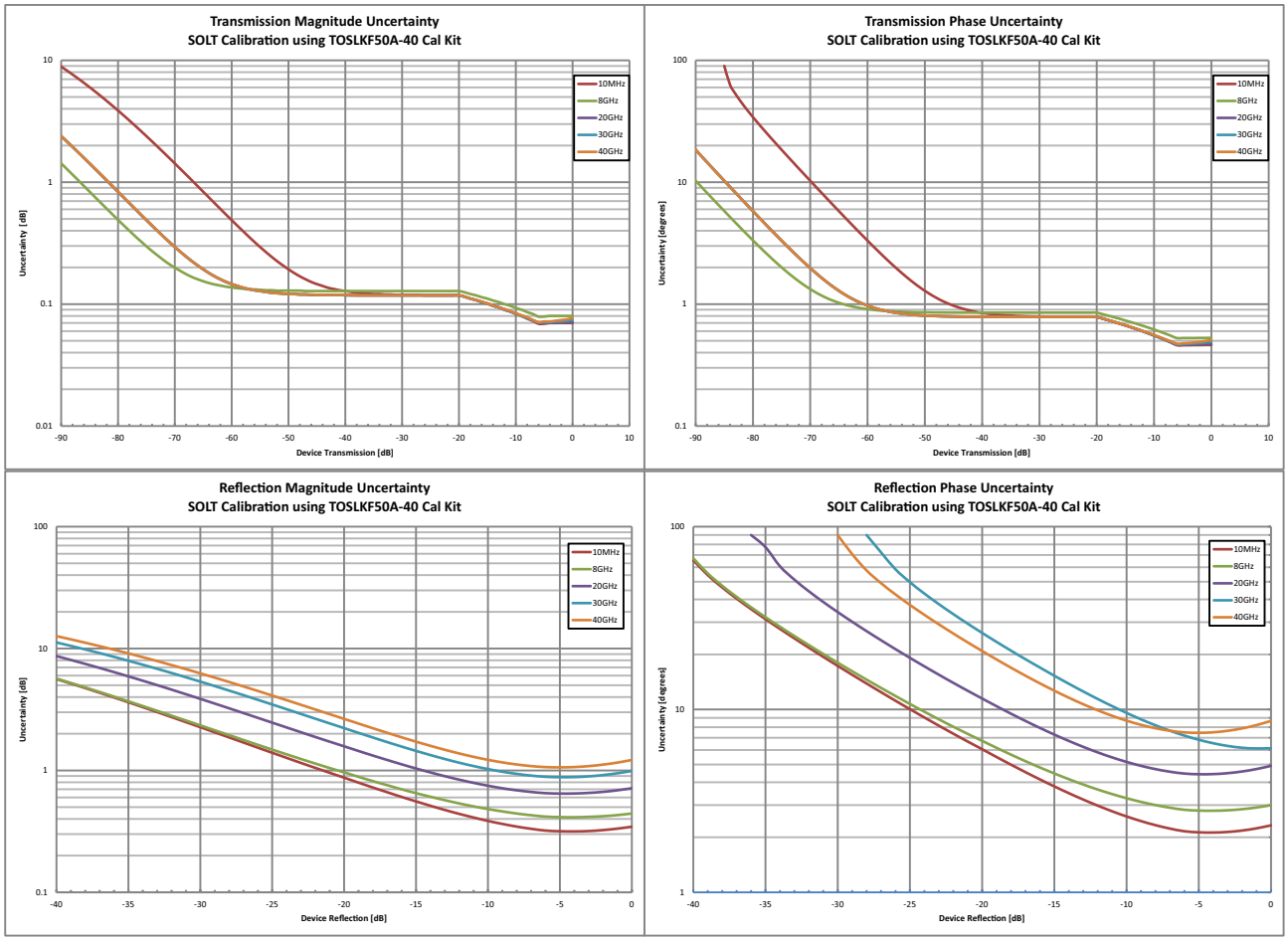
With 12-term SOLT Calibration using TOSLK50A-40 or TOSLKF50A-40 K type connector calibration kits.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
1 MHz to 10 GHz	≥ 42	≥ 33	≥ 42	±0.15	±0.06
> 10 GHz to 20 GHz	≥ 36	≥ 26	≥ 36	±0.15	±0.05
> 20 GHz to 30 GHz	≥ 32	≥ 22	≥ 32	±0.10	±0.05
> 30 GHz to 43.5 GHz	≥ 30	≥ 20	≥ 30	±0.10	±0.05

a. Characteristic performance.

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. For transmission uncertainties, it is assumed that $S_{11} = S_{22} = 0$. For reflection uncertainties, it is assumed that $S_{21} = S_{12} = 0$. All calibrations and measurements were performed at default port power.



MS46122B-010 VNA System Performance with SmartCal™

Error-Corrected Specifications

With 12-term calibration using the MN25208A SmartCal™ automatic calibration kit with connector options MN25208A-001, -002, -003, and -004.[a]

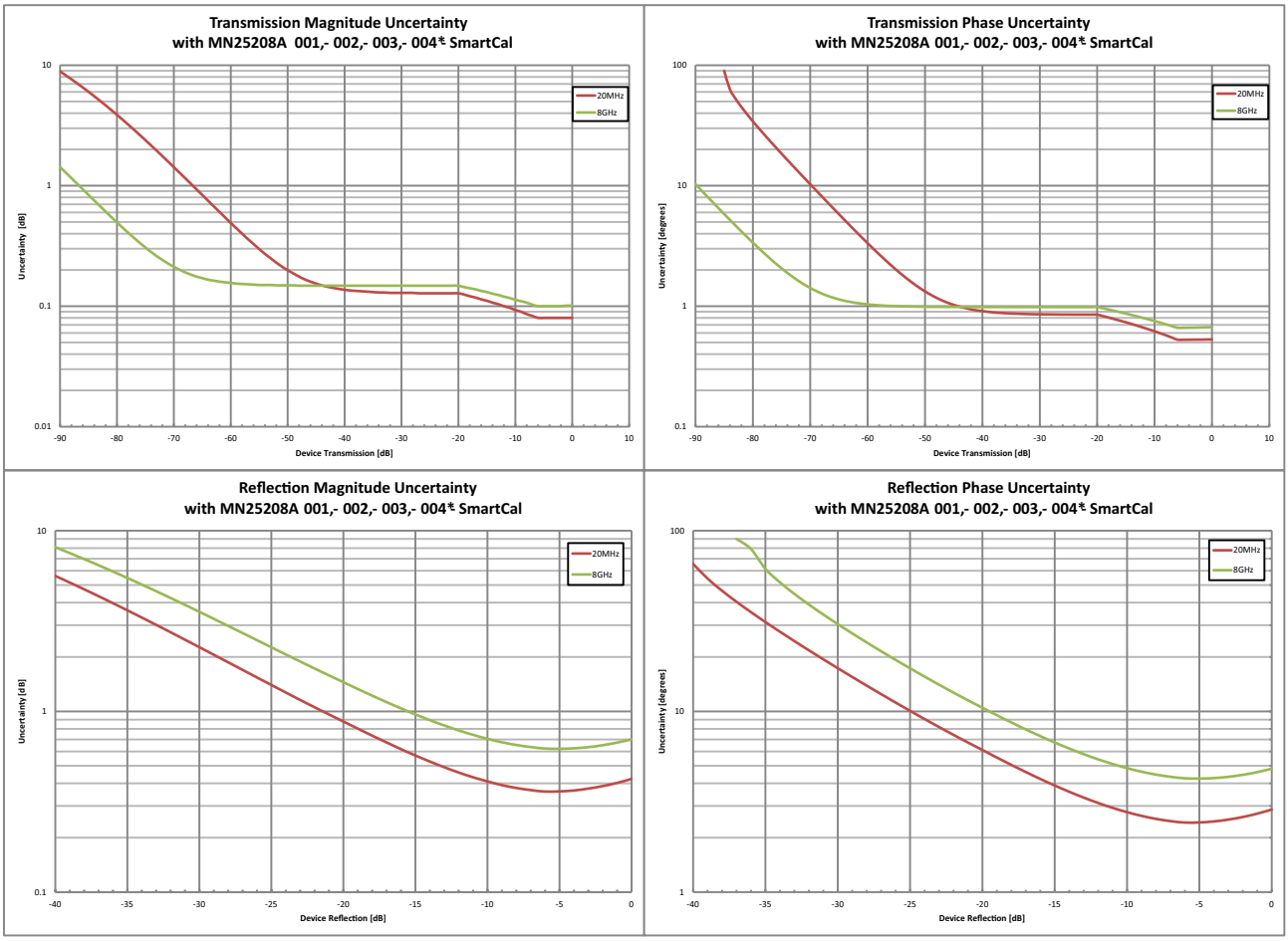
Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[b] (dB)	Reflection Tracking[b] (dB)	Transmission Tracking[b] (dB)
1 MHz to 3 GHz	≥ 42	≥ 33	≥ 42	±0.15	±0.06
3 GHz to 6 GHz	≥ 42	≥ 33	≥ 42	±0.15	±0.08
> 6 GHz to 8 GHz	≥ 37	≥ 33	≥ 37	±0.15	±0.08

a. MN25208A-004: All specifications are typical.

b. Characteristic performance.

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. For transmission uncertainties, it is assumed that $S_{11} = S_{22} = 0$. For reflection uncertainties, it is assumed that $S_{21} = S_{12} = 0$. All calibrations and measurements were performed at default port power.



* Specifications are not warranted. All values are typical.

MS46122B-010 and MS46122B-020 VNA System Performance with SmartCal™

Error-Corrected Specifications

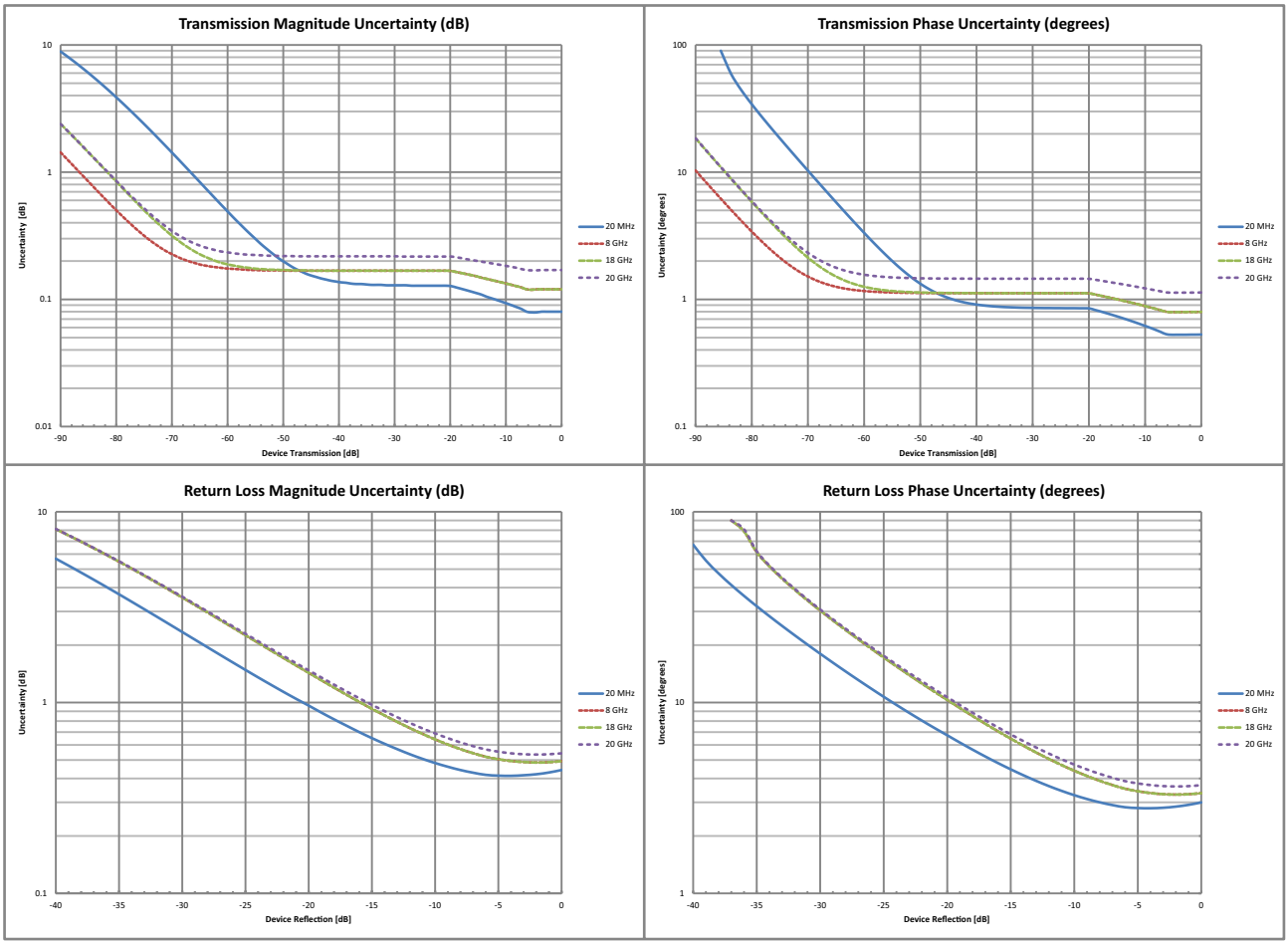
With 12-term calibration using the MN25218A SmartCal™ automatic calibration kit.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
1 MHz to < 10 MHz	≥ 42	≥ 33	≥ 42	±0.20	±0.20
10 MHz to 6 GHz	≥ 42	≥ 33	≥ 42	±0.15	±0.06
> 6 GHz to 18 GHz	≥ 37	≥ 33	≥ 37	±0.15	±0.10
> 18 GHz to 20 GHz	≥ 37	≥ 33	≥ 37	±0.20	±0.15

a. Characteristic performance.

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. For transmission uncertainties, it is assumed that $S_{11} = S_{22} = 0$. For reflection uncertainties, it is assumed that $S_{21} = S_{12} = 0$. All calibrations and measurements were performed at default port power.



MS46122B-040 VNA System Performance with Precision AutoCal™

Error-Corrected Specifications

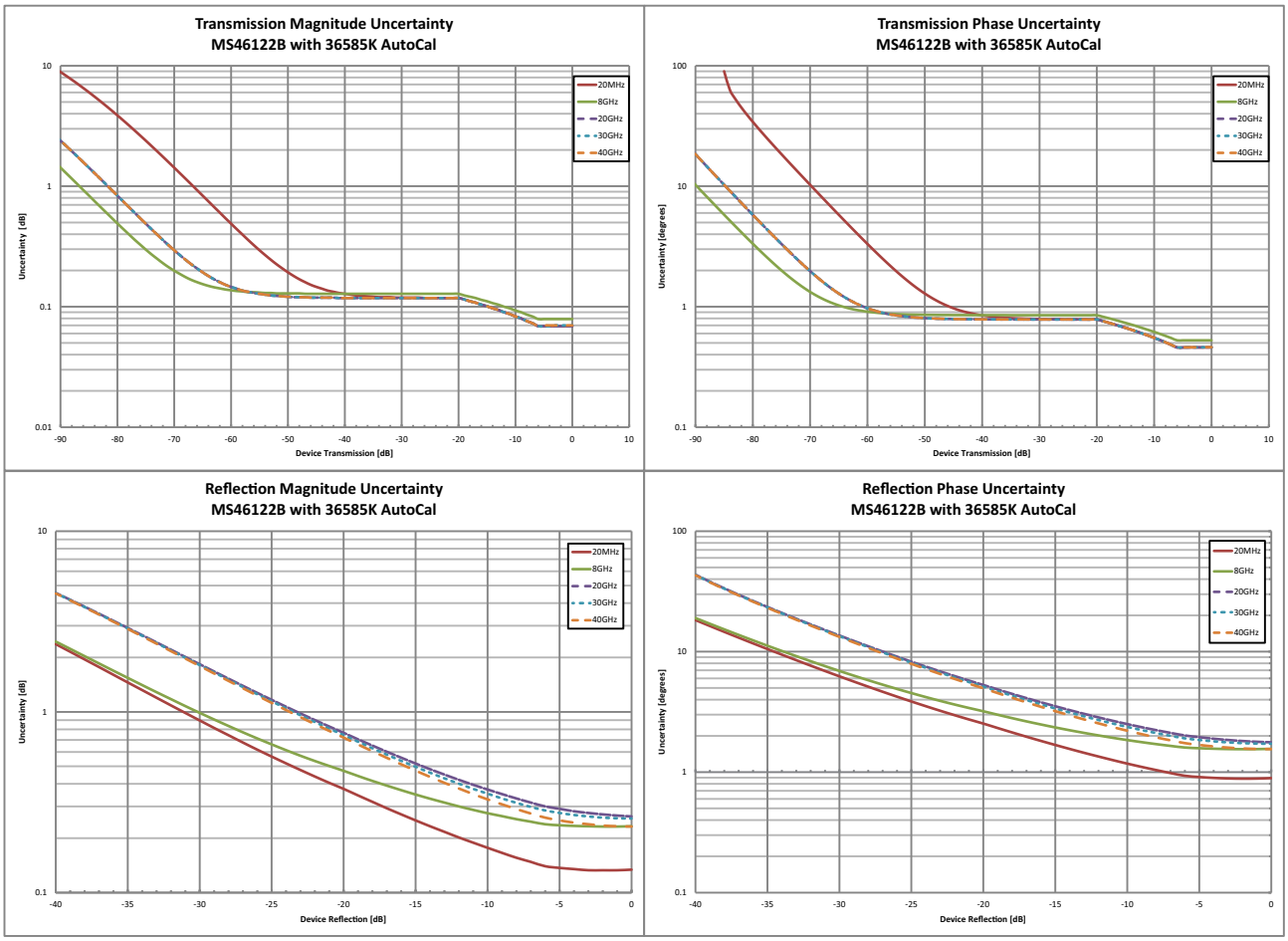
With 12-term calibration using the 36585K automatic calibrator (AutoCal). Performance is typical.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
1 MHz to < 10 GHz	≥ 50	≥ 49	≥ 42	±0.15	±0.06
10 GHz to < 20 GHz	≥ 45	≥ 49	≥ 36	±0.15	±0.05
20 GHz to < 30 GHz	≥ 45	≥ 45	≥ 36	±0.10	±0.05
30 GHz to 40 GHz	≥ 45	≥ 45	≥ 30	±0.10	±0.05

a. Characteristic performance.

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. For transmission uncertainties, it is assumed that $S_{11} = S_{22} = 0$. For reflection uncertainties, it is assumed that $S_{21} = S_{12} = 0$. All calibrations and measurements were performed at default port power.



Measurement Throughput

Measurement Speed

130 µs/point, typical. Per point single sweep time, including placing measurement data into memory. Average of narrow, mid, and wide frequency span sweeps. 300 kHz IFBW, 1601 points, 2 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

MS46122B-010	1 MHz to 8 GHz
MS46122B-020	1 MHz to 20 GHz
MS46122B-040	1 MHz to 43.5 GHz

Measurement Parameters

2-Port Measurements	S_{11}, S_{21}, S_{22}, S_{12}, and any user-defined combination of a_1, a_2, b_1, b_2, 1 Maximum Efficiency Analysis, Mixed-mode SDD, SDC, SCD, SCC
Domains	Frequency Domain, Time (Distance) Domain (Option 2)

Sweeps

Frequency Sweep Types	Linear, Log, or Segmented

Display Graphs

Single Rectilinear Graph Types	Log Magnitude, Phase, Group Delay, Linear Magnitude, Real, Imaginary, SWR, Impedance, KQ and η Max
Dual Rectilinear Graph Types	Log Mag and Phase, Linear Mag and Phase, Real and Imaginary, KQ and η Max
Circular Graph Types	Smith Chart (Impedance), Polar

Measurements Data Points

Maximum Data Points	2 to 16,001 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. 2 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 = 200
Sweep-by-Sweep	Sweep-by-sweep, maximum number of averages = 4096

IF Bandwidth

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

Group Delay

Group Delay Aperture	Defined as the frequency span over which the phase change is computed at a given frequency point.
Aperture	The aperture can be changed without recalibration.
Minimum Aperture	The minimum aperture is the frequency range divided by the number of points in calibration and can be increased to 20 % of the frequency range.
Group Delay Range	< 180° of phase change within the aperture

Channels, Display, and Traces

Channels and Traces	16 channels, each with up to 16 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.
Intra-trace Math	Any two traces within a channel can be combined (via addition, subtraction, multiplication, or division) and displayed on another trace.

Scale Resolution

	Minimum per division, varies with graph type.
Log Magnitude	0.001 dB
Linear Magnitude	10 µU
Phase	0.01°
Group Delay	0.1 ps
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	
	Short-Open-Load-Through (SOLT) Offset-Short-Offset-Short-Load-Through (SSLT) Triple-Offset-Short-Through (SSST) Short-Open-Load-Reciprocal (SOLR) Line-Reflect-Line (LRL) / Line-Reflect-Match (LRM) SmartCal™ AutoCal™ Thru Update available
Correction Models	
	2-Port (Forward, Reverse, or both directions) 1-Port (S_{11}, S_{22}, or both) Transmission Frequency Response (Forward, Reverse, or both directions) Reflection Frequency Response (S_{11}, S_{22}, or both)
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.
Adapter Removal Calibration	Characterizes and "removes" an adapter that is used during calibration that will not be used for subsequent device measurements; for accurate measurement of non-insertable devices.
Dispersion Compensation	Selectable as Coaxial, other non-dispersive (e.g., for coplanar waveguide), Waveguide, or Microstrip
Embedding/De-embedding	The MS46122B 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.
Extraction Utility	An extraction utility is part of this package that allows easier computation of de-embedding files based on additional calibration steps and measurements.
Optical/Electrical Conversion	
O/E & E/O	O/E and E/O setup wizard is provided
Impedance Conversion	Allows entry of different reference impedances (complex values) for different ports

Optional Capabilities

Time Domain Measurements, Option 2	Displays all S-parameters and overlays with Frequency Domain, Low-pass Mode with added harmonics frequency list flexibility, Band-pass Mode, Phasor Impulse Mode, Windowing, Gating (pass-band or reject-band), and Frequency with Time Gate.

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 Python programming environments.		
Triggering	Start Trigger	Software and Digital Edge	
	Input Range	+3.3 V logic level (+5 V tolerant)	
	Minimum Trigger Width	50 ns	
	Trigger Delay	6 µs, typical	

Front Panel Connections

MS46122B Front Panel

Test Ports 1 and 2		
	MS46122B-010	N(f)
	MS46122B-020	Ruggedized K(m)
	MS46122B-040	Ruggedized K(m)
	Damage Input Levels	+23 dBm maximum, ±50 VDC maximum
USB Ports		One mini type B USB port for connecting to an external PC controller.
Power Input		Input connector for external power supply.
10 MHz In		Signal presence is auto-sensing (better than 10 ppm frequency accuracy is recommended).
	Connector Type	BNC(f)
	Signal	+0 dBm, typical; 50 Ω, nominal
External Trigger Input		
	Connector Type	BNC(f)
	Voltage Input	0 to 3.3 V input (5 V tolerant)
	Impedance	High impedance (> 100 kΩ)
	Pulse Width	50 ns minimum input pulse width
	Trigger Delay	6 µs typical

Rear Panel Connections

MS46122B Series Rear Panel

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
	ShockLine software is compatible with Windows® 7,8, 8.1, or 10; 32 or 64 bit operating systems

Mechanical

Dimensions		Dimensions listed are for the instrument body without rack mount option attached.
	H x W x D	61.1 mm x 328.1 mm x 197.87 mm
Weight		< 2.2 kg (< 5 lb), typical weight for a fully-loaded MS46122B VNA

Regulatory Compliance

European Union	EMC 2014/30/EU, EN 61326:2013, CISPR 11/EN 55022, IEC/EN 61000-4-2/3/4/5/6/58/11 Low Voltage Directive 2014/35/EU Safety EN 61010-1:2010, IEC 60950-1 (when used with Anritsu Company supplied Power Supply) RoHS Directive 2011/65/EU
Australia and New Zealand	RCM AS/NZS 4417:2012
South Korea	KCC-REM-A21-0004

Environmental

MIL-PRF-28800F Class 3

Operating Temperature Range	0 °C to 50 °C
Storage Temperature Range	–40 °C to 75 °C
Maximum Relative Humidity	95 % RH at 40 °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	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	MS46122B, 2-Port ShockLine™ Economy VNA
Required Option	MS46122B-010, 1 MHz to 8 GHz, type N(f) ports
(Select one frequency option only)	MS46122B-020, 1 MHz to 20 GHz, Ruggedized type K(m) ports (compatible with 3.5 mm and SMA connectors)
	MS46122B-040, 1 MHz to 43.5 GHz, Ruggedized type K(m) ports (compatible with 3.5 mm and SMA connectors)

Included Accessories

	Each VNA comes with a set of included accessories.
User Documentation	Getting Started with Anritsu Flier, provides access to all ShockLine web content and services.
Power	40-187-R, 12 V, 5 A Power supply (and power cord)
USB Cable	3-2000RS-1815, USB 2.0 A to Mini B cable, 10 ft
Rack Mount	ND80788, Rack Mount Kit adds handles and removes rubber bumpers for shelf-mounting into a 19 inch universal rack

VNA Options

Main Options	MS46122B-002, Time Domain with Time Gating
Calibration Options	MS46122B-098, Standard Calibration, ISO 17025 compliant, without data
	MS46122B-099, Premium Calibration, ISO 17025 compliant, with data

Precision Automatic Calibrator Modules

MN25208A	2-port USB SmartCal Module, 300 kHz to 8.5 GHz, (available with various connector options)
MN25218A	2-port USB SmartCal Module, 300 kHz to 20 GHz, (available with K(f) connector option)
MN4765B-0070	2-port, 1480 nm to 1620 nm, O/E Calibration Module, 70 kHz to 70 GHz
MN4765B-0071	2-port, 1300 nm to 1330 nm, O/E Calibration Module, 70 kHz to 70 GHz
MN4765B-0072	2-port, dual 1530 nm to 1620 nm and 1300 nm to 1330 nm, O/E Calibration Module, 70 kHz to 70 GHz
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

3650A	SMA/3.5 mm Calibration Kit, Without Sliding Loads, DC to 26.5 GHz, 50 Ω
3650A-1	SMA/3.5 mm Calibration Kit, With Sliding Loads, DC to 26.5 GHz, 50 Ω
3652A	K Connector Calibration Kit, Without Sliding Loads, DC to 40 GHz, 50 Ω
3652A-1	K Connector Calibration Kit, With Sliding Loads, DC to 40 GHz, 50 Ω
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
OSLN50A-18	Precision N Male Open/Short/Load Mechanical Calibration Tee, DC to 18 GHz, 50 Ω
OSLNF50A-18	Precision N Female Open/Short/Load Mechanical Calibration Tee, DC to 18 GHz, 50 Ω
TOSLN50A-18	Precision N Male Through/Open/Short/Load Mechanical Calibration Tee, DC to 18 GHz, 50 Ω
TOSLNF50A-18	Precision N Female Through/Open/Short/Load Mechanical Calibration Tee, DC to 18 GHz, 50 Ω
TOSLK50A-20	Precision K Male Through/Open/Short/Load Mechanical Calibration Tee, DC to 20 GHz, 50 Ω
TOSLKF50A-20	Precision K Female Through/Open/Short/Load Mechanical Calibration Tee, DC to 20 GHz, 50 Ω
TOSLK50A-40	Precision K Male Through/Open/Short/Load Mechanical Calibration Tee, DC to 40 GHz, 50 Ω
TOSLKF50A-40	Precision K Female Through/Open/Short/Load Mechanical Calibration Tee, DC to 40 GHz, 50 Ω

RF Cables and Adapters

1091-26-R	SMA(m) to N(m), DC to 18 GHz, 50 Ω
1091-27-R	SMA(f) to N(m), DC to 18 GHz, 50 Ω
1091-80-R	SMA(m) to N(f), DC to 18 GHz, 50 Ω
1091-81-R	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

14RKFKF50-0.6	0.6 m (24”), DC to 40 GHz, Ruggedized K(f) to K(f), 50 Ω
14RKFKF50-1.0	1.0 m (39”), DC to 40 GHz, Ruggedized K(f) to K(f), 50 Ω
14RKFK50-0.6	0.6 m (24”), DC to 40 GHz, Ruggedized K(f) to K(m), 50 Ω
14RKFK50-1.0	1.0 m (39”), DC to 40 GHz, Ruggedized K(f) to K(m), 50 Ω
14KFKF50-0.6	0.6 m (24”), DC to 40 GHz, K(f) to K(f), 50 Ω
14KFKF50-1.0	1.0 m (39”), DC to 40 GHz, K(f) to K(f), 50 Ω
14KFK50-0.6	0.6 m (24”), DC to 40 GHz, K(f) to K(m), 50 Ω
14KFK50-1.0	1.0 m (39”), DC to 40 GHz, K(f) to K(m), 50 Ω
15NNF50-1.0B	1.0 m (39”), DC to 18 GHz, N(f) to N(m), 50 Ω
15NNF50-1.5B	1.5 m (59”), DC to 18 GHz, N(f) to N(m), 50 Ω
15NN50-1.0B	1.0 m (39”), DC to 18 GHz, 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
SC8267	Cable, 40 GHz, K(m) to K(f), 1 m (36"), 50 Ω

Phase-Stable 18 GHz and 40 GHz Semi-Rigid Cables (Armored)

3670K50-1	0.3 m (12”), DC to 40 GHz, K(f) to K(m), 50 Ω
3670K50-2	0.6 m (24”), DC to 40 GHz, K(f) to K(m), 50 Ω

Tools

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.

10100-00067	Product information, compliance, and safety
10410-00340	MS46122A/B Series VNA Operation Manual
10410-00337	MS46121A/B, MS46122A/B, and MS46322A/B Series VNA User Interface Reference Manual
10410-00338	MS46121A/B, MS46122A/B, and MS46322A/B Series VNA Programming Manual