

# 54100A/56100A

## Scalar Network Analyzers

1 MHz to 110 GHz

Technical Data Sheet



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*For economic measurement of SWR, loss/gain,  
relative group delay and distance-to-fault*

Introduction to Anritsu Scalar Analyzers

This data sheet details the potential applications and specifications of the Anritsu scalar network analyzer products. The reference table on pages 6 and 7 provides a guide to the accessories that you will need for your specific application.

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Accuracy of Scalar Measurements

Further information on Anritsu scalar analyzers, or other Anritsu products, can be found by contacting one of the offices listed on the back cover. For a full list of sales offices around the world, visit our web site at [www.anritsu.com](http://www.anritsu.com)



Anritsu offer a comprehensive range of scalar analyzers for economic network measurements to 110GHz.

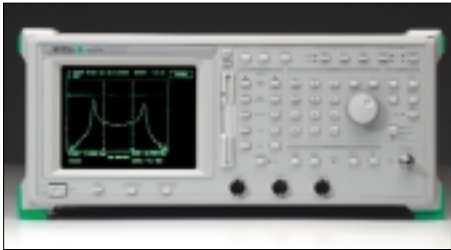
The 56100A scalar analyzer used in conjunction with a 68C series synthesizer offers the very best RF performance in a scalar measurement system. The 68C series synthesizer and 56100A analyzer communicate over a private GPIB link to form an integrated scalar measurement system.

The 56100A/68C scalar measurement systems offers 10MHz to 50GHz frequency coverage with -40dBc harmonics, up to +17dBm levelled power and fully synthesized sweeps. This combination is ideal where the best possible frequency accuracy and dynamic range are required.

Mixers and other frequency conversion devices can also be characterised by using two synthesizers in the system to generate frequency sweeps with a fixed offset.

The 54100A series integrated scalar network analyzers have built in crystal referenced sources to provide an economical and compact solution. They are ideal for production of devices such as filters and amplifiers from 1MHz to 50GHz. Optional software adds; distance to fault measurements for field testing of waveguides, cables and antennas, relative group delay software for economic filter characterisation and precision return loss that adds up to 20dB directivity improvement to SWR measurements.

	54100A	56100A plus 68C synthesizer
Standard measurements supported	Return loss (SWR), insertion loss/gain, power Precision return loss	Return loss (SWR), insertion loss/gain, power
Additional measurements (optional)	Distance-To-Fault Relative group delay	
Source	Internal	External Anritsu 69A/B series Anritsu 68B/C series Anritsu 67XXA/B series Wilton 6600A/B series HP 8340/8350 series
Two source control	No	Yes with synchronous sweeps for mixer measurements
Max source power	10dBm @ 20GHz	13dBm @20GHz 17dBm option (68C source)
Harmonics, 2 to 20GHz	-60dBc	-60dBc (68C source)
Frequency accuracy	Crystal controlled	Synthesized
110GHz reflectometer support	Yes	Yes
Autotesters and detectors	Available to 50GHz	Available to 50GHz
3.5 inch disk drive	Yes	No
Intelligent markers	Yes	Yes
GPIB as standard	Yes	Yes
Mean Time Between Failure (MTBF)	>10,000 hours	>10,000 hours
World-wide service and support	Yes	Yes



The 54100A Series Scalar Network Analyzers offer highly integrated and economic network measurements



The 56100A Scalar Network Analyzer operates with Anritsu's 68C and 69B series synthesizers. The separate source maximizes system performance and flexibility.

For scalar network measurements to 110GHz both 54100A and 56100A are complemented by the millimeter wave reflectometers.

54100A Series optional software

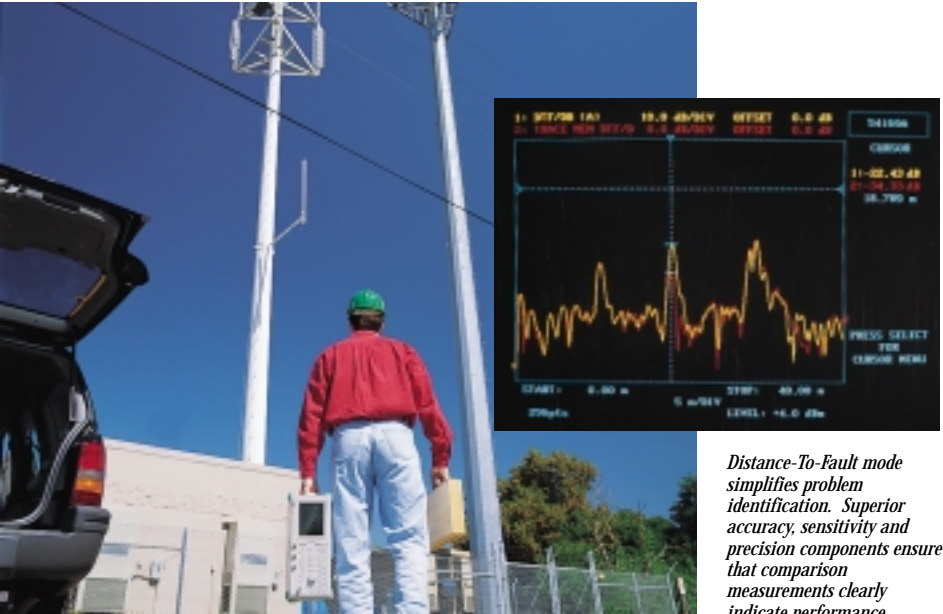


Distance-To-Fault

The most common failure in a microwave radio link is the transmission line, the waveguide and/or coaxial cables which connect radio equipment to the antennas. With the 54100A Series optional Distance-To-Fault (DTF) Software you can install and maintain tower equipment with confidence.

Anritsu's precision calibration components and low source harmonics provide industry leading return loss (or SWR) accuracy. With 0.1% distance accuracy, you're sure to identify degraded components or moisture quickly – before the problem causes a failure. Automatic anti-aliasing software and windowing filters ensure the peaks on the DTF display are really there, not erroneous fault indications caused by re-reflections.

With most elliptical waveguide components meeting 30 dB return loss performance, it's absolutely critical that the precision load used for calibration is of the highest quality to achieve repeatable, accurate measurements. Using poor quality 50 W loads for DTF calibration will cause abnormally high test data variations



during maintenance test intervals. Instead of saving time, technicians may find themselves chasing non-existent problems.

Distance-To-Fault mode simplifies problem identification. Superior accuracy, sensitivity and precision components ensure that comparison measurements clearly indicate performance degradation. Site technicians easily locate small problems before more serious failures result.

Specifications

The optional Distance-To-Fault software displays impedance discontinuities versus distance based on a swept frequency measurement of transmission line mismatch. The software is available by ordering Option 7 with 54100A Series Network Analyzers.

**Measurements:** Distance-To-Fault (meters or feet), Return loss or SWR of fault.

**Frequency Sampling:** 256, 512, or 1024 frequency points.

**Window Functions:** Hamming, 2-term, -42 dB sidelobes; Blackman-Harris, 3-term, -67 dB sidelobes.

**Anti-aliasing:** Filtering of post detected data rejects indications of false faults caused by signal re-reflections during high reflection fault conditions or out of band sweep on antenna systems.

**Distance Accuracy:** < 0.1% of range or 2 mm dependent upon knowledge of the propagation velocity for the device under test and the frequency sweep range.

**Dynamic Range:** > 80 dB, depending upon calibration component return loss and operating frequency range.

**Return Loss Amplitude Accuracy:** Effective Directivity is dependent upon the return loss of the precision termination used during calibration.

**Distance Range:** 1 to 5000 meters depending on measurement frequency range and hardware configuration.

**Distance Resolution (of one fault):** 0.4% of total distance (256 frequency measurement points), 0.2% of total distance (512 frequency

measurement points), 0.1% of total distance (1024 frequency measurement points).

**Transmission Lines Supported:**

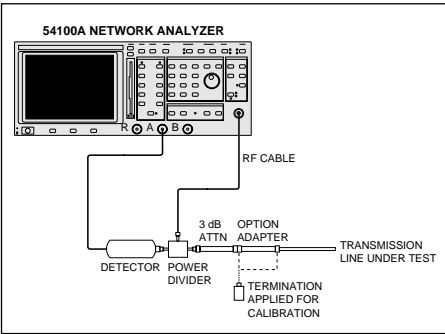
- Coaxial Cable
- Waveguide
- Waveguide with Coaxial Cable Input

Transmission line loss and velocity factor are corrected by the software. Waveguide dispersion is corrected based on the cutoff frequency, fc. For waveguide with coaxial cable input, a special operating mode is utilized to automatically compensate for the length of non-dispersive coaxial cable in front of the waveguide transmission line.

**Distance-To-Fault Measurement Accessories:**

Anritsu Distance-To-Fault test systems utilize standard diode detectors and measurement accessories.

**Non-Ratio Operation, Coaxial**



**POWER DIVIDERS**

These signal dividers are symmetrical, three-resistor tee designs that are used with the Distance-To-Fault option and other applications

requiring two inputs to be combined into a single output.

**Maximum Input Power:** +30 dBm

Power Divider Model	Frequency Range	Connectors	
		Input	Output
11N50B 50Ω	DC to 3 GHz	N (f)	N (f)
11N75B 75Ω	DC to 3 GHz	N (f)	N (f)
1091-29 50Ω	DC to 18 GHz	N (m)	N (f)
K240B 50Ω	DC to 26.5 GHz	K (f)	K (f)
K240C 50Ω	DC to 40 GHz	K (f)	K (f)
V240C 50Ω	DC to 65 GHz	V (f)	V (f)

3 dB Attenuator Model	Frequency Range	Connectors	
		Input	Output
1010-31	0.01 to 18 GHz	N (m)	N (f)
43KB-3	0.01 to 26.5 GHz	K (m)	K (f)
43KC-3	0.01 to 40 GHz	K (m)	K (f)
41V-3	0.01 to 60 GHz	V (m)	V (f)

**PRECISION TERMINATIONS**

Terminations are required for calibration and are occasionally used for terminating the output of the coaxial cable under test.

Model	Frequency Range	Connector
26N75A 75Ω	DC to 3 GHz	N (m)
26NF75A 75Ω	DC to 3 GHz	N (f)
28N50-2 50Ω	DC to 18 GHz	N (m)
28NF50-2 50Ω	DC to 18 GHz	N (f)
28S50-1 50Ω	DC to 26.5 GHz	WSMA (m)
28SF50-1 50Ω	DC to 26.5 GHz	WSMA (f)
28K50 50Ω	DC to 40 GHz	K (m)
28V50B 50Ω	DC to 65 GHz	V (m)



Precision Return Loss

Precision Return Loss (PRL) is a technique which uses vector signal addition principles to extend the directivity of scalar network analyzer (SNA) measurements. The 15 to 20 dB directivity improvement allows accurate verification and calibration of very high return loss devices such as terminations, attenuators, and adapters – components which are common to almost every RF test bench.

Test bench components are susceptible to a variety of problems including:

- 1) Repeated excess torque
- 2) Drops to the floor
- 3) Accumulation of dirt

Additionally, since adapters and attenuators are not always labeled for frequency range, they are occasionally used at frequency ranges beyond their specification.

PRL finds these problems quickly. The technique utilizes the same network analyzer which is used for the production process: test operators need only share an Airline and an Offset SWR Autotester.



PRL Accuracy

When testing single port RF devices such as terminations, the principle uncertainty terms are measurement directivity and channel accuracy. The directivity of a PRL measurement is limited by the return loss of the precision airline. Channel accuracy includes noise effects, logarithmic deviation, open/short cal uncertainty, linearity, and instrumentation stability. Additional second order uncertainty terms such as test port match and source match are typically negligible.

Measurement Uncertainty (dB) = Channel Accuracy + Directivity Uncertainty

Measurement Uncertainty (dB) = - 0.5 - 20 log (1 + 10<sup>-Ed/20</sup>)

where, Ed = Airline Return Loss (dB) - Measured Return Loss (dB)

When measuring two port devices such as adapters and attenuators, an additional term (load match) is required to account for the return loss of the precision termination which is attached to port two of the device.

Measurement Uncertainty (dB) = - 0.5 - 20 log (1 + 10<sup>-Ed/20</sup>) - 20 log (1 + 10<sup>-Et/20</sup>)

where, Et = Termination's Return Loss (dB) - Measured Return Loss (dB)

For ISO-9000 based manufacturing, the accuracy of production tests must be known. The PRL measurement technique helps to ensure test process compliance by verifying the

proper performance of test setup components. The use of NIST traceable Precision Airlines allow accurate calibration of those components.

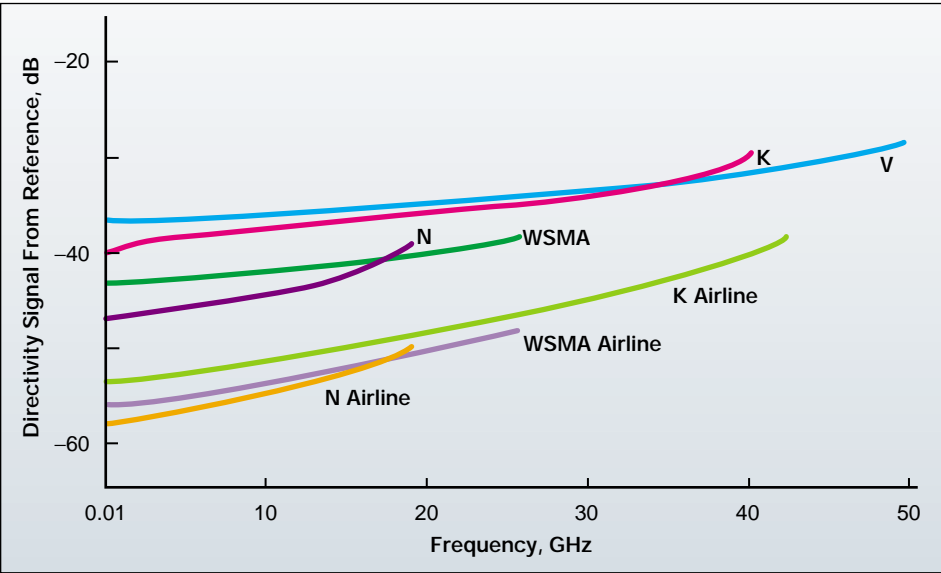
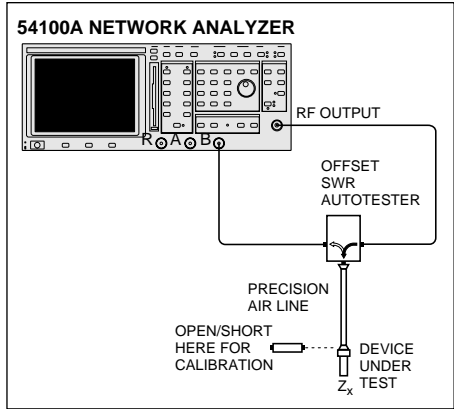
Components For High Return Loss Device Testing

Standard SWR autotesters are internally terminated to a precision 50 ohm match. The Offset SWR autotester replaces this 50 ohm termination with a 15 dB or 20 dB offset termination. This produces a readily measureable reference vector.

During measurement, the S<sub>11</sub> reflection vector of a high return loss will interfere with the reference - creating a ripple pattern on the display proportional to the DUT's return loss. The ripple pattern is automatically converted to a return loss display trace by the precision return loss mode's software.

With the implementation of ISO-9002, microwave test specialists must perform verification of common test stand components such as adapters and terminations on a daily or weekly basis rather than at annual calibration cycles. (Left) A technician tunes a precision termination in the Precision Return Loss TUNING mode.

Component Connections for Precision Return Loss Mode



Legend

- V-type SWR Autotester
- K-type SWR Autotester
- WSMA-type SWR Autotester
- N-type SWR Autotester
- K-type Offset SWR Autotester & K Airline
- K-type Offset SWR Autotester & WSMA Airline
- GPC-7 Offset SWR Autotester & N Airline

By utilizing the traceable performance of a Precision Airline, the Precision Return Loss technique overcomes the directivity limitations of standard SWR Autotesters (or bridges), allowing accurate calibration of very low return loss devices.

PRL ACCESSORY CONFIGURATION CHART

DUT Connector	Offset SWR Autotester	Airline	Open Short	Precision Terminations <sup>1</sup>
GPC-7	560-97A50-20	18A50	22A50	28A50 28A50-1
N male	560-97A50-20	18NF50	22N50	26N50
N female	560-97A50-20	18N50	22NF50	26NF50
SMA male	560-98KF50-15	19SF50	22S50	28S50 28S50-1
SMA female	560-98KF50-15	19S50	22SF50	28SF50 28SF50-1
3.5mm male	560-98KF50-15	19LF50 (SC4127)	22K50	28K50
3.5mm female	560-98KF50-15	19L50 (SC3588)	22KF50	28KF50
K male	560-98KF50-15	19KF50	22K50	28K50
K female	560-98KF50-15	19K50	22KF50	28KF50

<sup>1</sup>Terminations are needed for adapter verification tests and other two port device testing.

AIRLINE SPECIFICATIONS

Model	Freq. Range (GHz)	Test Port Connector	Beaded Port Connector	SWR	Dia. (mm)	Lgth (cm)
18A50	0.5 to 18	GPC-7	GPC-7	1.003 (Test Port) 1.020 (Beaded End)	7	30
18N50 18NF50	0.5 to 18	N (m) N (f)	GPC-7	1.006	7	30
19S50 19SF50	0.8 to 26.5	WSMA (m) WSMA (f)	WSMA male	1.006 to 18 GHz 1.010 to 26.5 GHz	3.5	25
19K50 19KF50	0.8 to 40	K (m) K (f)	1.020	1.020	2.9	15

Relative Group Delay

Optional relative group delay software identifies signal distortion caused by bandpass devices such as filters, receivers, power amplifiers, and up/down converters. Group delay is a key cause of high Bit Error Rate (BER). Group delay is important for 1) CDMA and spread spectrum communications 2) phase radars 3) high capacity satellite and terrestrial microwave links 4) PAL and HDTV television components and other RF systems sensitive to phase distortion.

Group Delay results from deviation in the rate of change of phase response versus change in frequency, df/dw. It indicates that different frequencies travel at different speeds through an RF device. RF systems which depend upon phase coded information suffer degradation when group delay is excessive.

The growth in wireless communications places a heavy demand on available frequency spectrum. More efficient communications standards have digital phase modulation with

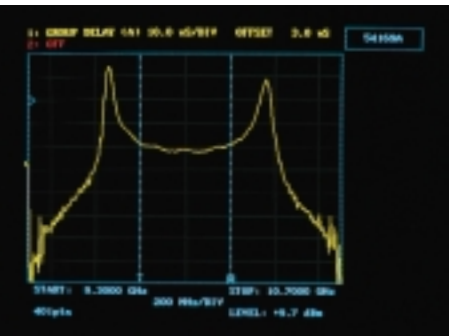
high bits-per-hertz specifications and high bandpass filter rolloff rates. Each of these conditions make the communications more susceptible to group delay induced bit error rate problems.

The 54100A saves time and expense by measuring group delay with the same, inexpensive network analyzer as is used for other tests.

Calibration requires only an RF path normalization with a standard RF detector. Relative group delay specifications assume measurement of bandpass devices. Frequency sweep must include at minimum 20 dB of transmission rolloff from mid-band response. For best results, set the frequency sweep to cover more than 20 dB rolloff is suggested.

Relative Group Delay Accuracy:

Typically < 1ns, < 5.0% of peak-to-valley range with noise averaged. Assumes the band limiting device within the DUT meets minimum phase shift design. Devices such as SAW filters, microwave phase equalizers, and branch



The 54100A utilizes transmission magnitude data to calculate relative group delay using a Hilbert transform software technique. No modulation is utilized. No aperture settings are necessary and frequency converter ALC loops are not disturbed during testing. The technique is applicable to devices with minimum phase transfer functions.

line couplers will have additional uncertainty. Calibration: A transmission path normalization is required.

54100A/56100A Series Network Analyzer Configuration Chart



Model Number	Source Frequency	DUT's Input Connector	SWR Autotester	Detector	Power Splitter	Splitter Adapter	Ext. Leveling Detector	Source Cable	Source Adapter	Power Divider	3 dB Attenuator	DUT Adapter	Precision Termination
Connection Diagram Reference Letter			A	B	C	D	E	F	G	H	I	J	K
54107A	0.001 to 1.5 GHz	50 Ω N (f) 50 Ω N (m)	5400-6N50 5400-6NF50	5400-71N50 5400-71N50	N241A50 N241A50	34NN50A 34NN50A	75N50B 75N50B	N120-6 N120-6	34NN50A 34NN50A	11N50B 11N50B	1010-31 1010-31	34NN50A n/a	28NF50-2 28N50-2
54109A	0.001 to 2.2 GHz	75 Ω N (f)	5400-6N75	5400-71N75	N241A75	34NN75B	n/a	n/a	34NN75B	11N75B	1010-53	n/a	26NF75A
54111A	0.001 to 3.0 GHz	75 Ω N (m)	5400-6NF75	5400-71N75	N241A75	34NN75B	n/a	n/a	34NN75B	11N75B	1010-53	n/a	26N75A
54147A 54137A 56100A + 68147C	0.01 to 20 GHz	50 Ω GPC-7	560-97A50-1	560-7A50	1091-28	34NN50A	75N50B	N120-6	34NN50A	1091-29	1010-31	34AN50	28A50-1
	2 to 20 GHz	50 Ω N (f) 50 Ω N (m)	560-97N50-1 560-97NF50-1	560-7N50B 560-7N50B	1091-28 1091-28	34NN50A 34NN50A	75N50B 75N50B	N120-6 N120-6	34NN50A 34NN50A	1091-29 1091-29	1010-31 1010-31	34NN50A n/a	28NF50-2 28N50-2
	0.01 to 20 GHz	50 Ω SMA (f) 50 Ω SMA (m)	560-98C50A <sup>3</sup> 560-98C50A <sup>3</sup>	560-7S50B 560-7S50B	K241B K241B	1091-27 1091-27	75KB50 75KB50	NS120MF-6 NS120MF-6	34RSN50 34RSN50	K240B K240B	43KB-3 43KB-3	K220B n/a	28SF50-1 28S50-1
54169A 54163A 56100A + 68167C	0.01 to 40 GHz	50 Ω SMA (f) 50 Ω SMA (m)	560-98C50A <sup>3</sup> 560-98C50A <sup>3</sup>	560-7S50-2 560-7S50-2	K241C K241C	K220B K220B	75KC50 75KC50	K120MF-15cm K120MF-15cm	K220B K220B	K240C K240C	43KB-3 43KB-3	K220B n/a	28SF50-1 28S50-1
	2 to 40 GHz	50 Ω K (f) 50 Ω K (m)	560-98C50A <sup>3</sup> 560-98C50A <sup>3</sup>	560-7K50 560-7K50	K241C K241C	K220B K220B	75KC50 75KC50	K120MF-15cm K120MF-15cm	K220B K220B	K240C K240C	43KC-3 43KC-3	K220B n/a	28KF50 28K50
	0.01 to 40 GHz	50 Ω V (f) 50 Ω V (m)	560-98VA50 560-98VFA50	560-7VA50 560-7VA50	V241C <sup>1</sup> V241C <sup>1</sup>	34VV50 34VV50	n/a n/a	K120MF-15cm K120MF-15cm	34RVRK50 34RVRK50	V240C <sup>2</sup> V240C <sup>2</sup>	41V-3 41V-3	34VV50 n/a	28VF50B 28V50B
54177A	0.01 to 50 GHz	50 Ω K (f) 50 Ω K (m)	560-98C50 <sup>3</sup> 560-98C50 <sup>3</sup>	560-7K50 560-7K50	K241C <sup>1</sup> K241C <sup>1</sup>	K220B K220B	75KC50 75KC50	K120MF-15cm K120MF-15cm	34RVRK50 34RVRK50	K240C <sup>2</sup> K240C <sup>2</sup>	43KC-3 43KC-3	K220B n/a	28KF50 28K50
56100A + 68177C		50 Ω V (f) 50 Ω V (m)	560-98VA50 560-98VFA50	560-7VA50 560-7VA50	V241C V241C	34VV50 34VV50	n/a n/a	K120MF-15cm K120MF-15cm	34RVRV50 34RVRV50	V240C V240C	41V-3 41V-3	34VV50 n/a	28VF50B 28V50B

<sup>1</sup> V to K interconnections require male (source) to female power splitter adapters. <sup>2</sup> Also requires a source adapter. <sup>3</sup> See page 12 to select appropriate test port heads.

**(A) SWR Autotesters**  
For optimum accuracy, the SWR Autotester test port must mate to the DUT's input connector. If you must use an adapter at the SWR Autotester test port, use a precision low SWR adapter to minimize degradation of directivity.

**(B) Detectors**  
One detector is required for transmission or DTF measurements in non-ratio configurations. Ratio measurements (monitors source output power) require a second detector.

**(C) Power Splitter**  
Two resistor power splitters are used for ratio measurements and external leveling.

**(D) Splitter Adapter**  
Adapter mates the power splitter output to the SWR Autotester input for Ratio and/or externally leveled measurements.

**(F) Source Cable**  
In manufacturing applications, using the source cable from the source output to the power splitter input (or, in Non-Ratio applications to the

SWR Autotester input) helps minimize long term wear of the SWR Autotester's test port connector. The cable mates directly to power splitter's input. Connection directly to SWR Autotesters requires a male-male adapter for WSMA, K, and V type SWR Autotesters.

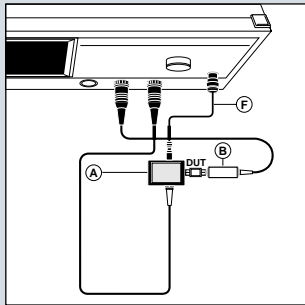
**(G) Source Adapter**  
This adapter mates the source output directly to the SWR Autotester input.

**(H) Power Divider**  
Distance-To-Fault testing procedures

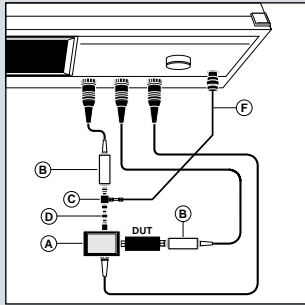
recommend use of a three resistor power divider. Except for the 1091-29, the power divider connection to the source output requires a male-male adapter or an RF extension cable with male connectors.

**(I) 3 dB Attenuators, (J) DUT Adapters, (K) Terminations**  
These components are used during coaxial Distance-To-Fault applications. Waveguide DTF applications may require a coaxial to waveguide adapter.

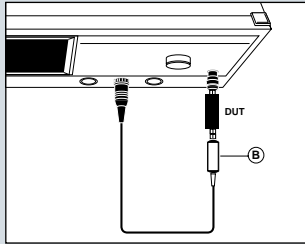
Connection Diagrams



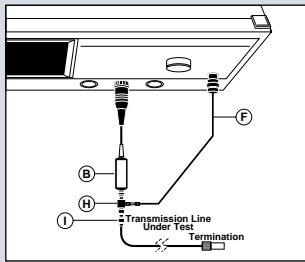
**Non-Ratio Measurements:** Eliminate one detector and the power splitter for measurements which do not need a source power reference detector.



**Ratio Measurements:** Use ratio techniques whenever source amplitude is adjusted during the measurement process.



**Gain (or Loss), Group Delay and Output Power:** An RF detector measures transmission characteristics. Group Delay measurement quality improves when a RF splitter and a second RF detector are used in a ratio configuration.



**Distance-To-Fault:** Faulty antenna systems and transmission lines are easily diagnosed with the 54100A Series optional Distance-To-Fault mode.



# 54100A Specification



## Measurements

The 54100A Series Network Analyzer include models and measurement components from 1 MHz to 110 GHz.

**Measurement Modes:** Transmission (dB), Return Loss (dB), Precision Return Loss (dB), SWR (linear SWR), Power (dBm), **optional** Distance-To-Fault (feet or meters) and Relative Group Delay (ns),

## Analyzer

**Dynamic Range:** -55 dBm to +16 dBm, Autozeroing implements AC detection on a single cycle per sweep basis using Anritsu 560 Series or 5400 Series Detectors and SWR Autotesters. DC detection is used during the sweep to improve accuracy and avoid disturbing automatic leveling controls in the device under test. Auto-zeroing can be disabled.

**Inputs:** Three. Two standard inputs, A and B, with an optional third reference channel, R (Option 5). Anritsu 560 Series and 5400 Series Detectors and Autotesters are designed to operate with the 54100A Network Analyzer. For millimeter wave applications, the 5400 Series Multiplier/Reflectometers provide integrated reference and return loss detection.

**Channels:** Two channels are used to select and simultaneously display any two inputs from A, B, or R. The inputs can also be displayed as ratios A/R or B/R.

**Display Resolution:**  
**Horizontal:** 51, 101, 201, or 401 points.  
**Vertical:** 0.025 dB, 0.0025 ns

**Graticule:** Ten vertical divisions. Horizontal axis automatically scales in frequency increments of 1, 2, 5. Graticule On/Off button turns all graticule lines off. Tick marks remain on axis to indicate graticule position.

**Vertical Scaling:**  
**Resolution:** 0.1 dB(m) to 10 dB(m) per division. Independent control for each channel 0.1 to 100 ns per division.  
**Offset range:** -99.9 dB to +99.9 dB, -99.9 to +99.9 ns.  
**Autoscale:** Automatically selects offset and resolution to provide optimum display of test data.

**External VGA Monitor Output:** Rear panel connection is provided to drive a VGA color display. Trace colors are menu selectable.

**Cursor:** The numerical amplitude of the test data and frequency are displayed for both channels. Display range -99.9 to +99.9 dB or ns.

**Relative Cursor:** Displays the amplitude and frequency differences between the Cursor and Relative Cursor for both channels.

**Cursor Functions:** Automatic cursor searches for trace Maximum, Minimum, dB Level, dB Bandwidth, Next Marker, and Active Marker may be performed.

**Display Data Correction:** System frequency response errors are removed from measurements with a through-line transmission calibration and an open-short reflection calibration. Calibration data is stored at 0.002 dB resolution over the selected frequency range. interpolation is used to maintain calibration as frequency sweep range is decreased.

**Smoothing:** Filtering, adjustable in five levels, to reduce noise and interference on low-level traces. Channels may be independently set.

**Averaging:** 2, 4, 8, 16, 32, 64, 128, or 256 successive traces may be averaged together to remove unwanted noise. Channels may be independently set.

**Limit Lines:** Two limit lines, either single value or multi-level segmented, for each trace. Complex lines may be made from up to 10 individually-editable segments.

**Trace Mask:** A swept measurement can be stored to a graticule Trace Mask for visual comparison to later measurements.

**Save/Recall:** Thirteen sets of front-panel set-ups and thirteen sets of trace memory can be stored in non-volatile instrument memory. Stored set-ups may be previewed on the CRT or printed prior to selection. Non-volatile memory can be erased for security purposes.

**3.5 Inch DOS Disk Drive:** Instrument configurations and trace data can be stored on a MS-DOS® compatible 3.5 inch, 1.44 MB floppy disk. Trace Data can be stored in a standardized ASCII format which easily reads into common PC spread sheets and word processing software.

## Source

**Frequency Range:** 1 MHz to 50GHz internal (see millimeterwave reflectometer for 110GHz coverage).

**Start-Stop:** Sweeps from start frequency to stop frequency.

**Center-Width:** Sweeps from center - (width/2) to center + (width/2)

**Alternate Sweep:** Sweeps alternately between frequency ranges set differently for Channel 1 and Channel 2.

**CW:** Provides single frequency output (both channels turned off).

**Frequency Resolution:**  
**RF Models (54107A, 54109A, 54111A):** ±10 kHz  
**Microwave Models:** ±100 kHz

**Start Frequency Accuracy:**  
**RF Models (54107A, 54109A, 54111A):** ±100 kHz  
**Microwave Models to 20 GHz:** ±200 kHz  
**Microwave Models, 20 to 40 GHz:** ±400 kHz  
**Microwave Models, 40 to 50 GHz:** ±800 kHz

**Sweep Time, Single Band:** Typically less than 70 ms for single channel with 101 point horizontal resolution, depending on frequency,

averaging, and smoothing settings. Trace update time is typically 130 ms with similar system settings.

**Residual FM:**  
1 MHz to 20 GHz < 10 kHz Peak  
20 GHz to 40 GHz < 20 kHz Peak  
40 GHz to 50 GHz < 40 kHz Peak  
Measured in 30 Hz to 15 kHz post-detection BW.

**Output Power:** Maximum guaranteed leveled output power is model dependent. Typical unleveled output power exceeds the specified leveled output power. Operation with unleveled output power degrades rated specifications and is not recommended.

**Reverse Power Protection:** Up to 1 Watt.

**Power Level Accuracy:** ±1 dB, leveled. ±3.0 dB for models above 20 GHz, and ±4.0 dB for 50 GHz models. Add ±0.2 dB for Option 4-75Ω output.

**Power Level Accuracy, Attenuator:** Optional 70 dB Step Attenuator (10 dB steps). Leveled power accuracy degrades by ±1.5 dB for models below 20 GHz and ±1.9 dB for 20 GHz models.

**Power Level Control, Internally Leveled:** Front panel control adjusts power over a 10 dB range (up to 20 dB in some models) or from -70.0 dBm to maximum leveled power when Option 2, 2A, 2B, 2C or 2D 70 dB Step Attenuator is installed.

**Power Level Control, Externally Leveled (Option 6):** Front panel control adjusts power range determined by external leveling detector output. Flatness determined by leveling detector and coupler characteristics.

**Leveling (With External Detector):** Levels output power at DUT input positions other than near the 54100A source output. A leveling detector tracks the RF power level by providing a positive or negative polarity detected signal of 30 to 200 mV to a rear panel BNC connector.

**Leveled Power Variation:**  
1.0 MHz to 1.0 GHz ± 0.3 dB ± 1.0 dB, Opt 2  
1.0 MHz to 2.0 GHz ± 0.4 dB ± 1.1 dB, Opt 2  
1.0 MHz to 3.0 GHz ± 0.6 dB ± 1.3 dB, Opt 2  
10.0 MHz to 20 GHz ± 0.8 dB ± 1.0 dB, Opt 2A  
10.0 MHz to 26.5 GHz ± 1.0 dB ± 2.5 dB, Opt 2B  
10.0 MHz to 32 GHz ± 2.0 dB ± 2.0 dB, Opt 2C  
10.0 MHz to 40 GHz ± 2.0 dB ± 2.0 dB, Opt 2C  
10.0 MHz to 50 GHz ± 3.0 dB ± 3.0 dB, Opt 2D  
Add ± 0.2 for 75 Ω sources

**Markers:** The numerical amplitude of the test data and frequency are displayed. Markers remain fixed at the set frequency, independent of displayed sweep frequency range.

## Application Functions

Application functions speed and ease the task of characterizing antennas, filters, amplifiers, and other microwave devices.

**Min/Max Hold:** Save the minimum and

maximum values of successive sweeps or the combination of the two. Ideal for acquiring data on drift or gain variation against temperature.

**Cursor Functions:** Automatic cursor search updates the bandwidth, minimum, or maximum levels of the displayed trace, "X" dB above or below the min/max point, or a selected bandwidth. This function can be set to repeat continuously.

**Compression Test Automation:** Determines the gain compression point over the operating frequency range of an amplifier by successively incrementing the source power and measuring the amount of compression until a preset "X" dB limit is exceeded.

## GPIB

**Interface:** IEEE-488.2 compliant interface with integrated GPIB Plotter Control is standard on all 54100A instruments. All front panel controls are GPIB-controllable except power on/off. Front panel configurable for instrument control or for control of GPIB plotter.

## Printer/Plotter

**Plotter:** The GPIB interface is compatible with HPGL plotters. Display traces, markers, cursor, and graticule information can be plotted.

**Printer:** Parallel printer interface is compatible with the Cannon BJ85 and most Epson FX-compatible printers.

**Internal Print and Plot Buffer:** A new test can be conducted while previously taken test data are being printed or plotted from the internal printer buffer. Portable printers may be purchased locally or through Anritsu. When purchased separately, a Centronics-to-

Centronics Printer Interface Cable will be needed for operation with the 54100A.

## I/O Connections

**Horizontal Sweep Ramp Output:** 0 to +10 V nominal.

**GPIB:** Connects 54100A to controller or plotter. Rear panel GPIB connector.

**Parallel Printer (Centronics):** Connects 54100A to printer. Rear panel.

**VGA Output:** Connects 54100A to external VGA color display (not supplied). Rear panel 15 pin "D" connector.

**External Leveling:** Option 6 adds external leveling capability. Levels output power at remote test position. (Rear panel BNC female connector).

## General

**Self Test:** Performs a self test every time power is applied or when SELF TEST push button is pressed. If an error is detected, a diagnostic code appears, identifying the cause and location of the error.

**Temperature Range:**  
**Operating:** 0°C to +50°C  
**Storage:** -40°C to +70°C

**Electromagnetic Compatibility:** Complies with European Community requirements for CE marking  
**Power:** 115V +10%/-20%, 230V +10%/-20%, 48-440 Hz, 300 VA maximum  
**Dimensions:** 177 H x 426 W x 476 D mm + 51 mm for feet (7 H x 16.75 W x 18.75 D in. + 2.0 in. for feet)  
**Weight:** Nominally 18 kg (39 lb.), 54147A

Model	Frequency Range	Harmonic <sup>2</sup>	Non Harmonic	Source SWR <sup>1</sup> (Leveled)	Output Power <sup>1</sup>	Connector
54107A	0.001 to 1.5 GHz	-40 dBc	-60 dBc	< 1.5	12 dBm, 50 Ω 10 dBm, 75 Ω	N (f)
54109A	0.001 to 2.2 GHz	-40 dBc	-60 dBc	< 1.5	12 dBm, 50 Ω 10 dBm, 75 Ω	N (f)
54111A	0.001 to 3 GHz	-40 dBc	-60 dBc	< 1.5	12 dBm, 50 Ω 10 dBm, 75 Ω	N (f)
54147A	0.01 to 20 GHz	-60 dBc, > 2 GHz -40 dBc, < 2 GHz	-60 dBc, > 2 GHz -50 dBc, < 2 GHz	< 1.8	10 dBm, 50 Ω	N (f)
54137A	2 to 20 GHz	-60 dBc, > 2 GHz -40 dBc, < 2 GHz	-60 dBc, > 2 GHz -50 dBc, < 2 GHz	< 1.8	10 dBm, 50 Ω	N (f)
54169A	0.01 to 40 GHz	-60 dBc, 2-20 GHz -40 dBc, > 20 GHz -40 dBc, < 2 GHz	-50 dBc, > 2 GHz -50 dBc, < 2 GHz	< 1.8	4.0 dBm, 50 Ω	K (f)
54163A	2 to 40 GHz	-60 dBc, 2-20 GHz -40 dBc, > 20 GHz -40 dBc, < 2 GHz	-50 dBc, > 2 GHz -50 dBc, < 2 GHz	< 1.8	4.0 dBm, 50 Ω	K (f)
54177A	0.01 to 50 GHz	-60 dBc, 2-20 GHz -40 dBc, > 20 GHz -40 dBc, < 2 GHz	-50 dBc, > 2 GHz -50 dBc, < 2 GHz	< 2.0	1.0 dBm, 50 Ω	V (f)

<sup>1</sup> At 25°C, internally leveled. Attenuator Options 2 through 2C reduce output power specification by 3.0 dB; 2D, 4.0 dB. <sup>2</sup> Loaded at 50 Ω

# 56100A Specification



## High Performance Scalar Measurements

The Anritsu 56100A Scalar Network Analyzer combined with a Anritsu 68C Series or 69B Series Synthesizer, forms a powerful swept frequency measurement system for both production and design applications.

Measure insertion loss, insertion gain, or RF power with 76 dB dynamic range over the 10 MHz to over 50 GHz frequency range—the widest frequency range available in coax. Measure device match as return loss in dB or as SWR.

Separate detectors can be used on all four inputs for multiple transmission measurements on duplexers or matched amplifiers. Direct detection allows simultaneous RF power measurement at different frequencies for example, at the RF, IF, and LO frequencies of mixers and converters.

## Versatile

Transmission and reflection measurements can be viewed simultaneously. Both traces can be scaled independently in dB, dBm or SWR.

Measurement of the ratio of two detector inputs may be applied to either channel for enhancing accuracy or for viewing differences. Built-in calibration allows subtraction of the unwanted transmission frequency response and the average of open/short reflections.

A Volt Mode is available for displaying voltage (with Volt Mode Adapter Cable). A 0 to 10 Volt Sweep Ramp Output Mode is also available. These modes, combined with a versatile Trace Memory Mode, allow easy testing of VCOs, PIN diodes, and detectors.

## Measurements

Measurement systems using the 56100A Scalar Network Analyzer include components from 1 MHz to 110 GHz.

**Function:** The 56100A has four detector inputs and two independent channels for measurement and display of detected RF power from Anritsu 560 Series Detectors and SWR Autotesters. Two independent channels display RF power (dBm), Transmission Gain or Loss in (dB), or reflected power. Voltage may be displayed with optional Volt Mode Adapter Cable.

**Measurement Modes:** Measures and displays in dB swept transmission and return loss characteristics. Power is displayed in dBm. Complete measurement parameters for all modes are displayed.

**Frequency Range:** 10 MHz to over 50 GHz in coax using Anritsu 560 Series Detectors and SWR Autotesters. Waveguide measurement components to 110 GHz support transmission, reflection, and power measurements.

**Frequency Accuracy:** Same as synthesizer frequency accuracy specification.

**Inputs:** Four inputs, A, B, R1, and R2 accept detected outputs from Anritsu 560 Series Detectors and SWR Autotesters.

**Dynamic Range:** 76 dB (-60 dBm to +16 dBm) on all channels, useable to -65 dBm.

**Data Correction:** System residuals, including the average of open and short reflections, are stored during normalization for automatic subtraction from test data.

**Normalization:** During the normalization sequence, each trace is stored with 0.002 dB resolution over any user-selected frequency range. Normalization data are automatically interpolated for ranges less than the original normalized range.

**Save/Recall:** Nine sets of front-panel settings can be stored for later recall. All stored data can be previewed on the CRT or printer output prior to selection. Four of the setups include their own calibration data.

## Display

**Channels:** Two channels are used to select and simultaneously display any two inputs from A, B, R1, or R2. The same inputs can be displayed as ratios of A/R1, A/R2, B/R1, or B/R2.

**Alternate Sweep:** Displays alternate sweeps between the current front-panel setup and any of nine stored setups.

**Graticule:** Ten vertical divisions. Horizontal divisions are set automatically in frequency increments of a 1, 2, 5 sequence. Graticule On/Off control turns all graticule lines off. Tick marks remain on axis to indicate graticule position.

**Display Resolution:**  
**Horizontal:** 101, 201, or 401 points over selected frequency range.  
**Vertical:** 0.005 dB

**Limit Lines:** Two lines, either straight or complex, for each trace. Complex lines may be made from up to 10 segments. Measurement data may be compared with limit lines for Pass/Fail testing.

**Scaling:**  
**Resolution:** 0.1 dB to 10 dB per division in 0.1 dB steps with independent control for each channel.  
**Offset Range:** -99 dB to +99 dB in 0.1 dB steps.

**Autoscale:** Automatically selects offset and resolution to provide optimum display of test data.

**Trace Update Time:** Typically less than 100 ms, varying with frequency range and the averaging and smoothing settings.

**Smoothing:** Off, Minimum, and Maximum selections use analog techniques to reduce noise on low-level traces. Trace update time is automatically adjusted for any combination of averaging and smoothing.

**Averaging:** 4, 8, 16, 32, 64, 128, or 256 successive traces can be averaged to smooth the trace display.

**CRT Intensity:** Continuously adjustable from off to bright.

## Markers and Cursor

**Markers:** Displays up to ten numerically identified markers (F1 thru F9) generated by the 68C or 69B Series Synthesizers. When a marker is selected as "Active", the cursor can be moved directly to the marker. The cursor can also be moved sequentially through markers until the desired marker is reached.

**Cursor:** Continuously variable with the tuning knob. The frequency and amplitude of test data at the cursor on both traces are digitally displayed.

**Relative Cursor:** Displays the frequency and amplitude difference between the main Cursor and the Relative Cursor for both traces. A menu selection reverses the position of the two cursors.

**Cursor Min/Max:** Automatically moves the cursor to the minimum or maximum value of test data on either trace.

**Cursor "X" dB:** Automatically moves cursor on either trace to an amplitude that is equal to the entered value of "X" dB or dBm.

**Cursor "X" Bandwidth:** Automatically displays cursors to the right and left of the cursor at the frequencies where the test data are equal to the entered value of "X" dB. The frequencies of the low and high cursors and the bandwidth between them are displayed.

**Cursor Next Marker:** Moves cursor to next highest frequency marker.

**Cursor Active Marker:** Moves cursor to the frequency of the active marker.

## Source

Internal software provides system compatibility with the following sources.  
Anritsu 69A/B      Anritsu 68B/C  
Anritsu 67XXA/B      Anritsu 6600A/B  
HP 8340/8350 series  
See individual source data sheet for specifications.

## Superior Accuracy

The 56100A is designed to provide superior accuracy to 110 GHz. When used with a synthesizer's step sweep mode, all measurement frequencies, including markers and cursors, have synthesizer accuracy. The exceptional return-loss accuracy is attributable to the low synthesizer harmonics and spurious, the high directivity and exceptional test port match of the Anritsu SWR Autotesters. To avoid the use of error-producing adapters, SWR Autotesters are available with GPC-7, Type N,



WSMA, or K Connector® test ports, all with high directivity. The 560-98C50A Convertible SWR Autotester tests devices with SMA, 3.5 mm or K Connectors.

## GPIB

**Interface:** IEEE-488 interface is standard. All front-panel controls are GPIB controllable except power on/off and CRT intensity. Pass-through commands allow control of the - microwave signal source through the 56100A GPIB port.

**Data Transfer:** The 56100A does not require an external controller; nevertheless, it is capable of providing high speed data transfer of test data and normalization data to an external GPIB controller.

## Printer/Plotter

**Plotter:** The GPIB interface is compatible with HPGL plotters. Display traces, markers, cursor, and graticule information can be plotted.

**Printer:** Parallel printer interface is compatible with the Canon BJ85 and most Epson FX-compatible printers.

**Internal Print and Plot Buffer:** A new test can be conducted while previously taken test data are printed or plotted from the internal printer buffer. Portable printers may be purchased locally or through Anritsu. When purchased separately, a Centronics-to-Centronics Printer Interface Cable will be needed for operation with the 56100A.

**Temperature Range:**  
**Operating:** 0°C to +50°C  
**Storage:** -40°C to +70°C  
**Power:** 100/120/220/240V AC +5%/-10%, 48-63 Hz, 100 VA maximum  
**Dimensions:** 77 H x 426 W x 476 D mm +51 mm for feet(7 H x 16.75 W x 18.75 D in. +2.0 in. for feet)  
**Weight:** 18 kg (39 lb.)

## Options

**Transit Case**  
**40010 Transit Case:** Hard shell case with custom foam inserts and carrying handle for maximum protection of the 56100A.  
Option 1      Rack Mounting 19 inch rack mount with slides optional  
Option 12      Front Panel Cover  
Option 13      Front Mounted Handles  
Option 25      Maintenance Manual  
Option 26      Extra Operation and GPIB Programming Manual  
Option 33      Ink-Jet Printer

## I/O Connections

**Horizontal Sweep Ramp Input:** 0 to +10V nominal, +12V maximum

**Sequential Sync Input:** +3.5V to +10V blanks trace during synthesizer retrace or bandswitching. -3.5V to -10V defines a marker which when in the range of -8V to -10V is an active marker. Rear panel BNC connector.

**Retrace Blanking Input:** +5V blanks traces during retrace. Rear panel BNC connector.

**Video Marker Input:** ±1V to ±10V peak input. Rear panel BNC connector.

**System GPIB:** Connects 56100A to GPIB. Rear panel GPIB connector.

**Dedicated GPIB:** Connects 56100A to signal source and plotter. Rear panel GPIB connector.

**Parallel Printer (Centronics):** Connects 56100A to printer. Rear panel.

**AUX I/O:** Connects 56100A to compatible source. Rear panel.

## General

**Self Test:** Performs a self test every time power is applied or when SELF TEST pushbutton is pressed. If an error is detected, a diagnostic code appears, identifying the cause and location of the error.

**Electromagnetic Compatibility and Susceptibility:**  
Compliant with European Community requirements for CE marking.



# Detectors and SWR Autotesters



## Detectors

The 5400 and 560 Series Detectors use zero-biased Schottky diodes. Measurement range is -55 dBm to +16 dBm using single cycle per sweep AC detection, Auto-zeroing with DC detection during the frequency sweep. Optional extender cables of over 3000 feet can be used with the 54100A Series. Contact local sales representative for special cables.

### Detectors

Model	Frequency Range	Impedance	Return Loss	Input Connector	Frequency Response
5400-71N50	0.001 to 3 GHz	50 Ω	26 dB	N(m)	± 0.2 dB, < 1 GHz ± 0.3 dB, < 3 GHz
5400-71N75	0.001 to 3 GHz	75 Ω	26 dB, ≤ 2 GHz 20 dB, ≤ 3 GHz	N(m)	± 0.2 dB, < 1 GHz ± 0.5 dB, < 3 GHz
560-7A50	0.01 to 18 GHz	50 Ω	15 dB, < 0.04 GHz 22 dB, < 8 GHz 17 dB, < 18 GHz	GPC-7	± 0.5 dB, < 3 GHz
560-7N50B	0.01 to 20 GHz	50 Ω	15 dB, < 0.04 GHz 22 dB, < 8 GHz 17 dB, < 18 GHz 14 dB, < 20 GHz	N(m)	± 0.5 dB, < 18 GHz ± 1.25 dB, < 20 GHz
560-7S50B	0.01 to 20 GHz	50 Ω	15 dB, < 0.04 GHz 22 dB, < 8 GHz 17 dB, < 18 GHz 14 dB, < 20 GHz	WSMA(m)	± 0.5 dB, < 18 GHz ± 2.0 dB, < 20 GHz
560-7S50-2	0.01 to 26.5 GHz	50 Ω	16 dB, < 0.04 GHz 22 dB, < 8 GHz 17 dB, < 18 GHz 14 dB, < 26.5 GHz	WSMA(m)	± 0.5 dB, < 18 GHz ± 2.0 dB, < 26.5 GHz
560-7K50	0.01 to 40 GHz	50 Ω	13 dB, < 0.04 GHz 22 dB, < 8 GHz 17 dB, < 18 GHz 16 dB, < 26.5 GHz 15 dB, < 32 GHz 13 dB, < 40 GHz	K(m)	± 0.5 dB, < 18 GHz ± 1.25 dB, < 26.5 GHz ± 2.2 dB, < 32 GHz ± 2.5 dB, < 40 GHz
560-7VA50	0.01 to 50 GHz	50 Ω	19 dB, < 20 GHz 15 dB, < 40 GHz 10 dB, < 50 GHz	V(m)	± 0.5 dB, < 18 GHz ± 1.25 dB, < 26.5 GHz ± 2.5 dB, < 40 GHz ± 3.0 dB, < 50 GHz



**Maximum Input Power:** +20 dBm  
**Standard Cable Length:** 122 cm (4 ft.)  
**Dimensions:** 7.6 x 2.9 x 2.2 cm  
(3 x 1-1/8 x 7/8 in.)  
**Weight:** 170 g (6 oz.)

## SWR Autotesters (Open/Short supplied with each)

Model	Frequency Range	Directivity	Impedance	Test Port SWR	Connector	Input Connector
5400-6N50	0.001 to 3 GHz	40 dB, < 3 GHz	50 Ω	< 1.08, 2 GHz < 1.11, > 2 GHz	N (m)	N (f)
5400-6NF50	0.001 to 3 GHz	40 dB, < 3 GHz		< 1.08, 2 GHz < 1.11, > 2 GHz	N (f)	N (f)
5400-6N75	0.001 to 3 GHz	40 dB, < 3 GHz	75 Ω	< 1.10, 2 GHz < 1.17, > 2 GHz	N (m)	N (f)
5400-6NF75	0.001 to 3 GHz	40 dB, < 3 GHz		< 1.10, 2 GHz < 1.17, > 2 GHz	N (f)	N (f)
560-97A50	0.01 to 18 GHz	36 dB	50 Ω	< 1.10, 2 GHz	GPC-7	N (f)
560-97A50-1		40 dB		< 1.17, 2 GHz		
560-97N50	0.01 to 18 GHz	35 dB	50 Ω	< 1.10, 8 GHz	N (m)	N (f)
560-97N50-1		38 dB		< 1.17, > 8 GHz		
560-97NF50		35 dB		< 1.17, 8 GHz	N (f)	
560-97NF50-1		38 dB		< 1.27, > 8 GHz		
560-98S50	0.01 to 26.5 GHz	37 dB, < 18 GHz 36 dB, < 26.5 GHz	50 Ω	< 1.14, 8 GHz < 1.22, 18 GHz < 1.27, ≤ 26 GHz	WSMA (m)	Ruggedized K (f)
560-98S50-1		40 dB, < 18 GHz 38 dB, < 26.5 GHz				
560-98SF50		37 dB, < 18 GHz 36 dB, < 26.5 GHz		< 1.14, 8 GHz < 1.22, 18 GHz < 1.27, ≤ 26 GHz	WSMA (f)	Ruggedized K (f)
560-98SF50-1		40 dB, < 18 GHz 38 dB, < 26.5 GHz				
560-98K50	0.01 to 40 GHz	35 dB, < 18 GHz 32 dB, < 32 GHz 30 dB, < 40 GHz	50 Ω	< 1.14, 8 GHz < 1.26, 18 GHz < 1.29, 26.5 GHz < 1.33, 32 GHz < 1.38, 40 GHz	K (m)	Ruggedized K (f)
560-98KF50		35 dB, < 18 GHz 32 dB, < 32 GHz 30 dB, < 40 GHz		K (f)		
560-98VA50	0.01 to 50 GHz	30 dB, < 40 GHz 30 dB, < 50 GHz	50 Ω	< 1.25, 40 GHz 1.25, 50 GHz	V (m)	Ruggedized V (f)
560-98VFA50		30 dB, < 40 GHz 30 dB, < 50 GHz		< 1.25, 40 GHz 1.25, 50 GHz	V (f)	
560-98C50A	0.01 to 40 GHz	34 dB, ≤ 20 GHz 32 dB, ≤ 26.5 GHz 29 dB, ≤ 40 GHz	50 Ω	< 1.20, 20 GHz < 1.30, 40 GHz	WSMA (m and f) 3.5 mm (m and f) K (m and f)	Ruggedized K (f)

## SWR Autotesters

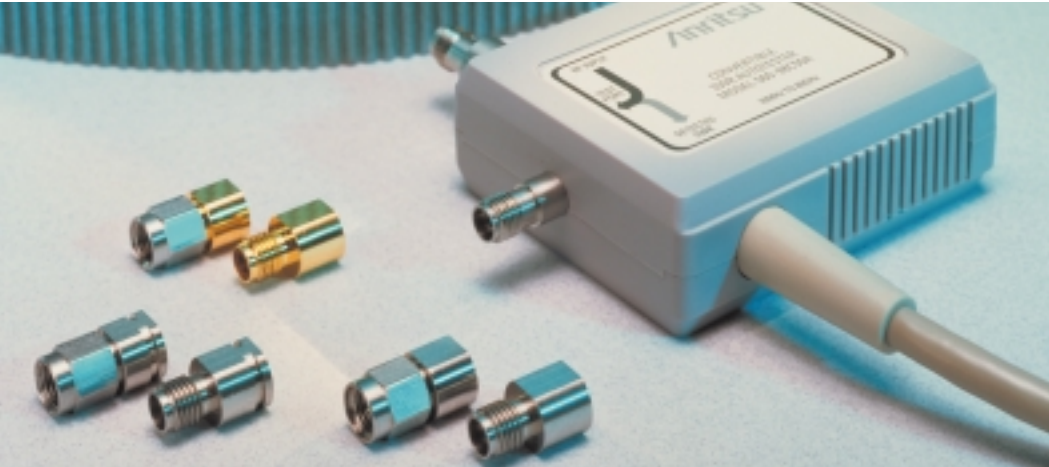
Autotesters are bridges with integrated detectors to simplify return loss measurements in coaxial systems. 5400 series RF autotesters and 560 series microwave autotesters have fixed test port connections. They offer the best possible directivity for accurate measurement of return loss.

When a variety of DUT's with differing test port connectors need to be measured, the 560-98C50 convertible SWR autotesters reduce capital equipment and maintenance costs. These autotesters accurately measure the return loss or SWR of devices with SMA, 3.5mm or K connectors. Six interchangeable test port heads (male and female for each connector standard) are precision tuned to the convertible autotesters internal bridge circuit.

The inexpensive test port heads save repair and calibration costs because they are interchangeable. Repetitive connect/disconnection cycles will eventually wear out test port connectors – especially when excess torque is applied and the connector's mating surfaces are rotated against each other.

It is common practice to reduce maintenance costs by using adopters or connector savers on the test port of the directional device. These adopters attached to the test port reduce measurement accuracy. Directional devices are tuned for optimum directivity at a specific phase reference point, known as the test port. Any test port adapter will degrade the effective directivity. Convertible autotesters from Anritsu with interchangeable test port heads eliminate this measurement degradation.

### 560-98C50A CONVERTIBLE AUTOTESTER



### CONVERTIBLE SWR AUTOTESTER TEST PORT HEADS

DUT Connector	Test Head Model	Frequency Range	Open/Short Model
SMA (f)	25S50	DC to 26.5 GHz	22KF50
SMA (m)	25SF50	DC to 26.5 GHz	22K50
3.5 mm (f)	25LF50	DC to 30 GHz	22K50
K (f)	25K50	DC to 40 GHz	22KF50
K (m)	25KF50	DC to 40 GHz	22K50
SMA (f), SMA (m) K (f), K (m)	25SK50 (Set of Four)	DC to 26.5 GHz DC to 40 GHz	22KF50 22K50

Millimeter Wave Reflectometers

Millimeter Wave Measurement Systems

The Anritsu Millimeter Wave Reflectometers are designed to operate with the 54100A and 56100A Scalar Measurement Systems. The system source must cover at least to 20 GHz to operate the millimeter wave reflectometers. The millimeter wave multiplier includes subharmonic filters and an isolator, to dramatically improve reflection accuracy.

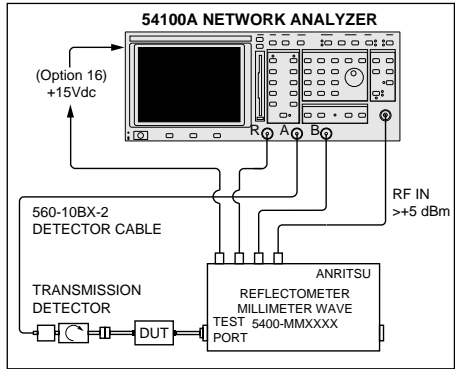
Excellent multiplier source match provided by the internal isolators and the improved detector return loss allow accurate, simultaneous return loss and transmission measurements.

110 GHz Reflectometers

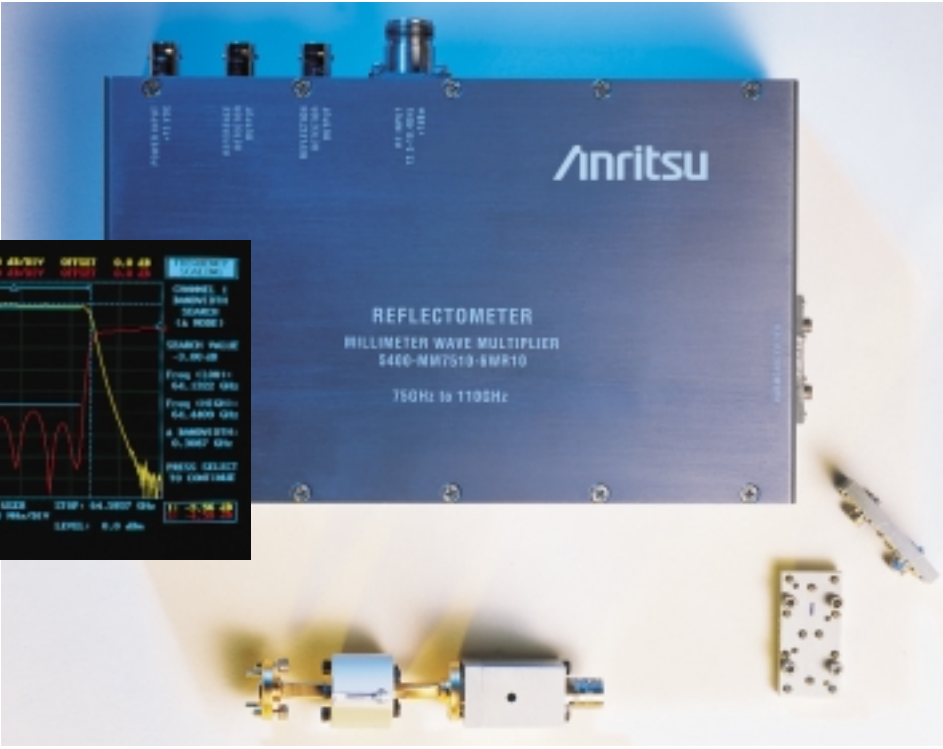
54000 Series Millimeter extensions with ultra-low -55 dBc harmonics and > 40 dB typical directivity provide precision measurements in waveguide to > 110 GHz. The multiplier based reflectometers compact a bench full of waveguide test components into a single, rugged package.

Manufacturing and engineering benefit from the high accuracy and low cost of Anritsu's millimeter wave measurement systems. The multiplier based design offers low source harmonics, high reliability, rugged construction, small size, and fast setup.

The Reflectometers integrate amplifiers, multipliers, isolation, filters, couplers, detector, and detector matching circuits in one small package. High quality detectors maximize two port transmission measurement accuracy.



Special Waveguide Reflectometers Reflectometers have integrated multipliers/amplifiers. Input frequency is < 20 GHz					
Model	Frequency Range	Directivity	Test Port		Input Connector
			Return Loss	Flange	
54000-6WR15	50 to 75 GHz	35 dB, 40 dB typ.	< 1.9 dB (< 1.7 typ.)	WR-15	N (f)
54000-6WR10	75 to 110 GHz	35 dB, 40 dB typ.	< 1.9 dB (< 1.7 typ.)	WR-10	N (f)
Millimeter Wave Detectors					
Model	Frequency Range	Directivity	Input Port		Input Connector
			Return Loss	Flange	
54000-7WR15	50 to 75 GHz	> 56 dB typ.	17 dB	WR-15	BNC (f)
54000-7WR10	75 to 110 GHz	> 56 dB typ.	17 dB	WR-10	BNC (f)



High Performance, Low Pricing – Anritsu's V-band and W-band Reflectometers are designed to operate with the 54147A Scalar Measurement System. Test port match is excellent and source harmonics are better than -55dBc.

Reflection Accuracy Characteristics

**Source Match:** < 1.9 (< 1.7 Typical)  
**Directivity:** 35 dB (> 40 dB Typical)  
**Dynamic Range:** > 56 dB  
**Channel Accuracy:** Channel Accuracy is degraded by ± 0.4 dB from standard 54100A specifications  
**Output Power, Minimum:** Levelled or Uneveled  
**V-band:** 0.0 dBm min. (+ 4.0 dBm Typ.)  
**W-band:** -5.0 dBm min. (+1.0 dBm Typ.)  
**Power Flatness, Uneveled:** ± 3.0 dB Typ.  
**Required Input Frequency:**  
**V-band:** 12.75 to 18.75 GHz  
**W-band:** 12.75 GHz to 18.33 GHz  
**Required Input Harmonics:** < -60 dBc  
**Spurious Signals:**  
**Harmonic:** < -55 dBc (< -60 dBc Typical)  
**Nonharmonic:** < -55 dBc (< -60 dBc Typical)  
**Frequency Accuracy:** Source Dependent  
**Frequency Resolution:** Source Dependent

Millimeter Reflectometer Accessories

**12"N(m) to N(m) RF input cable:**PN: N120-12  
**Precision Attenuators:** 1.08:1.0 SWR  
Precision loads and attenuators allow low insertion loss devices such as couplers and waveguide sections to be accurately tested.  
**V band** 3 dB: SM4784; 6 dB, SM4786  
**W band** 3 dB: SM4785; 6 dB, SM4787  
**Precision Loads:** 1.06: 1.0 SWR  
**V band,** SM4782  
**W band,** SM4783  
**DC Power Connections:**  
SM4819 Twinax (m) - Twinax (m) cable  
SM4816 Twinax to Dual Banana Plug  
SM4818 Twinax to Dual EZ Hooks  
**Physical Characteristics**  
**Size:** 9.5 x 4.5 x 1.5 inches  
**Millimeter Wave Detectors**  
**Maximum Input Power, Damage Level:** +21 dBm  
**Return Loss:** 17 dB

System Measurement Accuracy



Errors due to source harmonics are most evident when testing wide band filters. As the source's fundamental frequency passes 2 GHz, the -33 dBc second harmonic is at 4 GHz – within the pass band of the wideband filter.



The Return Loss measurement of a low pass filter is grossly distorted when high harmonics are present. When the source's fundamental frequency passes 2 GHz, the second harmonic (at 4 GHz) enters the lowpass filter's reject band; thus, 100% of the second harmonic power is reflected back toward the source. Thus, the reflected harmonic power is measured and then erroneously displayed as the return loss characteristic between 2 and 4 GHz.



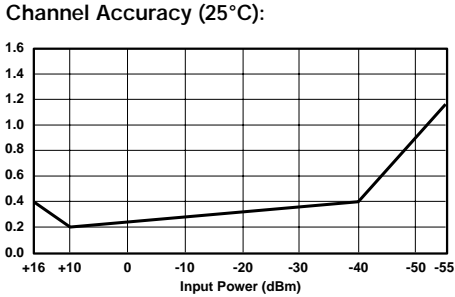
The Return Loss measurements (above) were created by the same bandpass filter. Measurement was performed with and without a test port adapter. Differences in the ripple display are caused by the vector error signal of the adapter's SWR reflection, which alternately adds and subtracts from the true return loss magnitude.

For a typical test system the most common causes of measurement uncertainty are:

- Excessive source harmonics
- Poor effective directivity due to test port adapters
- Poor quality test components

**Transmission Loss or Gain Measurement**  
Uncertainties from the frequency response of components are automatically subtracted from test data during the path calibration procedure. Overall accuracy is then:

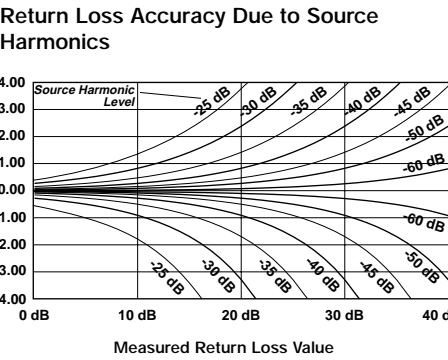
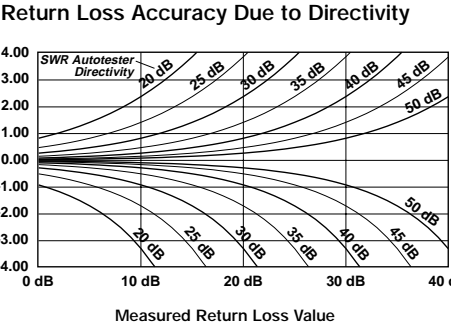
**Channel Accuracy**  
**+ Mismatch Uncertainty**  
**+ Distortion From Source Harmonics**  
**Transmission Measurement Accuracy**  
Effects of source, test device, SWR Autotester, and detector mismatch can be significant. This mismatch uncertainty is minimized by the exceptionally low reflection characteristics of Anritsu's detectors, sources, and SWR Autotesters. Anritsu's ultra low source harmonics maximize the accuracy of measurements on filters, receivers, mixers, and amplifiers.



**Return Loss Measurement Accuracy**  
Uncertainties resulting from SWR Autotester and source frequency response and from system open and short characteristics are subtracted automatically from test data. Overall accuracy is then:

**Channel Accuracy**  
**+ Autotester Accuracy**  
**+ Distortion From Source Harmonics**  
**Return Loss Measurement Accuracy**

Autotester accuracy is composed of error due to directivity and error due to test port match. Unless the DUT has very poor return loss (high SWR), directivity will be largest source of error. When an adapter is used at the test port, use Effective Directivity to determine possible errors. Note: Return loss errors due to source harmonics will be significant when the harmonic level is within 10 dB of the DUT's measured return loss.



This chart assumes full reflections of a single source harmonic at the DUT input. Multiple harmonics can cause additional measurement uncertainty. Source harmonics are a significant source of return loss measurement uncertainty when testing banded devices such as filters, receivers, transmitters, power amplifiers, and antennas.

SWR Autotester Accuracy, Microwave:

Model	SWR Autotester Error Terms		
	10 MHz to 8 GHz	8 GHz to 18 GHz	18 GHz to 26.5 GHz
560-97A50	0.016 ± 0.06Γ <sup>2</sup>	0.016 ± 0.10Γ <sup>2</sup>	N/A
560-97A50-1	0.016 ± 0.06Γ <sup>2</sup>	0.010 ± 0.10Γ <sup>2</sup>	N/A
560-97N50	0.018 ± 0.08Γ <sup>2</sup>	0.018 ± 0.12Γ <sup>2</sup>	N/A
560-97N50-1	0.013 ± 0.08Γ <sup>2</sup>	0.013 ± 0.12Γ <sup>2</sup>	N/A
560-97NF50	0.018 ± 0.08Γ <sup>2</sup>	0.018 ± 0.12Γ <sup>2</sup>	N/A
560-97NF50-1	0.013 ± 0.08Γ <sup>2</sup>	0.013 ± 0.12Γ <sup>2</sup>	N/A
560-98S50	0.014 ± 0.07Γ <sup>2</sup>	0.014 ± 0.10Γ <sup>2</sup>	0.016 ± 0.12Γ <sup>2</sup>
560-98S50-1	0.010 ± 0.07Γ <sup>2</sup>	0.010 ± 0.10Γ <sup>2</sup>	0.013 ± 0.12Γ <sup>2</sup>
560-98SF50	0.014 ± 0.07Γ <sup>2</sup>	0.014 ± 0.10Γ <sup>2</sup>	0.016 ± 0.12Γ <sup>2</sup>
560-98SF50-1	0.010 ± 0.07Γ <sup>2</sup>	0.010 ± 0.10Γ <sup>2</sup>	0.013 ± 0.12Γ <sup>2</sup>
560-98K50	0.018 ± 0.07Γ <sup>2</sup>	0.018 ± 0.12Γ <sup>2</sup>	0.025 ± 0.13Γ <sup>2</sup>
560-98K50-1	0.018 ± 0.07Γ <sup>2</sup>	0.018 ± 0.12Γ <sup>2</sup>	0.025 ± 0.13Γ <sup>2</sup>

Accuracy of Measured Reflection Coefficient (Γ) depends upon autotester directivity, test port reflection, output source SWR, and the SWR Autotester's insertion loss. The SWR Autotester Accuracy tables identify directivity (first term) and test port reflection (second term) return loss accuracy contributions.



## NETWORK ANALYZER 54100A series 1 MHz to 110 GHz



CE GPIB

3

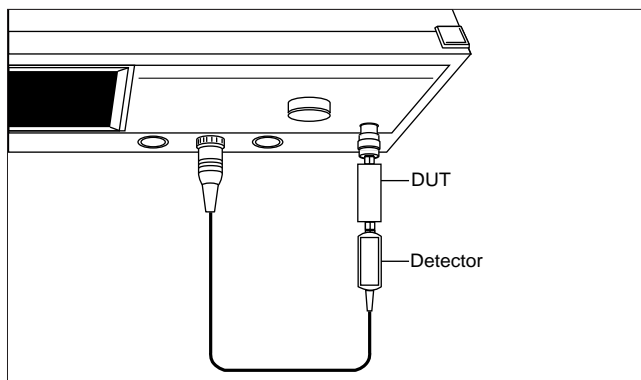
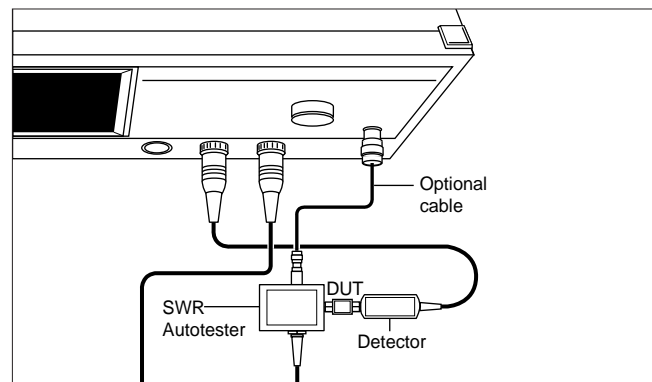
54100A series Network Analyzers provide characterization of devices such as amplifiers, antennas, attenuators, adapters, RF bridges, duplexers, couplers, attenuators, cables, waveguide transmission lines, isolators, circulators, mixers, receivers, transceivers, up/down converters, multiplexers, power dividers, VCOs, switches, and filters. Advanced hardware and software features speed productivity and improve accuracy. Speed tuning processes with automated bandwidth search functions. Fast recall mode quickly steps through test procedures and sophisticated limit line controls quickly identify conformance to specifications. Low source harmonics and high directivity SWR autotesters assure accuracy.

### Features

- Fast, accurate measurement of transmission, return loss, precision return loss, SWR, group delay, absolute power, and distance-to-fault
  - Crystal-based source for exceptional stability and accuracy
  - Built-in automation features including distance-to-fault
  - Built-in floppy disk drive
  - Rugged, reliable chassis
  - **Transmission gain (loss), group delay and power measurements**
- The basic configuration requires a single detector. For very low transmission loss devices (<0.25 dB), a second detector should be used to monitor any source power variations.

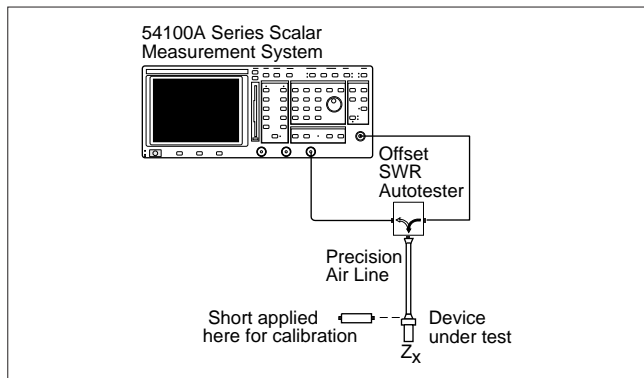
### • Transmission and return loss (or SWR)

Return loss or Standing Wave Ratio (SWR) measurements require a high directivity SWR autotester to separate the incident signal from the reflected signal from the device under test. The configuration below will simultaneously display transmission and return loss characteristics.



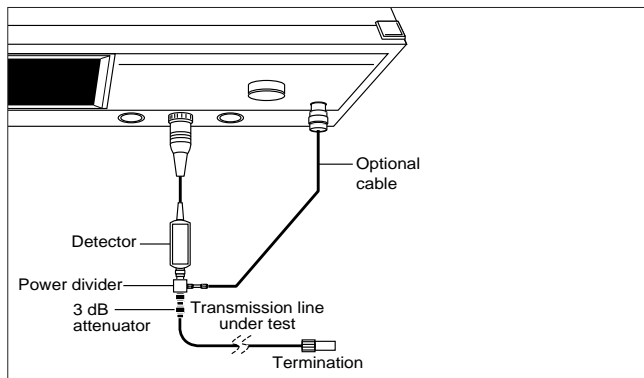
## • Adapters, attenuators, terminations, couplers, RF bridges

The 54100A series precision return loss mode measures high return loss devices accurately traceable to NIST. The measurement system uses an offset SWR autotester and a precision airline - a physical impedance standard. Additionally, by exchanging the offset SWR autotester with a 20 dB offset termination, the directivity of couplers and RF bridges is displayed directly on the 54100A.



## Distance-to-fault

The 54100A's optional distance-to-fault software accurately verifies transmission line and antenna system performance during installation, link/site commissioning, and at regular maintenance intervals. Transmission lines are typically the most common failure point in an antenna system. Finding the problem connectors, cables and antennas before a complete failure saves down-time, and expense. Faulty antenna systems and transmission lines are easily diagnosed. A wide variety of coaxial and waveguide types are supported with standard catalog components.



## Common causes of antenna feed problems

### • Cable and waveguide problems

- Cable discontinuities
- Moisture
- Braid wire ground shield fault (appears as a notch filter)
- Damaged/cut ground shields
- Dielectric fault or narrowed dielectric diameter
- Fasteners pinch cables

### • Connector problems

- Corroded connectors
- Low quality connectors
- Connector pin offset (poor mating contact)

### • Antenna problems

- Antenna out of specification
- Antenna storm/shipping damage

## Performance

### • Preventing “ghost” faults

The 54100A uses a low harmonic source and high performance anti-aliasing software to prevent the display of false or “ghost” transmission line faults. This is a common problem when the end of the DUT is unterminated or damaged.

Anritsu's precision components and low harmonic sources prevent “ghost” faults, assuring accurate, repeatable results.

### • High dynamic range

The 54100A distance-to-fault software optimizes sensitivity and accuracy. For example, a precision termination is used during calibration to achieve industry leading dynamic range. If the termination is not of high quality, it will reflect some of the source energy rather than absorb it –causing errors in the measurement process.

The use of a specialized discrete fourier transform rather than a more common fast fourier transform also improves low level sensitivity. Low source harmonics also ensure that fault indications are actual transmission line not re-reflections of source harmonic energy.

## Relative group delay

Optional relative group delay software identifies signal distortion caused by bandpass devices such as filters, receivers, power amplifiers, and up/down converters. Group delay is a key cause of high Bit Error Rate (BER). Group delay is important for 1) CDMA and spread spectrum communications 2) phase array radars 3) high capacity satellite and terrestrial microwave links, 4) PAL and HDTV television components and other RF systems sensitive to phase distortion.

The 54100A saves time and expense by eliminating several pieces of expensive test equipment – combining the capabilities into a single, low cost test station. Manufacturing processes save re-test/re-tuning time by utilizing a single 54100A instead of two separate tuning stations – one for scalar transmission and return loss and the other for relative phase group delay. Furthermore, the 54100A can accurately test frequency conversion devices without the wideband reference converters required with vector network analyzers or microwave system analyzers.

## Convertible SWR autotester

Convertible SWR autotesters reduce capital equipment and maintenance costs. A single convertible SWR autotester accurately measures the return loss or SWR of devices with SMA, 3.5 mm, or K connectors. Six interchangeable test port heads (male and female for each connector standard) are precision tuned to the convertible SWR autotester's internal bridge circuit.



**The 560-98C50 Convertible SWR Autotester improves test accuracy and reduces maintenance cost without using error prone test port adapters or connector savers.**

The inexpensive test port heads save repair and calibration costs because they are interchangeable.



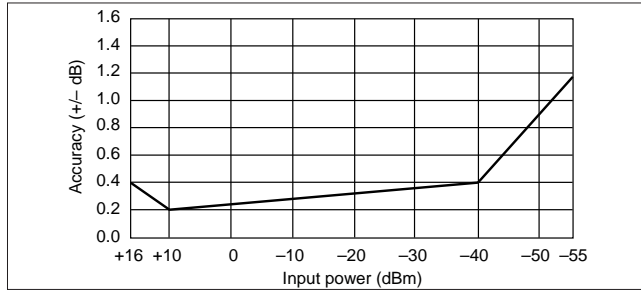
## Measurement accuracy

### • Transmission loss or gain measurement accuracy

Uncertainties from the frequency response of components are automatically subtracted from test data during the path calibration procedure. Overall accuracy is then:

$$\begin{aligned} &\text{Channel accuracy} \\ &+ \text{Mismatch uncertainty} \\ &+ \text{Distortion from source harmonics} \\ &\text{Transmission measurement accuracy} \end{aligned}$$

Effects of source, test device, SWR autotester, and detector mismatch can be significant. This mismatch uncertainty is minimized by the exceptionally low reflection characteristics of Anritsu's detectors, sources, and SWR autotesters. Anritsu's ultra low source harmonics maximize the accuracy.



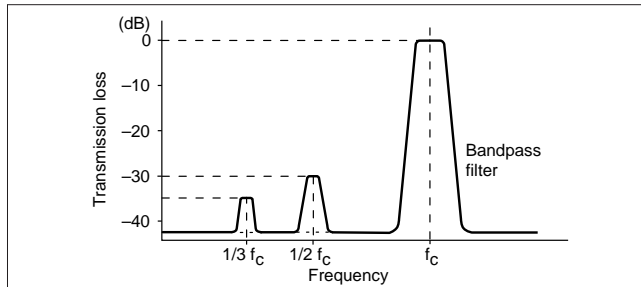
Channel accuracy (25°C)

### • Distortion from source harmonics

Poor source harmonics cause large measurement errors. If the sweep range is set wide enough, at some point during the sweep, the harmonic will pass through the filter's pass band. Since the transmission detector is a broadband diode, the harmonic's signal power is measured. Thus, the analyzer displays the response of the harmonic in addition to the fundamental sweep frequency.

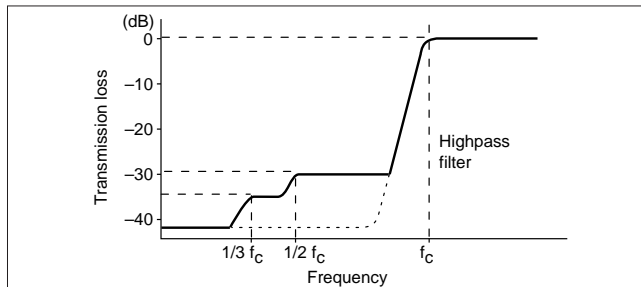
### • Bandpass filter, distortion from source harmonics

If the source has a -30 dBc second harmonic and a -35 dBc third harmonic, at the beginning of the sweep, the harmonics pass through the filter's passband.



### • Highpass filter, distortion from source harmonics

A highpass (or wide bandpass) filter responds similarly to the bandpass filter, except the presence of the harmonic in the filter's pass band limits the useful dynamic range of the analyzer.



## Return loss measurement accuracy

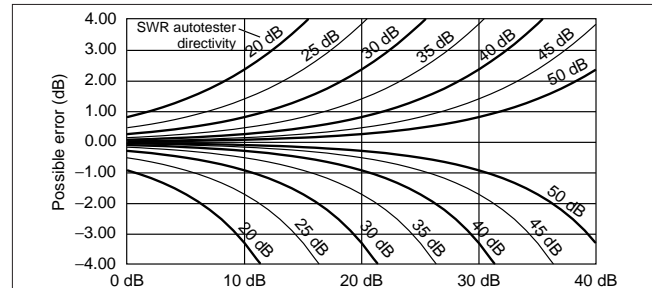
Uncertainties resulting from SWR autotester and source frequency response and from system open and short characteristics are subtracted automatically from test data. Overall accuracy is then:

$$\begin{aligned} &\text{Channel accuracy} \\ &+ \text{Autotester accuracy} \\ &+ \text{Distortion from source harmonics} \\ &\text{Return loss measurement accuracy} \end{aligned}$$

Autotester accuracy is composed of error due to directivity and error due to test port match. Unless the DUT has very poor return loss (high SWR), test port match will be negligible. When an adapter is used at the test port, use effective directivity to determine possible errors.

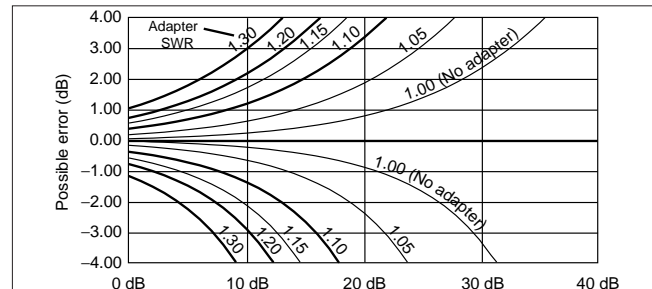
### • Return loss accuracy due to directivity

Improved directivity decreases SWR (or return loss) measurement errors. The chart below identifies maximum error due to directivity.



### • Return loss accuracy due to effective directivity

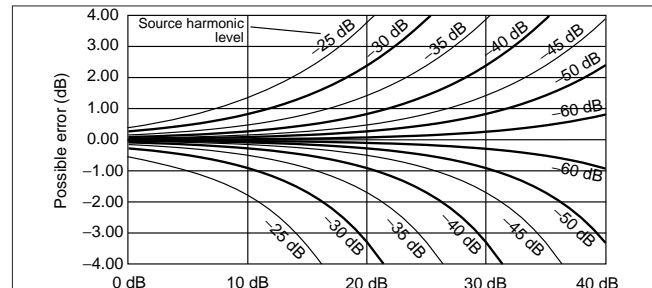
Effective directivity is the reduction to directivity due to a test port adapter's SWR performance. Adapters severely degrade measurement directivity. The chart below shows the maximum degradation to a 40 dB directivity SWR autotester caused by test port adapters of varying quality.



### • Return loss accuracy due to source harmonics

Source harmonics are a significant source of return loss measurement uncertainty when testing banded devices such as filters, receivers, transmitters, power amplifiers, and antennas.

In many cases, the harmonic errors are larger than uncertainty due to directivity, which is typically assumed to be the largest uncertainty factor.



This chart assumes full reflections of a single source harmonic at the DUT input. Multiple harmonics can cause additional measurement uncertainty.

## Specifications

Analyzer	Measurement modes	Transmission (dB), return loss (dB), SWR (linear SWR), optional group delay (ns), power (dBm) precision return loss (dB) and optional distance-to-fault
	Dynamic range	-55 to +16 dBm, autozeroing with DC detection
	Inputs	Three, two standard inputs, A and B, with optional third reference channel, R (Option 5)
	Display channels	Two channels are used to select and simultaneously display any two inputs from A, B, or R. The inputs can also be displayed as ratios A/R or B/R.
	Scale resolution	0.1 to 10 dB(m) per division in 0.1 dB steps
	Cursor functions	Searches for trace maximum, minimum, dB level, dB bandwidth, next marker and active marker
	Averaging	2, 4, 8, 16, 32, 64, 128, or 256
	Limit lines	Two limit lines, either single value or multi level segmented, for each trace. Segmented lines may be made from up to 10 individually editable segments.
	Auto-zero	Performs an AC modulation cycle and low level calibration during sweeper retrace
	Save/Recall	Thirteen sets of front panel set-ups and thirteen sets of trace memory can be stored in non-volatile instrument memory.
	Trace mask	A swept frequency measurement can be stored to a graticule trace mask for visual comparison to later measurements.
	Disk drive	Built-in 3.5 inch, 1.44 MB floppy disk drive
Source	Autosave	Automatically increments the trace data file name and reference number during successive data storage operations to the DOS disk
	Frequency range	1 MHz to 110 GHz, model dependent
	Alternate sweep	Sweeps alternately between frequency ranges set differently for channel 1 and channel 2
	CW	Provides single frequency output (both channels turned off)
	Frequency resolution	RF Models (54107A, 54109A, 54111A): 10 kHz, Microwave models: 100 kHz
	Output power	Maximum guaranteed levelled output power is model dependent.
Application function	Reverse power protection	Up to 5 Watts. Limited to 1 Watt with attenuator option
	Min/Max hold	Save the minimum and maximum values of successive sweeps or the combination of the two
	Cursor functions	Automatic cursor search updates the bandwidth, minimum, or maximum levels of the displayed trace.
	Compression test automation	Determines the gain compression point over the operating frequency range of an amplifier by successively incrementing the source power and measuring the amount of compression until a preset "X" dB limit is exceeded.
	Self test	Performs a self test every time power is applied or when SELF TEST pushbutton is pressed. If an error is detected, a diagnostic code appears, identifying the cause and location of the error.
General	Operating temperature	0° to +50°C
	Power	115 V $\pm 10\%$ , 230 V $\pm 10\%$ , 48 to 400 Hz, 300 VA
	Mass	18 kg (39 lb.)
	Printer	Parallel printer interface is compatible with the Canon BJ30, BJ200e, and most Epson FX-compatible printers.
	Transit case	Hard shell case with custom foam inserts, PN: 760-183
	EMC	Meets European community requirements for CE marking

## Ordering information

Please specify model/order number, name and quantity when ordering.

Model/Order No.	Name
	<b>Main frame</b>
54107A	Scalar Measurement System (0.001 to 1.5 GHz)
54109A	Scalar Measurement System (0.001 to 2.2 GHz)
54111A	Scalar Measurement System (0.001 to 3.0 GHz)
54117A	Scalar Measurement System (0.01 to 8.6 GHz)
54119A	Scalar Measurement System (2 to 8.6 GHz)
54128A	Scalar Measurement System (8 to 12.4 GHz)
54130A	Scalar Measurement System (12.4 to 20 GHz)
54131A	Scalar Measurement System (10 to 16 GHz)
54136A	Scalar Measurement System (17 to 26.5 GHz)
54137A	Scalar Measurement System (2 to 20 GHz)
54147A	Scalar Measurement System (0.01 to 20 GHz)
54154A	Scalar Measurement System (2 to 32 GHz)
54161A	Scalar Measurement System (2 to 40 GHz)
54163A	Scalar Measurement System (0.01 to 32 GHz)
54169A	Scalar Measurement System (0.01 to 40 GHz)
54177A	Scalar Measurement System (0.01 to 50 GHz)

Model/Order No.	Name
	<b>Options</b>
Option 1	Rack mounting with slides
Option 2	70 dB RF step attenuator
Option 2A	70 dB, 20 GHz MW step attenuator
Option 2B	70 dB, 26.5 GHz MW step attenuator
Option 2C	70 dB, 40 GHz MW step attenuator
Option 2D	70 dB, 50 GHz MW step attenuator
Option 4	75 $\Omega$ source output (available to 3.0 GHz)
Option 5	Add reference channel
Option 6	Add external levelling
Option 7	Internal distance-to-fault software
Option 8	Internal relative group delay software
Option 12	Add front panel cover
Option 13	Add front mounted handles
Option 16	+15 V DC supply for millimeter wave source modules (available with <20 GHz models only)
Option 25	Maintenance manual
Option 26	Extra operation and GPIB programming manual
Option 33	Canon printer