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ShockLine™ MS46524A

Description **Page**

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.
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.
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. Dynamic Range specification is typical from 2300 MHz to 2500 MHz. High Level Noise specification is typical from 1450 MHz to 1550 MHz.
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 the maximum specified source power and the noise floor (RMS) at the specified reference plane at 10 Hz IF Bandwidth.

Frequency Range	Standard (dB)	Typical (dB)
10 MHz to 7 GHz	> 110	115

Receiver Compression Levels

Port power level beyond which the response may be compressed more than 0.3 dB relative to the normalization level. Measured at 300 Hz IF bandwidth. Match not included. Performance is typical.

Frequency Range	Standard (dBm)
10 MHz to 7 GHz	+10

High Level Noise

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

Frequency	Magnitude (dB)	Phase (deg)
10 MHz to 7 GHz	< 0.006	< 0.1

Output Power Range

Minimum to maximum rated power level. Performance is characteristic.

Frequency	Standard (dBm)
10 MHz to < 6 GHz	-30 to +15
6 GHz to 7 GHz	-30 to +12

Output Default Power

Instrument default power is +5 dBm. For maximum rated power, refer to Output Power Range above.

Power Accuracy Performance is typical.

Output Power	Accuracy (dB)
At +5 dBm	± 1.0
At 0 dBm	± 1.0
At –30 dBm	± 3.0

Setting Resolution

Output Power	Setting Resolution (dB)
10 MHz to 7 GHz	0.01

Frequency Resolution, Accuracy, and Stability

All specifications typical.

Resolution	Accuracy	Stability/Temperature	Stability/Time
1 Hz	± 1.0 ppm (at time of calibration)	± 0.1ppm/10° C to 70° C	± 0.02 ppm/24 Hr. ± 0.2 ppm/1 Mo. ± 1.0 ppm/1 Yr. ± 2.0 ppm/3 Yr.

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)
10 MHz to < 50 MHz	< –20	< –30	> 60
50 MHz to 7 GHz	< –30	< –30	> 60

Uncorrected (Raw) Port Characteristics

All specifications typical. User and system correction off.

Frequency Range	Directivity (dB)	Port Match (dB)[a]
10 MHz to < 1 GHz	> 9	> 15
1 GHz to < 4 GHz	> 7	> 7
4 GHz to 7 GHz	> 4	> 7

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

VNA System Performance for MS46524A-004 and MS46524A-007 Frequency Options

Error-Corrected Specifications

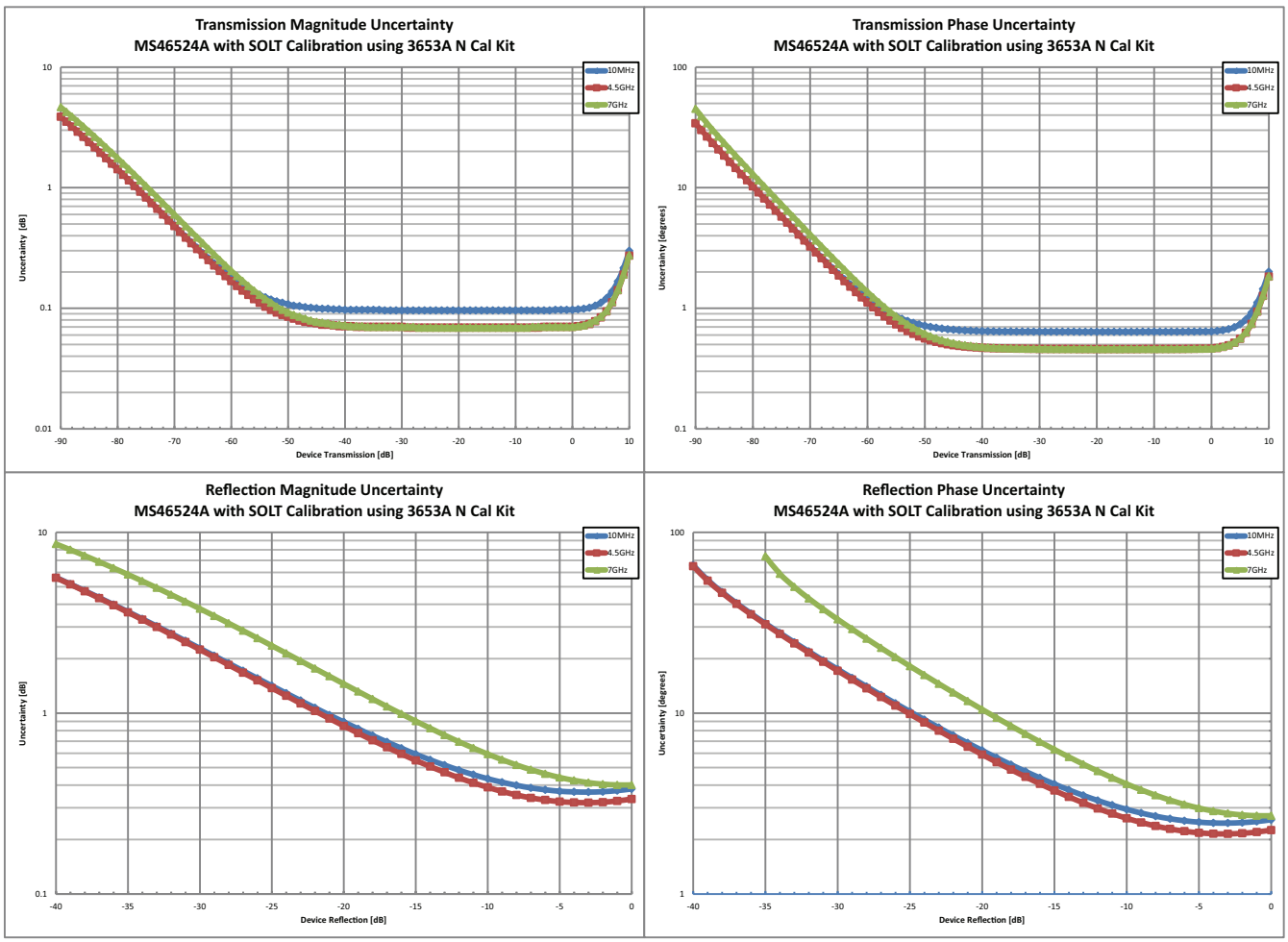
With 12-term SOLT Calibration using the 3653A N Type Connector Calibration Kit.

Frequency Range	Directivity (dB)	Source Match (dB)	Load Match[a] (dB)	Reflection Tracking[a] (dB)	Transmission Tracking[a] (dB)
10 MHz to < 30 MHz	> 42	> 35	> 38	±0.15	±0.09
30 MHz to < 5 GHz	> 42	> 35	> 38	±0.08	±0.05
5 GHz to 7 GHz	> 36	> 35	> 33	±0.08	±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.



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	6	17	31	116	7	18	34	130	61	229	454	1810
2-Port Cal	12	32	60	232	12	35	67	258	121	460	911	3623
4-Port Cal	25	67	125	466	28	72	134	512	241	919	1822	7247
Start 10 MHz, stop 4.5 GHz												
Uncorrected	9	19	33	118	8	21	36	132	61	231	457	1811
2-Port Cal	15	36	64	234	14	40	71	261	124	464	916	3626
4-Port Cal	30	74	131	473	30	79	143	520	248	928	1832	7253
Start 10 MHz, stop 7 GHz												
Uncorrected	9	20	33	117	9	22	37	133	66	231	457	1812
2-Port Cal	15	37	65	236	15	40	72	262	125	465	917	3628
4-Port Cal	31	75	143	475	32	81	145	522	249	929	1834	7255

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

MS46524A-004 10 MHz to 4.5 GHz
MS46524A-010 10 MHz to 7 GHz

Measurement Parameters

4-Port Measurements: 16 single-ended S-parameters, and any user-defined combination of a_{1-4}, b_{1-4}, and 1. 16 mixed-mode S-parameters (DD, CC, DC, CD); uses the superposition technique.

Domains: Frequency Domain, and Time (Distance) Domain

Sweeps

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, and Impedance

Circular Graph Types: Smith Chart (Impedance)

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.

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, 50, 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.
Attenuations	Attenuations (with frequency slope) and constant phase offsets can be entered to better describe any reference plane distortions.

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 per trace
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) Short-Open-Load-Reciprocal (SOLR) Line-Reflect-Line (LRL) / Line-Reflect-Match (LRM) Thru Update available
Correction Models	4-port Cals (uses two Full 2-port Cals and up to 4 additional Thru/Reciprocals, minimum of 1) 3-port Cals (uses one Full 2-port Cal, one Full 1-port Cal, and up to 2 additional Thru/Reciprocals, minimum of 1) 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 MS46524A 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	
MS46524A-004	N(f)
MS46524A-007	N(f)
Damage Input Levels	+27 dBm maximum, 50 VDC maximum
USB Ports	Two type A USB 2.0 Ports for peripherals such as keyboard, mouse, memory stick, hardware key, and similar devices.
Chassis Grounding Port	Banana(f)

MS46524A Front Panel

Rear Panel Connections

MS46524A 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 ports for peripherals such as keyboard, mouse, flash drive, hardware key.
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 < 12.5 kg (< 28 lb), typical weight for a fully-loaded MS46524A-007 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	MS46524A, 4-Port ShockLine™ VNA
Requires One Frequency Option	MS46524A-004, 50 kHz to 4.5 GHz MS46524A-007, 50 kHz to 7 GHz

Included Accessories

Each VNA comes with a set of included accessories.

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

Main VNA Options

MS46524A-001	Rack Mount, adds handles and removes feet for shelf-mounting into a 19 inch universal rack
MS46524A-002	Time Domain with Time Gating

Calibration Options

MS46524A-098	Standard Calibration, ISO 17025 compliant, without data
MS46524A-099	Premium Calibration, ISO 17025 compliant, with data

Mechanical Calibration Kits

3650	SMA/3.5 mm Calibration Kit
3653A	N Calibration Kit, Without Sliding Loads
TOSLN50A-8	Precision N Male Through/Open/Short/Load Mechanical Calibration Tee
TOSLNF50A-8	Precision N Female Through/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

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
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

Test Port Cables, Flexible, Ruggedized, Phase Stable

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, K(m) to K(f), 40 GHz, 36 inches

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

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
01-204	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 flash drive provided with the instrument. The Maintenance Manual is available from Anritsu Customer Service. For more information, please contact ShockLineVNA.support@Anritsu.com.
10410-00330	MS46522A/524A Series VNA Operation Manual (OM)
10410-00332	MS46522A/524A Series VNA User Interface Reference Manual (UIRM)
10410-00333	MS46522A/524A Series VNA Programming Manual (PM), for IEEE 488.2 and SCPI Commands

Notes

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MS46524A ShockLine™ TDS

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