Technical Data Sheet

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2TEST

ShockLine™ Performance Vector Network Analyzers

MS46522B

50 kHz to 43.5 GHz, E-Band

SHOCKLINE™

Introduction

The MS46522B is part of the ShockLine family of Vector Network Analyzers from Anritsu. It is a high performance, 3U high, 2-port VNA available in broadband frequency ranges from 50 kHz to 43.5 GHz and a banded E-band option covering the 55 GHz to 92 GHz frequency range. It is capable of measuring s-parameters and time domain characteristics of passive RF devices.

The VNA supports SCPI command programming and has software driver support for the most common programming environments. The MS46522B uses industry standard LAN communications for robust remote control in test applications. ShockLine VNAs provide a powerful graphical user interface for manual testing of devices. A full-featured user interface is enabled by attaching a (user-supplied) touchscreen monitor, keyboard, and mouse.

This document provides detailed specifications for the MS46522B Vector Network Analyzers (VNAs) and related options.

Instrument Models and Operating Frequencies

Base Model

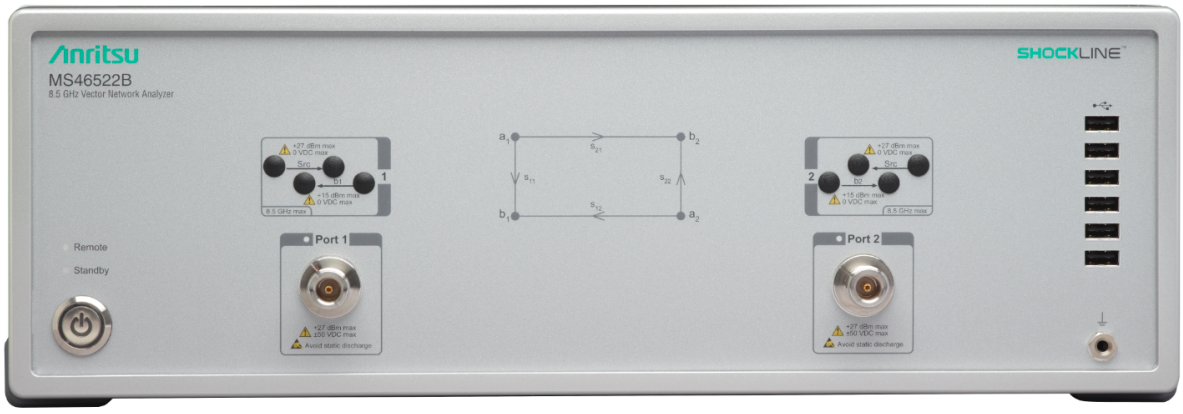
- MS46522B, 2-Port ShockLine VNA

Requires one Frequency Option

- MS46522B-010, 50 kHz to 8.5 GHz
- MS46522B-020, 50 kHz to 20 GHz
- MS46522B-040, 50 kHz to 43.5 GHz
- MS46522B-082, 55 GHz to 92 GHz

Principal Options

- MS46522B-002, Time Domain
- MS46522B-022, Advanced Time Domain
- MS46522B-051, Access Loops (Only available with Option 10)
- MS46522B-061, Bias Tee (Only available with Option 10)



MS46522B ShockLine Performance VNA (8.5 GHz model shown)

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Definitions

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

Warm-Up Time	After 45 minutes of warm-up time, where the instrument is left in the ON state.
Temperature Range	Over the 25 °C ± 5 °C temperature range.
Frequency Range	The instrument operates in the following frequency ranges without any implied or warranted specifications: 50 kHz to 300 kHz, 40 GHz to 43.5 GHz, 55 GHz to 60 GHz, and from 90 GHz to 92 GHz.
Error-Corrected Specifications	For error-corrected specifications, over 23 °C ± 3 °C, with < 1 °C variation from calibration temperature. For error-corrected specifications are warranted and include guard-bands, unless otherwise stated.
Simultaneous Sweep Mode	Specifications are not warranted in simultaneous sweep mode (only applicable to the 8.5 GHz model).
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 with mandatory frequency option only.
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.
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[1]

System dynamic range is calculated as the difference between the test port maximum source power and the RMS noise floor at 10 Hz IF Bandwidth with averaging off and smoothing on after calibrating the instrument for transmission frequency response and isolation.

Frequency Range	Standard (dB)	Typical (dB)
300 kHz to 1 MHz	90	101
> 1 MHz to 50 MHz	100	108
> 50 MHz to 2 GHz	140	144
> 2 GHz to 4 GHz	137	142
> 4 GHz to 6 GHz	130	137
> 6 GHz to 8 GHz[a]	128	130
> 8 GHz to 8.5 GHz	120	127[a]
> 8.5 GHz to 25 GHz	117	122
> 25 GHz to 40 GHz	120	127
> 40 GHz to 43.5 GHz	–	120

a. Dynamic range degrades by 4 dB for Options 20 and 40.

Receiver Compression Levels

Port power level beyond which the response may be compressed more than 0.1 dB relative to the normalization level. Measured at 300 Hz IF bandwidth. Match not included. Performance is typical.

Frequency Range	Level (dBm)
300 kHz to 43.5 GHz	+15

High Level Noise[2]

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

Frequency	Magnitude (dB)	Phase (deg)
300 kHz to 1 GHz	0.004 (0.003, typical)	0.04 (0.02, typical)
> 1 GHz to 25 GHz	0.003 (0.002, typical)	0.05 (0.02, typical)
> 25 GHz to 40 GHz	0.004 (0.002, typical)	0.05 (0.04, typical)
> 40 GHz to 43.5 GHz	(0.002, typical)	(0.05, typical)

Output Power Range

Minimum to maximum rated leveled output power. Performance is characteristic.

Frequency	Standard (dBm)	Typical (dBm)
300 kHz to 6 GHz	–30 to +15	–30 to +17
> 6 GHz to 8 GHz	–30 to +12[a]	–30 to +13
> 8 GHz to 8.5 GHz	–30 to +10	–30 to +11
> 8.5 GHz to 40 GHz	–30 to +7	–30 to +10
> 40 GHz to 43.5 GHz	–	–30 to +4

a. Maximum power degrades by 2 dB for Options 20 and 40.

Output Default Power

Instrument default power is 0 dBm. For maximum rated power, refer to Output Power Range above. Not applicable to MS46522B-082.

Power Accuracy

Performance is characteristic. Not applicable to MS46522B-082.

Output Power	Standard (dB)	Typical (dB)
At +5 dBm	± 1.0[a]	± 0.7
At 0 dBm	± 1.5[b]	± 0.5
At –30 dBm	± 3.0	± 1.8

a. Power accuracy degrades by 0.5 dB (>8.5 GHz to 25 GHz), and by 1 dB (>25 GHz to 40 GHz).

b. Power accuracy degrades by 0.5 dB (>8.5 GHz).

Setting Resolution

Output Power	Setting Resolution (dB)
300 kHz to 43.5 GHz	0.01

1. System dynamic range is degraded by 20 dB from the standard specifications in simultaneous sweep mode. Performance is typical.
2. High level noise specification in simultaneous sweep mode: Magnitude 0.005 dB (typical), Phase 0.05 degree (typical).

Frequency Resolution, Accuracy, and Stability

All specifications typical. Not applicable to MS46522B-082.

Resolution	Accuracy	Stability/Temperature	Stability
1 Hz	±0.1 (at time of calibration)	± 0.1 ppm/10 °C to 50 °C	± 0.02 ppm/24 hours ± 0.2 ppm/1 month ± 1.0 ppm/1 year ± 2.0 ppm/3 years

Source Harmonics and Non-Harmonics (Spurious)

Measured at 0 dBm. All specifications typical.

Frequency	Harmonics (second and third) (dBc)	Non-Harmonic Spurious (dBc)	Phase Noise @ 10 kHz Offset (dBc/Hz)
300 kHz to 8.5 GHz	< –30	< –30	> 60

Uncorrected (Raw) Port Characteristics

User correction off. System correction on. All specifications typical.

Frequency Range	Directivity (dB)	Port Match (dB)[a]
300 kHz to 1 GHz	> 21	> 17
> 1 GHz to 4 GHz	> 21	> 17
> 4 GHz to 8.5 GHz	> 15	> 15
> 8.5 GHz to 43.5 GHz	> 15	> 15

a. Port Match is defined as the worst of source and load match.

MS46522B-010 VNA System Performance with Manual Cal Kits

Error-Corrected Specifications

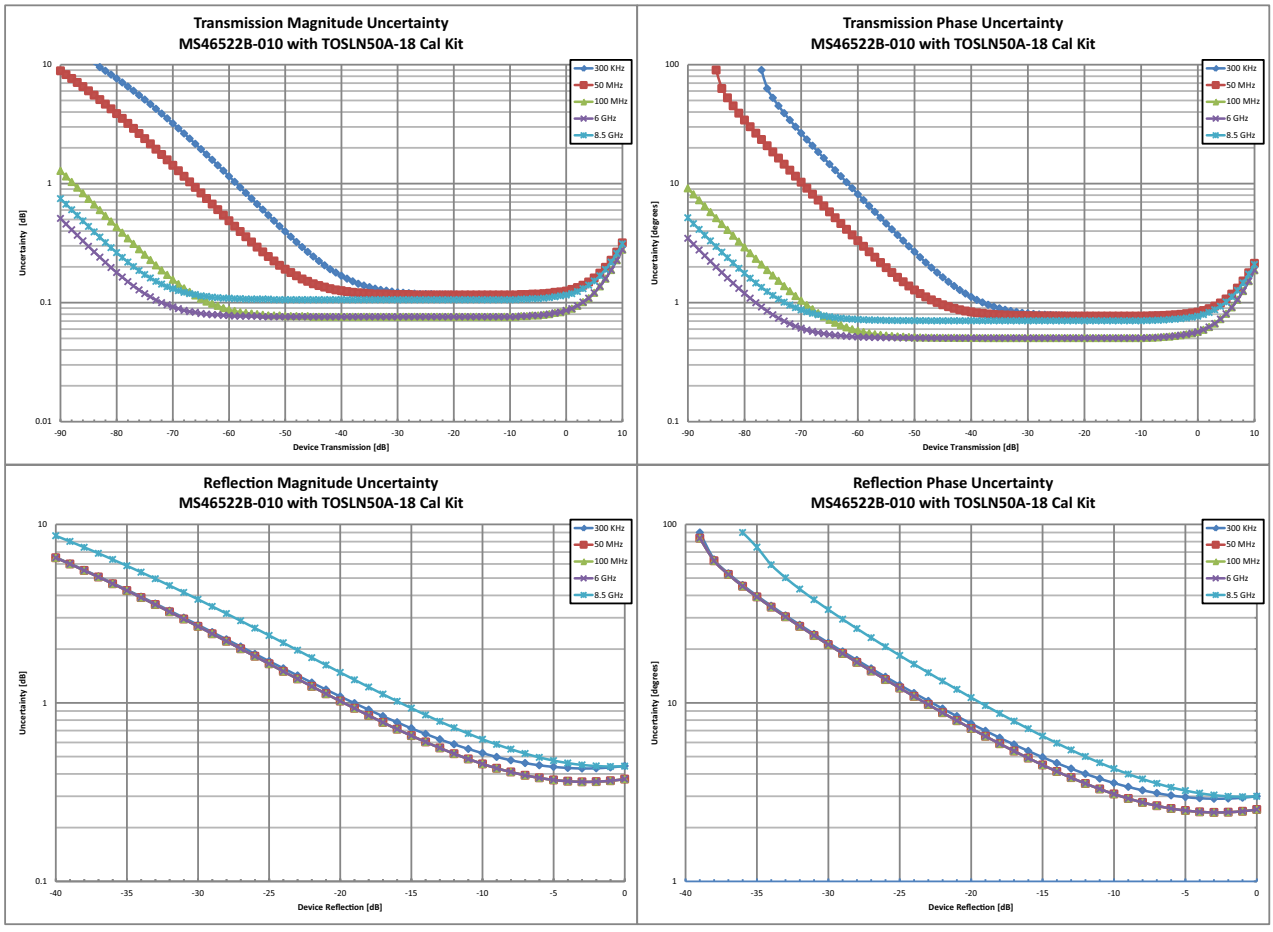
With 12-term SOLT Calibration using the TOSLN50A-18 N Type Connector Calibration Kit.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
300 kHz to 50 MHz	> 40	> 35	> 38	±0.15	±0.09
> 50 MHz to 6 GHz	> 40	> 35	> 38	±0.08	±0.05
> 6 GHz to 8 GHz	> 36	> 35	> 34	±0.08	±0.05
> 8 GHz to 8.5 GHz	> 36	> 35	> 34	±0.10	±0.08

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 0 dBm or default port power, whichever is less. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



MS46522B-020 VNA System Performance with Manual Cal Kits

Error-Corrected Specifications

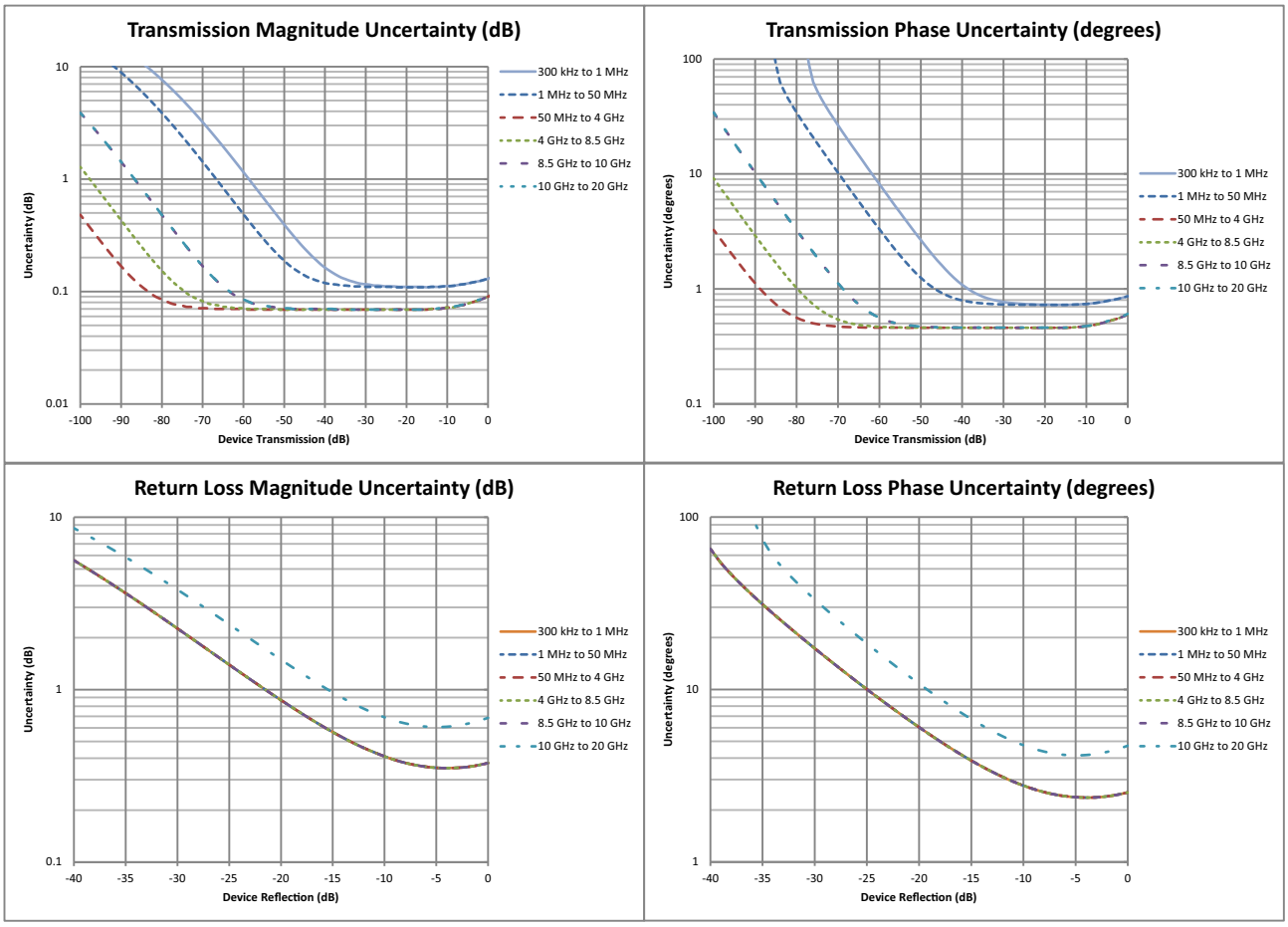
With 12-term SOLT Calibration using the TOSLKF50A-40 K Type Connector Calibration Kit.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
300 kHz to 50 MHz	> 42	> 35	> 42	±0.10	±0.09
> 50 MHz to 10 GHz	≥ 42	≥ 35	≥ 42	±0.10	±0.05
> 10 GHz to 20 GHz	≥ 36	≥ 26.5	≥ 36	±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 0 dBm or default port power, whichever is less. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



MS46522B-040 VNA System Performance with Manual Cal Kits

Error-Corrected Specifications

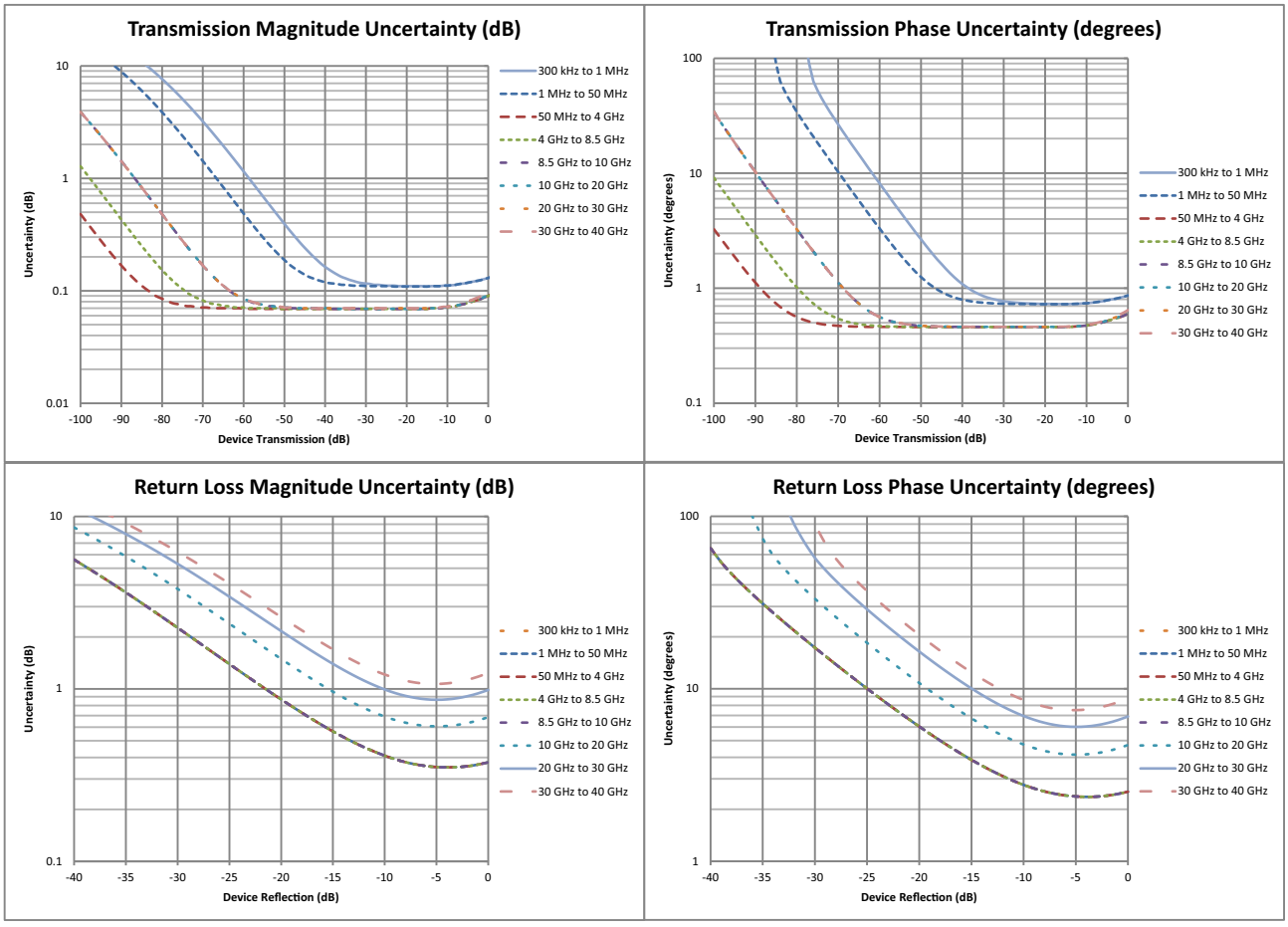
With 12-term SOLT Calibration using the TOSLKF50A-40 K Type Connector Calibration Kit.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
300 kHz to 50 MHz	> 42	> 35	> 42	±0.10	±0.09
> 50 MHz to 10 GHz	≥ 42	≥ 35	≥ 42	±0.10	±0.05
> 10 GHz to 20 GHz	≥ 36	≥ 26.5	≥ 36	±0.10	±0.05
> 20 GHz to 30 GHz	≥ 32	≥ 22.5	≥ 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 0 dBm or default port power, whichever is less. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



MS46522B-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]

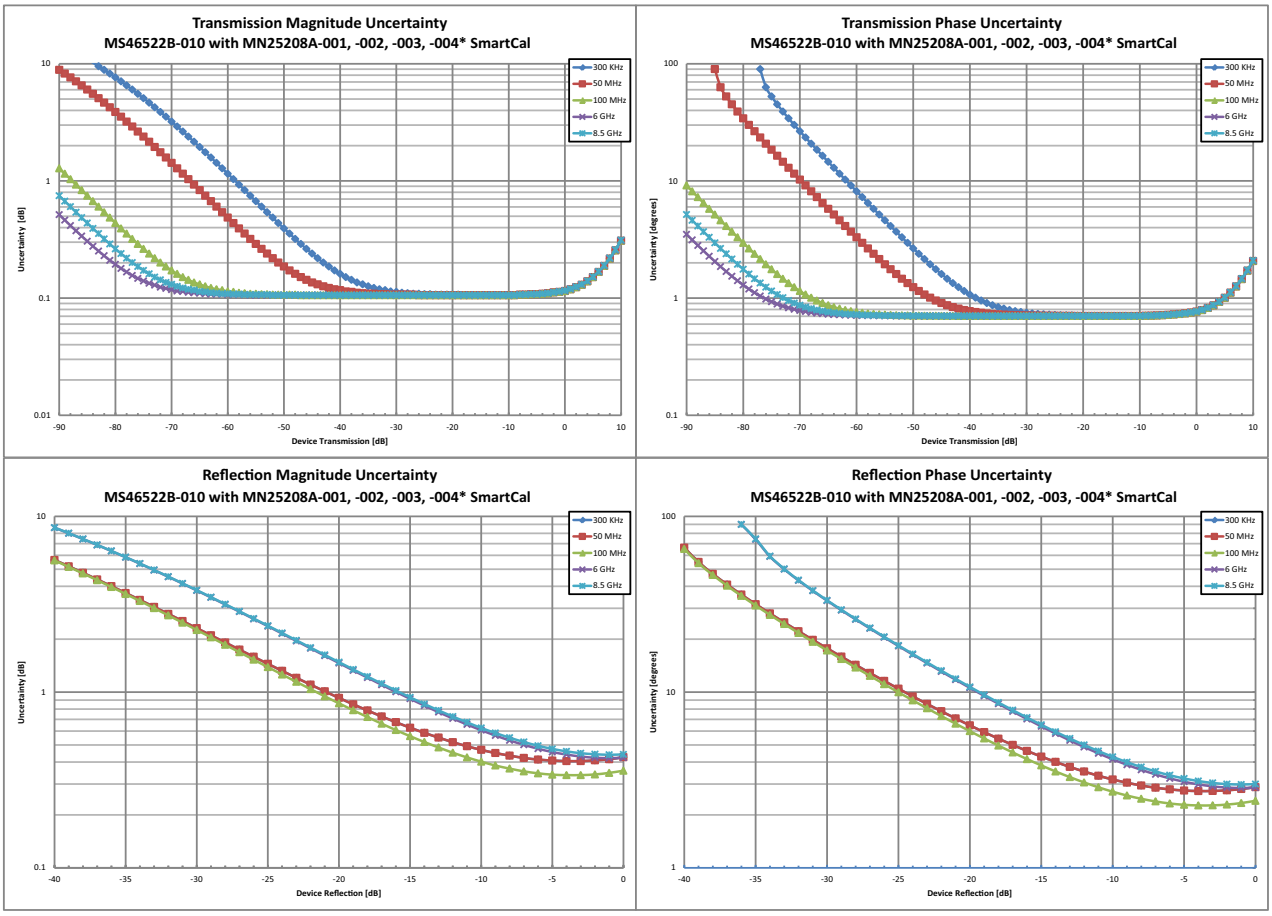
Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[b] (dB)	Reflection Tracking[b] (dB)	Transmission Tracking[b] (dB)
300 kHz to 50 MHz	> 42	> 35	> 38	±0.15	±0.08
> 50 MHz to 5 GHz	> 42	> 35	> 38	±0.08	±0.08
> 5 GHz to 8 GHz	> 36	> 35	> 33	±0.08	±0.08
> 8 GHz to 8.5 GHz	> 36	> 35	> 33	±0.10	±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 0 dBm or default port power, whichever is less. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



* Specifications are not warranted. All values are typical.

MS46522B-020 VNA System Performance with SmartCal™

Error-Corrected Specifications

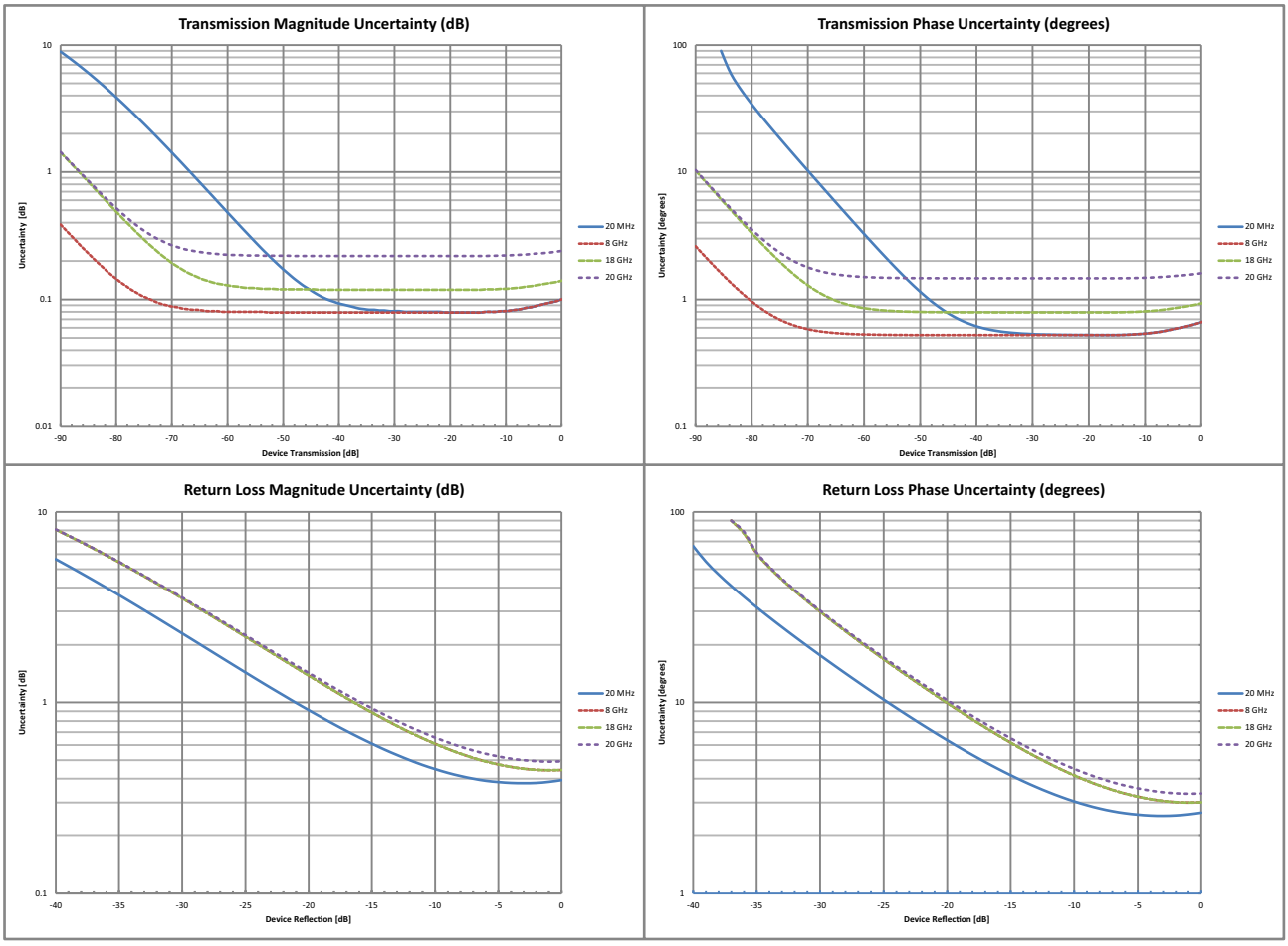
With 12-term calibration using the MN25218A SmartCal™ automatic calibration kit.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[b] (dB)	Transmission Tracking[b] (dB)
1 MHz to 10 MHz	> 42	> 33	> 42	±0.20	±0.20
> 10 MHz to 50 MHz	> 42	> 33	> 42	±0.15	±0.06
> 50 MHz to 10 GHz	> 37	> 33	> 42	±0.15	±0.06
> 10 GHz to 18 GHz	> 37	> 33	> 37	±0.15	±0.10
> 18 GHz to 20 GHz	> 37	> 33	> 37	±0.20	±0.20

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 0 dBm or default port power, whichever is less. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



MS46522B-040 VNA System Performance with Precision AutoCal™

Error-Corrected Specifications

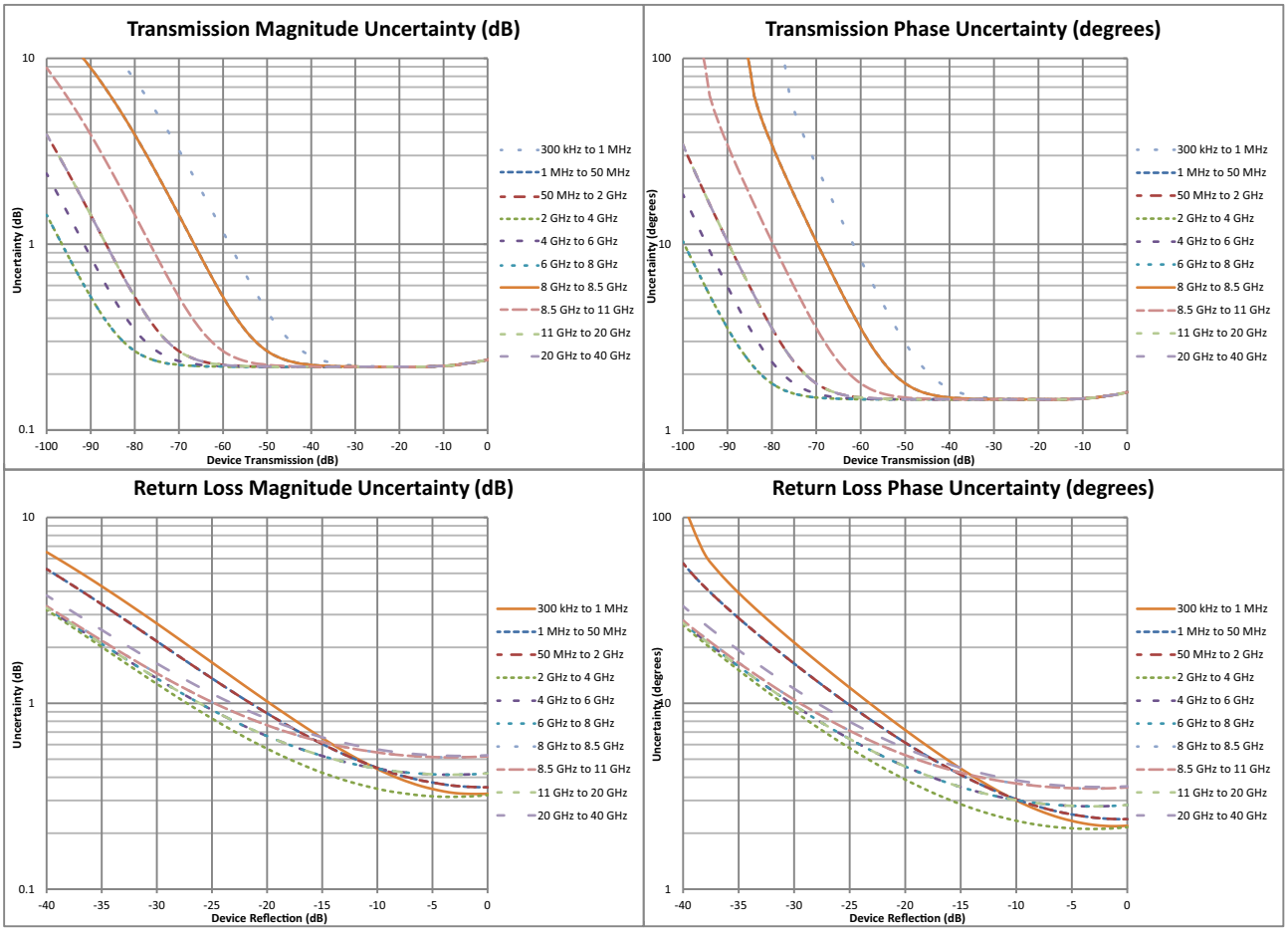
With 12-term calibration using the 36585K series automatic calibration kit with type K connectors

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
300 kHz to < 10 MHz	≥ 40	≥ 40	≥ 40	±0.10	±0.20
10 MHz to < 2.5 GHz	≥ 43	≥ 47	≥ 43	±0.20	±0.20
2.5 GHz to < 4 GHz	≥ 50	≥ 47	≥ 50	±0.20	±0.20
4 GHz to < 8 GHz	≥ 50	≥ 47	≥ 50	±0.30	±0.20
8 GHz to < 11 GHz	≥ 50	≥ 47	≥ 50	±0.40	±0.20
11 GHz to < 20 GHz	≥ 50	≥ 47	≥ 50	±0.30	±0.20
20 GHz to < 40 GHz	≥ 48	≥ 47	≥ 48	±0.40	±0.20

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 0 dBm or default port power, whichever is less. For other conditions, please use our free Exact Uncertainty Calculator software, available for download from the Anritsu web site at www.anritsu.com.



MS46522B-082 E-Band VNA System Performance

Introduction

The E-band Option 82 consists of the MS46500B Series VNA base chassis and small source/receiver modules. The modules are attached to the chassis through one meter flexible tethers that are permanently attached to the unit.

Band	Frequency Range	Waveguide Flange
Extended E-Band	55 GHz to 92 GHz	WR-12

MS46522B E-Band VNA

System Dynamic Range

System dynamic range is calculated as the difference between the test port maximum source power and the RMS noise floor at 10 Hz IF Bandwidth with averaging off and smoothing on after calibrating the instrument for transmission frequency response and isolation.

Frequency	Standard (dB)	Typical (dB)
60 GHz to 67 GHz	109	115
> 67 GHz to 87 GHz	113	120
> 87 GHz to 90 GHz	101	115

High Level Noise

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

Frequency	Magnitude (mdB)	Phase (deg)
60 GHz to 90 GHz	4	0.06

Output Power Range

Minimum to maximum rated leveled output power. Performance is typical

Frequency	Standard (dBm)
60 GHz to 69 GHz	–55 to –5
> 69 GHz to 88 GHz	–50 to 0
> 88 GHz to 90 GHz	–60 to –10

Power Accuracy

Accuracy is defined at max rated power –5 dB. Performance is typical

Frequency	Accuracy (dB)	Resolution (dB)
60 GHz to 90 GHz	±2.0	0.01

MS46522B-082 E-Band VNA System Performance with Waveguide Cal Kit

Error-Corrected Specifications

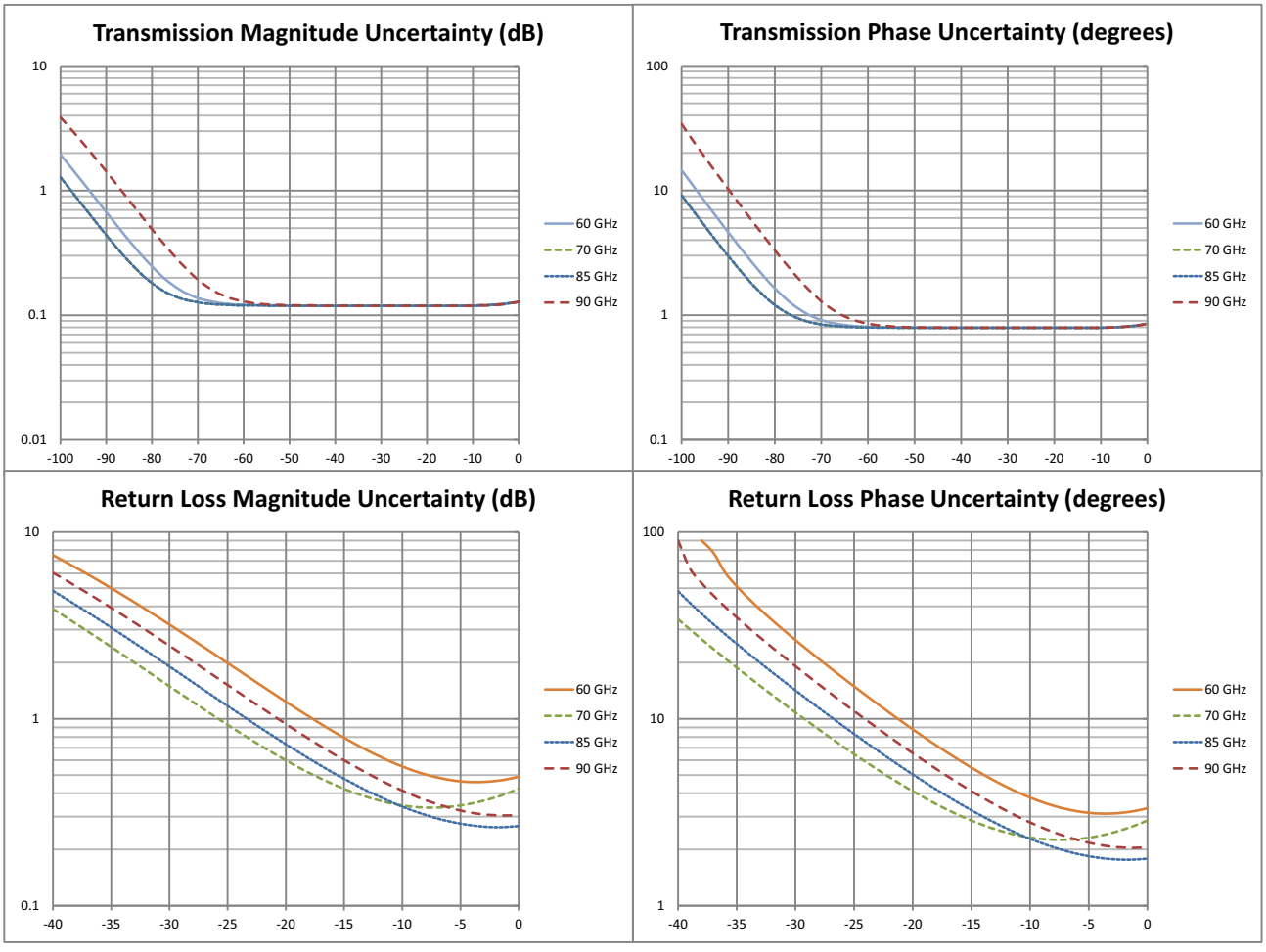
With 12-term SSLT Calibration using the 3655E WR12 Waveguide Calibration Kit. Typical.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
60 GHz to 63 GHz	> 36	> 31	> 36	±0.10	±0.10
> 63 GHz to 67 GHz	≥ 45	≥ 29	≥ 45	±0.10	±0.10
> 67 GHz to 71 GHz	≥ 47	≥ 31	≥ 47	±0.10	±0.10
> 71 GHz to 75 GHz	≥ 42	≥ 33	≥ 42	±0.10	±0.10
> 75 GHz to 79 GHz	≥ 40	≥ 36	≥ 40	±0.10	±0.10
> 79 GHz to 83 GHz	≥ 44	≥ 36	≥ 44	±0.10	±0.10
> 83 GHz to 87 GHz	≥ 44	≥ 42	≥ 44	±0.10	±0.10
> 87 GHz to 90 GHz	≥ 41	≥ 40	≥ 41	±0.10	±0.10

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 0 dBm or default port power, whichever is less. 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 Summary

Cycle Time for Measurement Completion (ms)

Number of traces = 1; system error correction on. Typical performance data.

	500 kHz IF Bandwidth				100 kHz IF Bandwidth				1 kHz IF Bandwidth			
Number of Points	**51**	**201**	**401**	**1601**	**51**	**201**	**401**	**1601**	**51**	**201**	**401**	**1601**
Start 1 GHz, stop 1.2 GHz												
Uncorrected	2	6	11	41	2	6	11	41	54	211	421	1677
2-Port Cal, S21	8	19	35	129	8	21	39	151	113	433	860	3422
Start 300 kHz, stop 4.5 GHz												
Uncorrected	3	7	12	43	3	7	12	43	55	213	422	1680
2-Port Cal, S21	9	20	37	135	10	23	41	154	115	434	865	3421
Start 300 kHz, stop 8.5 GHz												
Uncorrected	4	7	12	43	4	8	13	43	56	213	423	1680
2-Port Cal, S21	9	21	36	129	10	23	42	153	119	435	861	3424

Data Transfer Time (ms)

Transferred complex S11 data, using "CALC:DATA:SDATA?" command. Typical performance data.[a]

Number of Points	**51**	**201**	**401**	**1601**
SCPI over LAN				
REAL 64	4	4	4	8
REAL 32	4	4	4	8
ASCII	14	34	60	209

a. Data transfer time varies depending on the PC and control software used with the VNA.

Standard Capabilities

Operating Frequencies

MS46522B-010	50 kHz to 8.5 GHz
MS46522B-020	50 kHz to 20 GHz
MS46522B-040	50 kHz to 43.5 GHz
MS46522B-082	55 GHz to 92 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), Power Domain

Sweeps

Sweep Configurations	Standard or Simultaneous (MS46522B-010 option only)
Frequency Sweep Types	Linear, Log, or Segmented
Power Sweep Types	Linear

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 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. 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 = 4096
Sweep-by-Sweep	Sweep-by-sweep, maximum number of averages = 4096

IF Bandwidth		10, 20, 30, 50, 70, 100, 200, 300, 500, 700 Hz 1, 2, 3, 5, 7, 10, 20, 30, 70, 100, 200, 300, 500 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	0.001 dB
Markers	Markers	12 markers + 1 reference marker per trace
	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) Short-Open-Load-Reciprocal (SOLR) Offset-Short-Offset-Short-Load-Through (SSLT) Triple-Offset-Short-Through (SSST) Line-Reflect-Line (LRL) / Line-Reflect-Match (LRM) Source Calibration Receiver Calibration 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. Use predefined coefficients for Anritsu calibration kits in ShockLine software. 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
Power	
Power Meter Correction	Different power meter calibrations are available to enhance power accuracy at the desired reference plane. The source power will match the target calibration power, as read by the power meter, to within ~0.1 dB for short periods of time (determined by thermal drift of the system and the power meter). The absolute accuracy of the calibrated power will be dependent on the power meter and sensor used.
Flat Power Calibrations	A flat power calibration (when in frequency sweep mode) is available at a user-selectable power level, if it is within the power adjustment range of the internal source. The flat power correction is applied to other power levels.
Linear Power Calibrations	A linear power calibration is performed over a range of power levels for use in power sweep mode and is performed at a specified frequency or frequency range.
External Power Meter	Both calibrations are performed using an external USB power sensor (Anritsu MA24106A, MA24108A, MA24118A, MA24126A, MA24330A, MA24340A, MA24350A) over a USB 2.0 port.
Embedding/De-embedding	The MS46522B 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

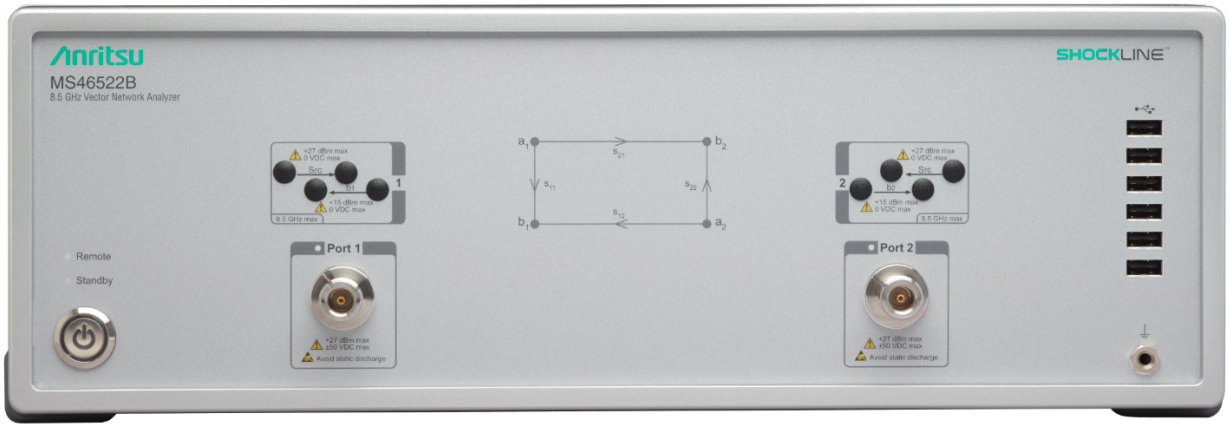
Time Domain Measurements, Option 2	Displays all S-parameters and overlays with Frequency Domain, Low-pass Mode with added harmonics frequency list flexibility, Band-pass Mode, Phasor Impulse Mode, Windowing, Gating (pass-band or reject-band), and Frequency with Time Gate.
Advanced Time Domain Measurements, Option 22	The ATD option has two basic elements. The first element is an Eye Diagram automatically created from a stored .SnP data file after launching the ADK software. The second element accesses the following functions: Check Passivity and Causality, Combine .SnP Files, Plot Eye Diagram, Plot Crosstalk, Plot TDT/TDR/Skew, and Perform Compliance Test. Option 2 recommended with Option 22, but is not required.

Remote Operability

ShockLine supports several remote operability options.

Communication Type	Data Format	Performance	Description
Via LAN	Using VXI-11 Protocol	Gigabit Data Transfer Speed	Use SCPI commands
Drivers for LAN	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



MS46522B Front Panel (8.5 GHz model shown)

Test Ports 1 and 2		
	MS46522B-010	N(f)
	MS46522B-020	K(m)
	MS46522B-040	K(m)
	MS46522B-082	WR12 Waveguide Flange
	Damage Input Levels	+27 dBm maximum, 50 VDC maximum
Ports 1 to 2 Access Loops (Only available with Option 10)		
	Source Path	K(f)
	Damage Input Levels	+27 dBm max, 0 VDC max
	Required	Only available with frequency Option 10
	Receiver path	K(f)
	Damage Input Levels	+15 dBm max, 0 VDC max
	Required	Only available with frequency Option 10
USB Ports		Six type A USB 2.0 Ports for peripherals such as keyboard, mouse, memory stick, hardware key, and similar devices.
Chassis Grounding Port		Banana(f)

Rear Panel Connections

MS46522B Rear Panel

AC Power Input		AC Input connector, with On/Off switch, and fuses 350 VA maximum, 90 to 264 VAC, 47 to 63 Hz (power factor controlled)
USB and LAN		
	USB Ports	Four type A USB 3.0 for peripherals such as keyboard, mouse, memory stick, USB monitor, and hardware key.
	LAN Port	Gigabit Ethernet
Media	HDMI and Display Port	Video output, touchscreen compatible
	Audio	External stereo speaker and microphone (3.5 mm)

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
10 MHz Out	Signal presence is synchronized to and dependent upon the 10 MHz input signal
Connector Type	BNC(f)
Signal	+8 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
External Trigger Output	
Connector type	BNC(f)
Voltage Output	0 to 3.3 V (HCMOS logic)
Drive Current	24 mA maximum
Pulse Width	1 µs, typical
Bias Inputs (Only available with Option 10)	
Connector	BNC(f) (one input per port); 50 VDC maximum, 0.5 A maximum
Required	Only available with frequency Option 10

CPU, Memory, and Security Features

CPU	Intel Core™ i5
Storage	Serial-ATA (SATA) Solid State Drive for OS, Programs, and Data (> 30 GB).
Security Features	If the VNA is attached to a network, best practices recommend installing anti-virus software.

Mechanical

Dimensions	Dimensions listed are for the instrument body only, without rack mount option attached.
H x W x D	152 mm x 445 mm x 442 mm
Weight	< 11 kg (< 25 lb), typical weight for a fully-loaded MS46522B-010 VNA < 13 kg (< 28 lb), typical weight for a fully-loaded MS46522B-020 or MS46522B-040 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

MS46522B	ShockLine 2-Port Vector Network Analyzer (base model)
Requires One Frequency Option	
MS46522B-010	50 kHz to 8.5 GHz, type N(f) ports
MS46522B-020	50 kHz to 20 GHz, type K(m) Ruggedized ports (compatible with 3.5 mm and SMA connectors)
MS46522B-040	50 kHz to 43.5 GHz, type K(m) Ruggedized ports (compatible with 3.5 mm and SMA connectors)
MS46522B-082	55 GHz to 92 GHz, WR12 waveguide flange

Included Accessories

Each VNA comes with a power cord and instructions on where to download software and related literature.

Main VNA Options

MS46522B-001	Rack Mount, adds handles and removes feet for shelf-mounting into a 19 inch universal rack
MS46522B-002	Time Domain with Time Gating
MS46522B-022	Advanced Time Domain
MS46522B-051	Access Loops (Only available with Option 10)
MS46522B-061	Bias Tee (Only available with Option 10)

Calibration Options (not available for the MS46522B-082)

MS46522B-098	Standard Calibration, ISO 17025 compliant, without data
MS46522B-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 Precision AutoCal Module, 70 kHz to 40 GHz, K(m) to K(m)
36585K-2F	K Precision AutoCal Module, 70 kHz to 40 GHz, K(f) to K(f)
36585K-2MF	K 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)

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

USB Power Sensors

MA24106A	True-RMS USB Power Sensor, 50 MHz to 6 GHz
MA24108A	True-RMS USB Power Sensor, 10 MHz to 8 GHz
MA24118A	True-RMS USB Power Sensor, 10 MHz to 18 GHz
MA24126A	True-RMS USB Power Sensor, 10 MHz to 26 GHz
MA24330A	Microwave CW USB Power Sensor, 10 MHz to 33 GHz
MA24340A	Microwave CW USB Power Sensor, 10 MHz to 40 GHz
MA24350A	Microwave CW USB Power Sensor, 10 MHz to 50 GHz

Cables and Adapters

N120-6	RF Cables, Semi-Rigid, N(m) to N(m), 1 each, 0.01 to 18 GHz, 50 Ω, 15 cm (5.9 in)
NS120MF-6	RF Cables, Semi-Rigid, N(f) to N(f), 1 each, 0.01 to 18 GHz, 50 Ω, 15 cm (5.9 in)
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
34NN50A	Precision Adapter, N(m) to N(m), DC to 18 GHz, 50 Ω
34NFNF50	Precision Adapter, N(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, K(m) to K(m), DC to 40 GHz, 50 Ω
K222B	Precision Adapter, K(f) to K(f), DC to 40 GHz, 50 Ω
K224B	Precision Adapter, K(m) to K(f), DC to 40 GHz, 50 Ω
SC7260	WR12 to W1(m) Adapter, W1 (1 mm) to WR12 Waveguide
SC7442	WR12 to W1(f) Adapter, W1 (1 mm) to WR12 Waveguide
35WR12WF-EE	Precision Waveguide to Coax Adapter Kit, 56 GHz to 94 GHz, WR-12 to 1.0 mm(f)

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, 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

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
3670N50-1	0.3 m (12”), DC to 18 GHz, N(f) to N(m), 50 Ω
3670NN50-1	0.3 m (12”), DC to 18 GHz, N(m) to N(m), 50 Ω
3670N50-2	0.6 m (24”), DC to 18 GHz, N(f) to N(m), 50 Ω
3670NN50-2	0.6 m (24”), DC to 18 GHz, N(m) to N(m), 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)
01-204	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

10100-00067	Product information, compliance, and safety
10410-00743	MS46522B/524B VNA Operation Manual
10410-00744	MS46522B/524B VNA User Interface Reference Manual
10410-00746	MS46522B/524B VNA Programming Manual, for IEEE 488.2 and SCPI Commands
10410-00753	MS46522B/524B VNA Calibration and Measurement Guide