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.

Frequency Range	Standard (dB)	Typical (dB)
1 MHz[a] to < 20 MHz	85	105
20 MHz to < 8 GHz	100	115
8 GHz to < 14 GHz	95	110
14 GHz to 40 GHz	100	100

a. Decrease specification by 20 dB below 10 MHz.

Receiver Compression Levels

Performance is typical.

Frequency Range	Standard (dBm)
1 MHz to 40 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 dB, typical)	<0.2 (<0.035 typical)
20 MHz to 40 GHz	0.006 (0.001 dB, typical)	< 0.1 (<0.05 typical)

Output Power Settings

Power Setting	Standard (dBm)
High	-3 dBm, typical
Low	-20 dBm, typical

Frequency Resolution, Accuracy, and Stability

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

Uncorrected (Raw) Port Characteristics

User and System Correction Off. All specifications typical.

Frequency Range	Directivity (dB)	Port Match(dB)
1 MHz to 40 GHz	> 8 dB across frequency	> 8 dB across frequency

VNA System Performance for MS46322A-004 and MS46322A-010 Frequency Options

Error-Corrected Specifications

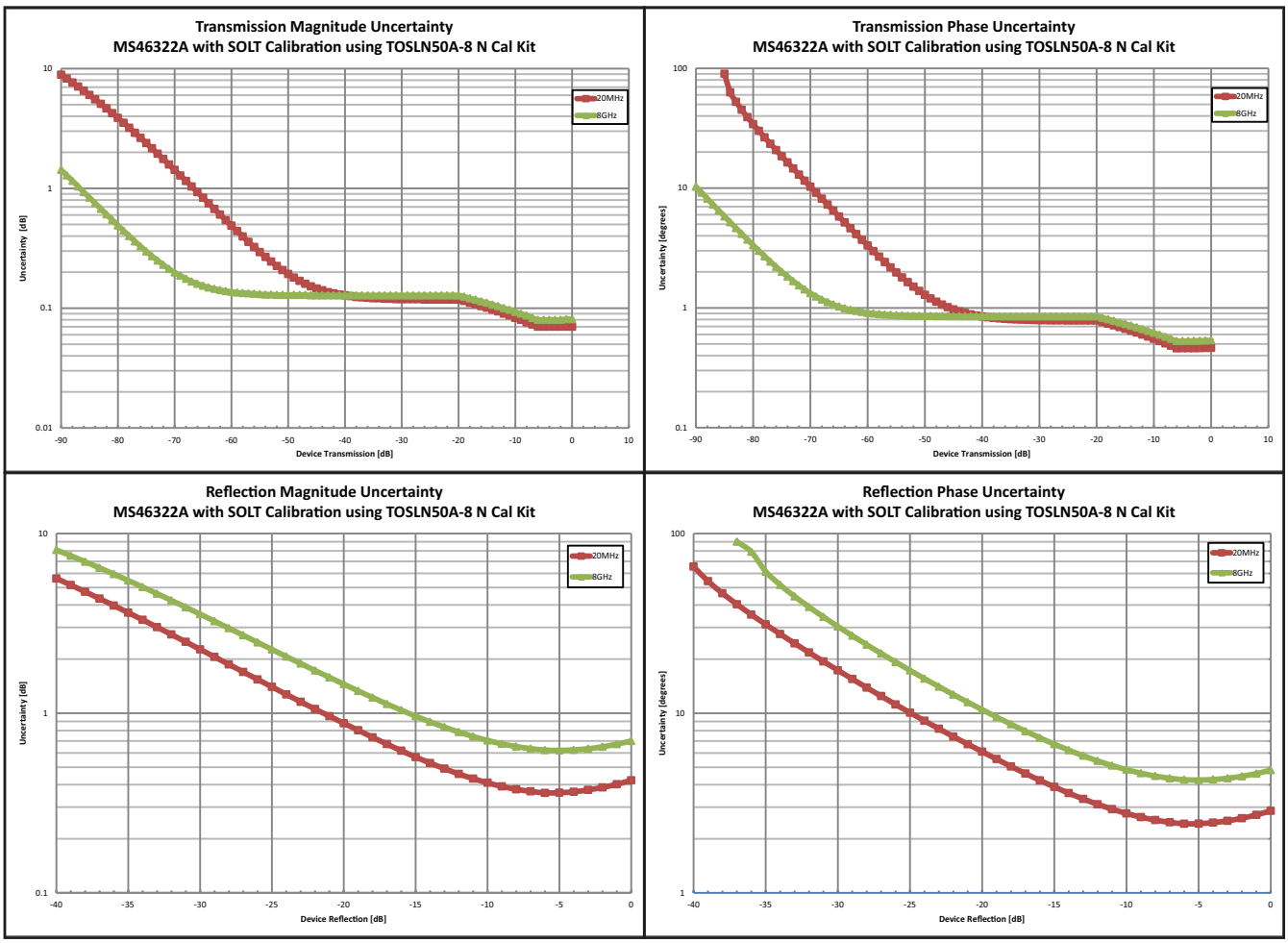
With 12-term SOLT Calibration using TOSLN50A-8 or TOSLNF50A-8 N type connector calibration kits.

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. Typical 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.



VNA System Performance for MS46322A-014 and MS46322A-020 Frequency Options

Error-Corrected Specifications

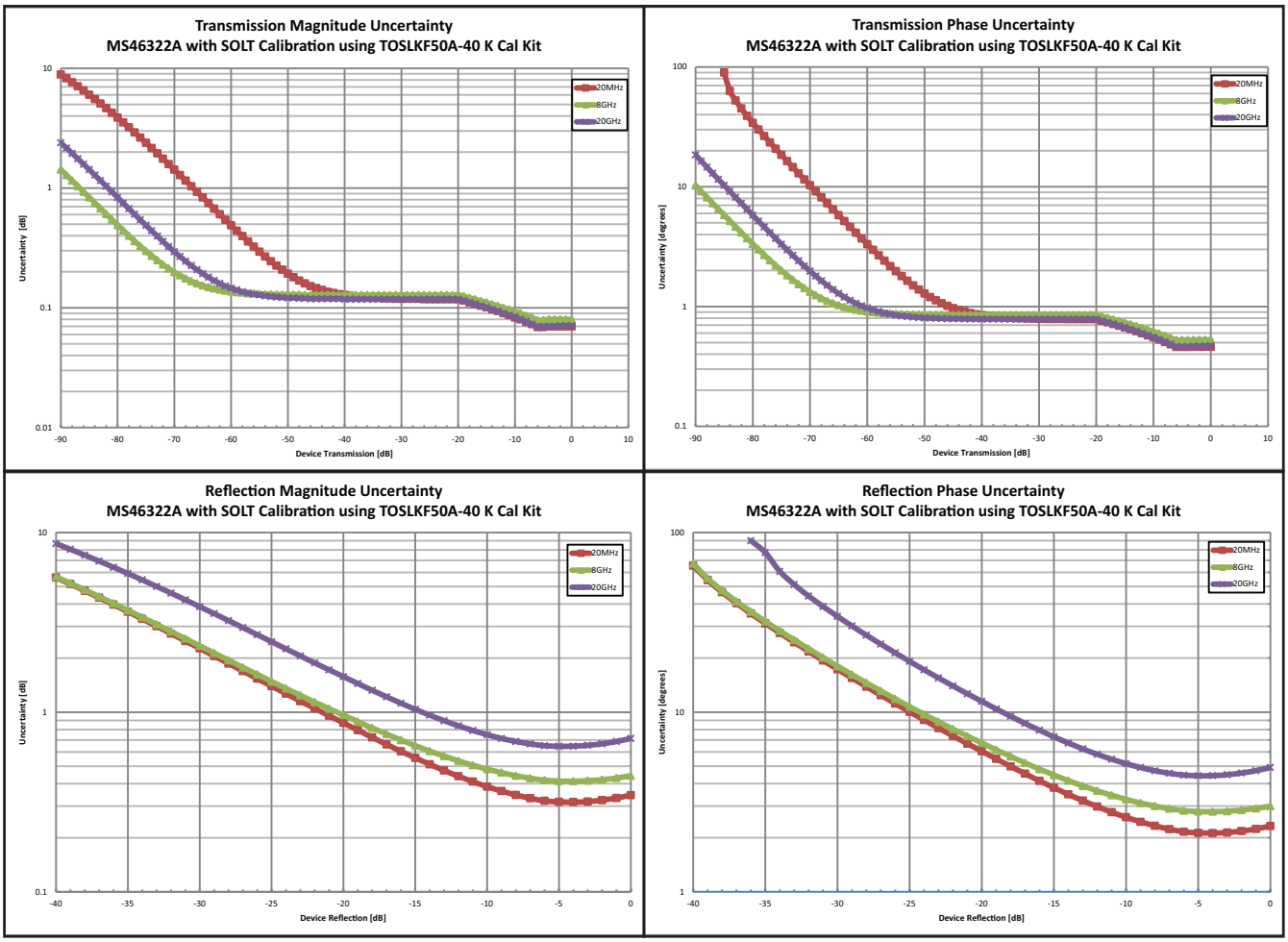
With 12-term SOLT calibration using the TOSLK50A-20 or TOSLKF50A-20 K type connector calibration kits.

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. Typical 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.



VNA System Performance for MS46322A-030 and MS46322A-040 Frequency Options

Error-Corrected Specifications

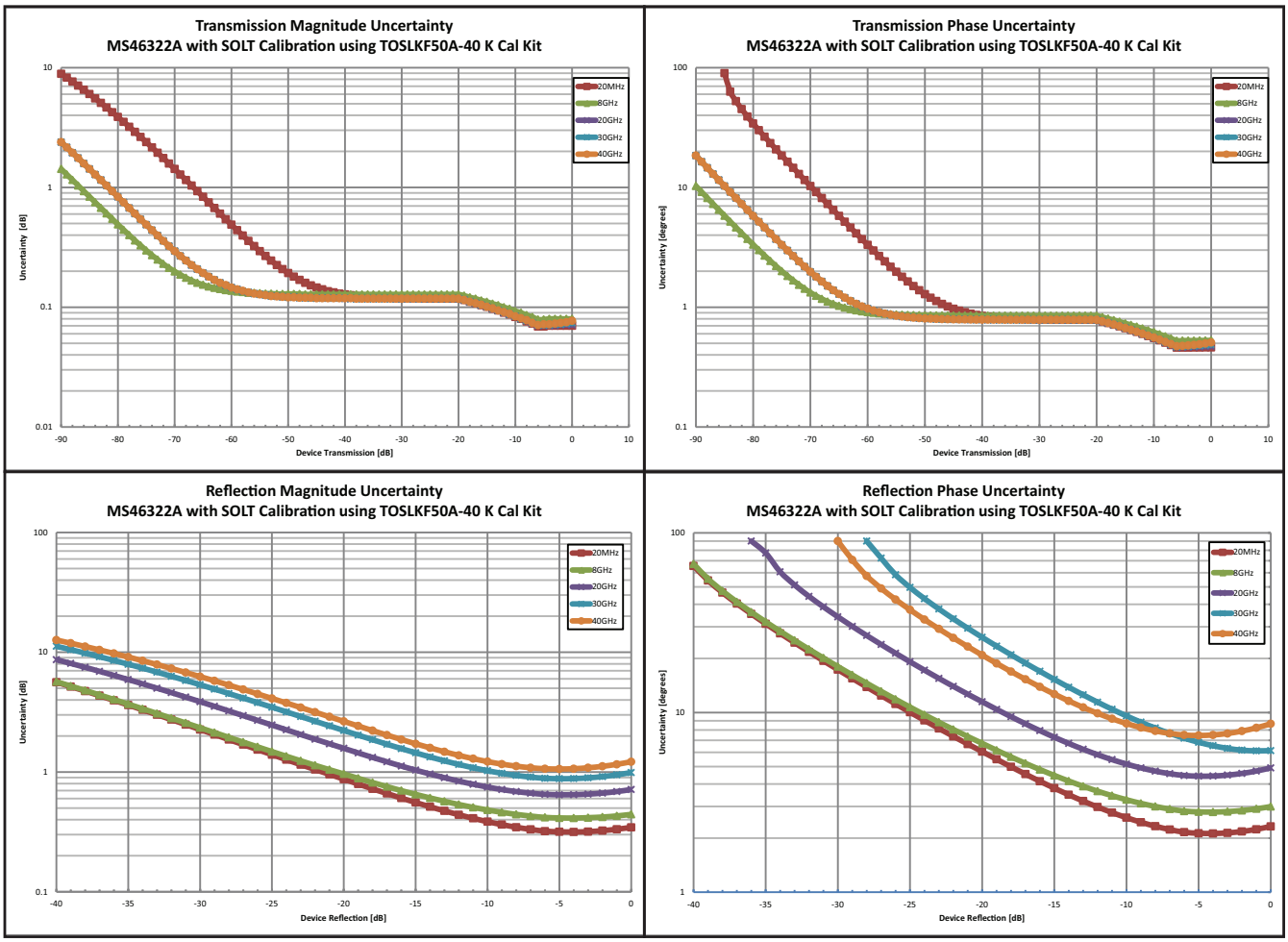
With 12-term SOLT Calibration using TOSLK50A-40 or TOSLKF50A-40 K type connector calibration kits.

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	≥ 36	≥ 22	≥ 36	± 0.10	± 0.05
> 30 GHz to 40 GHz	≥ 30	≥ 20	≥ 30	± 0.10	± 0.05

a. Typical 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

Measurement Speed 220 us/point, typical

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

MS46322A-004	1 MHz to 4 GHz
MS46322A-010	1 MHz to 8 GHz
MS46322A-014	1 MHz to 14 GHz
MS46322A-020	1 MHz to 20 GHz
MS46322A-030	1 MHz to 30 GHz
MS46322A-040	1 MHz to 40 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.
Domains	Frequency Domain, and Time (Distance) Domain

Sweeps

Frequency Sweep Types	Linear

Display Graphs

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

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.

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, 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.

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

Display and Traces

Traces	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 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.

Calibration and Correction Capabilities

Calibration Methods	Short-Open-Load-Through (SOLT) 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 MS46322A 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.

Optional Capabilities

Time Domain Measurements Option 002	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
Via LAN	Using VXI-11 Protocol	Gigabit Data Transfer Speed	Use SCPI commands
Driver for LAN	Please contact Anritsu Customer Service (ShockLineVNA.support@Anritsu.com) for details.		
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

Test Ports 1 and 2	
MS46322A-004	N(f)
MS46322A-010	N(f)
MS46322A-014	Ruggedized K(m)
MS46322A-020	Ruggedized K(m)
MS46322A-030	Ruggedized K(m)
MS46322A-040	Ruggedized K(m)
Damage Input Levels	+23 dBm maximum, 50 VDC maximum
USB Ports	Two type A USB 2.0 Ports for peripherals such as keyboard, mouse, flash drive, hardware key, and similar devices.
Chassis Grounding Port	Banana(f)

MS46322A Front Panel

Rear Panel Connections

MS46322A Series 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	Two type A USB 2.0 Ports and two type A USB 3.0 for peripherals such as keyboard, mouse, memory stick, hardware key, etc.
	LAN Port	Gigabit Ethernet
HDMI Port		Video output, touchscreen compatible
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
	Edge Trigger	Programmable edge trigger
	Trigger Delay	6 µs typical

CPU, Memory, and Security Features

CPU	Intel Core™ i5
Storage	Serial-ATA (SATA) Solid State Drive (SSD), for OS, Programs, and Data. (> 30 GB)

Security Features

Virus Protection, Best Practices	If the VNA is attached to a network, best practices recommend installing anti-virus software.

Mechanical

Dimensions Dimensions listed are for the instrument body without rack mount option attached.

H x W x D	108 mm x 484 mm x 590 mm

Weight < 11 kg (< 25 lb), typical weight for a fully-loaded MS46322A VNA

Environmental

Operating Specification Conforms to MIL-PRF-28800F (class 3)

Temperature Range	0 °C to +50 °C
Relative Humidity	5 % to 95 % at +40 °C, Non-condensing

Non-Operating

Temperature Range	–40 °C to +75 °C
Relative Humidity	0 % to 90 % at +65 °C, Non-condensing

Electromagnetic Compatibility

EMI Conforms to and meets the requirements of:

EMC Directive	2004/108/EC
Low Voltage Directive	2006/95/EC
Emissions	EN55011:2009+A1:2010 Group 1 Class A
Immunity	EN 61000-4-2-2009, 4 kV CD, 8 kV AD EN 61000-4-3:2006+A2:2010, 3 V/m EN 61000-4-4:2004, 0.5 kV S-L, 1 kV P-L EN 61000-4-5:2006, 0.5 kV S-L, 1 kV L-E EN 61000-4-6:2009, 3 V EN 61000-4-11:2004, 100% @ 20 ms

Safety

European Union	CE Mark
Standard:	EN 61010-1:2010

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	MS46322A, 2-Port ShockLine™ Economy VNA
Required Option (Select one frequency option only)	MS46322A-004, 1 MHz to 4 GHz, type N(f) ports MS46322A-010, 1 MHz to 8 GHz, type N(f) ports MS46322A-014, 1 MHz to 14 GHz, type Ruggedized K(m) ports (compatible with 3.5 mm and SMA connectors) MS46322A-020, 1 MHz to 20 GHz, type Ruggedized K(m) ports (compatible with 3.5 mm and SMA connectors) MS46322A-030, 1 MHz to 30 GHz, type Ruggedized K(m) ports (compatible with 3.5 mm and SMA connectors) MS46322A-040, 1 MHz to 40 GHz, type Ruggedized K(m) ports (compatible with 3.5 mm and SMA connectors)

Included Accessories

Each VNA comes with a set of included accessories.

User Documentation	The user documentation USB device includes Adobe Acrobat PDF files for the ShockLine Operation Manual, User Interface Reference Manual, Programming Manual, Calibration and Measurement Guide, and the Technical Data Sheet and Configuration Guide.
Power	Power Cord

Main VNA Options

MS46322A-001	Rack Mount, adds handles and removes feet for shelf-mounting into a 19 inch universal rack
MS46322A-002	Time Domain with Time Gating

Calibration Options

MS46322A-098	Standard Calibration, ISO 17025 compliant, without data
MS46322A-099	Premium Calibration, ISO 17025 compliant, with data

Mechanical Calibration Kits

3650	SMA/3.5 mm Calibration Kit
3650A	SMA/3.5 mm Calibration Kit, Without Sliding Loads
3650A-1	SMA/3.5 mm Calibration Kit, With Sliding Loads
3652A	K Calibration Kit, Without Sliding Loads
3652A-1	K Calibration Kit, With Sliding Loads
3653A	N Calibration Kit, Without Sliding Loads
OSLN50A-8	Precision N Male Open/Short/Load Mechanical Calibration Tee
OSLNF50A-8	Precision N Female Open/Short/Load Mechanical Calibration Tee
TOSLN50A-8	Precision N Male Through/Open/Short/Load Mechanical Calibration Tee
TOSLNF50A-8	Precision N Female Through/Open/Short/Load Mechanical Calibration Tee
OSLN50A-18	Precision N Male Open/Short/Load Mechanical Calibration Tee
OSLNF50A-18	Precision N Female Open/Short/Load Mechanical Calibration Tee
TOSLN50A-18	Precision N Male Through/Open/Short/Load Mechanical Calibration Tee
TOSLNF50A-18	Precision N Female Through/Open/Short/Load Mechanical Calibration Tee
TOSLK50A-20	Precision K Male Through/Open/Short/Load Mechanical Calibration Tee
TOSLKF50A-20	Precision K Female Through/Open/Short/Load Mechanical Calibration Tee
TOSLK50A-40	Precision K Male Through/Open/Short/Load Mechanical Calibration Tee
TOSLKF50A-40	Precision K Female Through/Open/Short/Load Mechanical Calibration Tee

Verification Kits

3663-2	N Verification Kit
3668-2	K Verification Kit

RF 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
71693-R	Ruggedized adapter, K(f) to N(f), DC to 18 GHz, 50 ohm
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, 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	Test Port Cable, Flexible, Phase Stable, N(f) to N(m), 1.0 m
15NNF50-1.5B	Test Port Cable, Flexible, Phase Stable, N(f) to N(m), 1.5 m
15NN50-1.0B	Test Port Cable, Flexible, Phase Stable, N(m) to N(m), 1.0 m
15LL50-1.0A	Test Port Cable, Armored, Phase Stable, DC to 20 GHz, 3.5 mm(m) to 3.5 mm(m), 1.0 m, 50 Ω
15LLF50-1.0A	Test Port Cable, Armored, Phase Stable, DC to 20 GHz, 3.5 mm(m) to 3.5 mm(f), 1.0 m, 50 Ω
15KK50-1.0A	Test Port Cable, Armored, Phase Stable, DC to 20 GHz, K(m) to K(m), 1.0 m, 50 Ω
15KKF50-1.0A	Test Port Cable, Armored, Phase Stable, DC to 20 GHz, K(m) to K(f), 1.0 m, 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
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

Transit Case

760-269	ShockLine™ VNA Transit Case, Hard plastic with wheels

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

Documentation

User Documentation	Soft copies of the manuals as Adobe Acrobat PDF files are included on the User Documentation USB memory device provided with the instrument. The Maintenance Manual is available from Anritsu Customer Service. For more information, please contact ShockLineVNA.support@Anritsu.com.
10410-00335	MS46322A Series VNA Operation Manual (OM)
10410-00336	MS46322A Series VNA Calibration and Measurement Guide (MG)
10410-00337	MS46322A Series VNA User Interface Reference Manual (UIRM)
10410-00338	MS46322A Series VNA Programming Manual (PM), for IEEE 488.2 and SCPI Commands

SHOCKLINE™

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