PLANAR R140

Vector Reflectometer

COPPER MOUNTAIN
TECHNOLOGIES

KEY FEATURES

- Frequency range: 85 MHz – 14 GHz
- Reflection coefficient magnitude and phase, cable loss, DTF
- Transmission coefficient magnitude when using two reflectometers
- Dynamic range from 85 MHz to 4.8 GHz - 105 dB, typ.
- Dynamic range from 4.8 GHz to 14 GHz - 74 dB, typ.
- Measurement time per point: 200 µs
- Frequency setting resolution 25 Hz
- Time domain with gating standard
- Powered and operated via USB interface
- No test cable needed

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Real Performance, Real Value.

Advanced

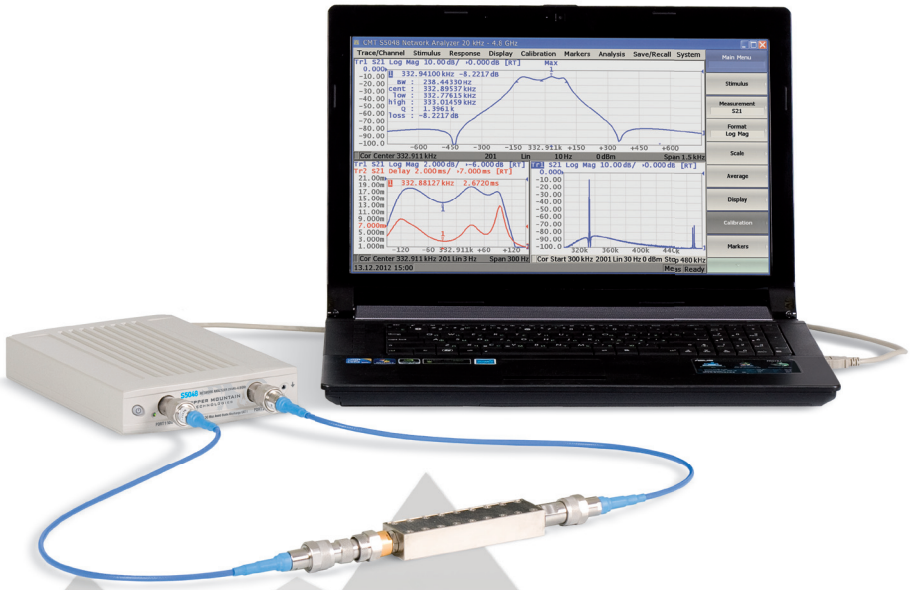
CMT analyzers take advantage of breakthrough advances in RF technology as well as the faster processing power, larger display, and more reliable performance of an external PC, while also simplifying maintenance of the analyzer.

Accurate

Our VNAs are made with high standards. Every instrument is lab-grade quality, with a low noise floor, high resolution sweep, and a variety of other advanced features. The metrology of the Planar R140 delivers real measurement accuracy and reliability.

Cost Effective

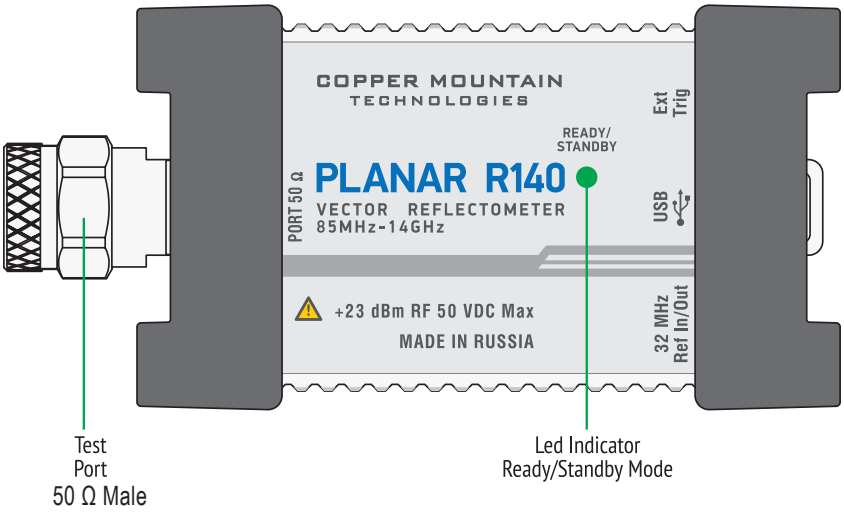
CMT VNAs are flexible, easy to maintain, and are well-suited for lab, production, field, and secure testing environments. With every bit of performance of traditional analyzers, but at a fraction of the cost, now every engineer and technician can have a highly accurate VNA.

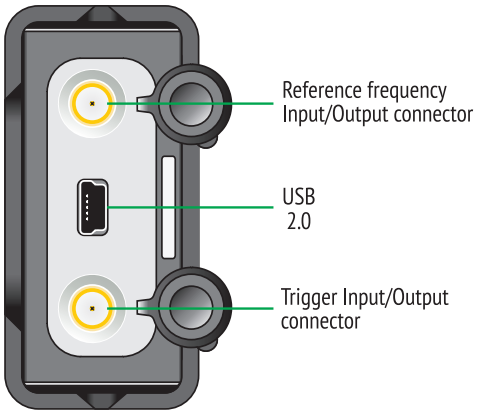


Planar R140 is a PC-driven vector reflectometer that operates in the frequency range from 85 MHz to 14 GHz. It is designed for use in the process of development, production, and field testing of various electronic devices in multiple environments, including operation as a component of an automated measurement system.

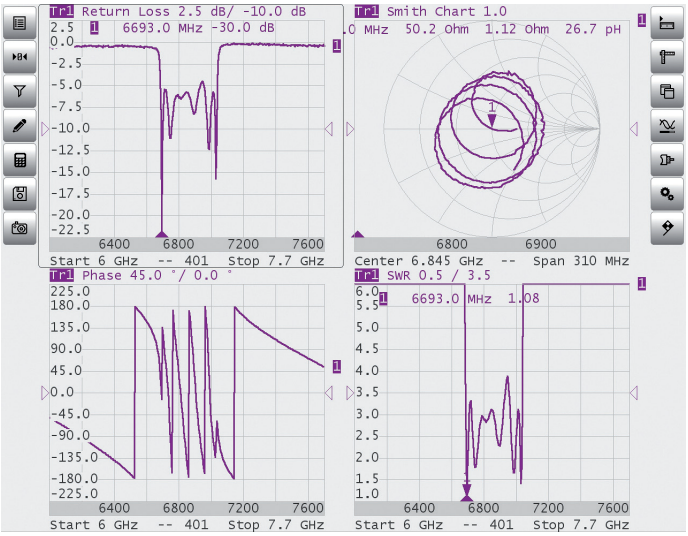
Planar R140 connects directly to the DUT without the use of a test cable, so there is higher calibration stability in the test setup and the cost of accessory replacement is significantly decreased. The device works with software on an external PC and is powered and operated by a USB interface.

This reflectometer is unique for its ultra compact dimensions. At just 10.6 oz, it is easily transported between workstations or used in applications requiring mobility. Planar R140 presents an excellent value solution for engineers and technicians: while it performs with the accuracy of a benchtop unit, it is equally well suited to field use or mass production environments.





Measurement Capabilities



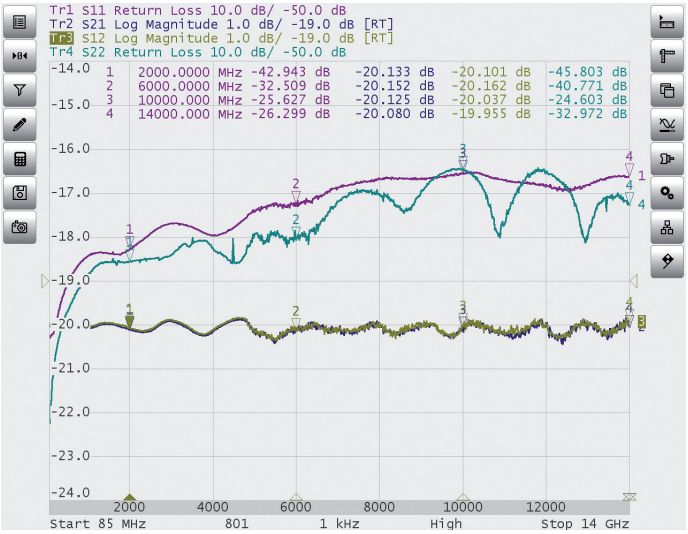
Measured parameters

S_{11}, cable loss

S_{11}, $|S_{21}|$, $|S_{12}|$, S_{22} - using two Reflectometers.

Number of measurement channels

Up to 4 independent logical channels. Each logical channel is represented on the screen as an individual channel window. A logical channel is defined by such stimulus signal settings as frequency range, number of test points, etc.

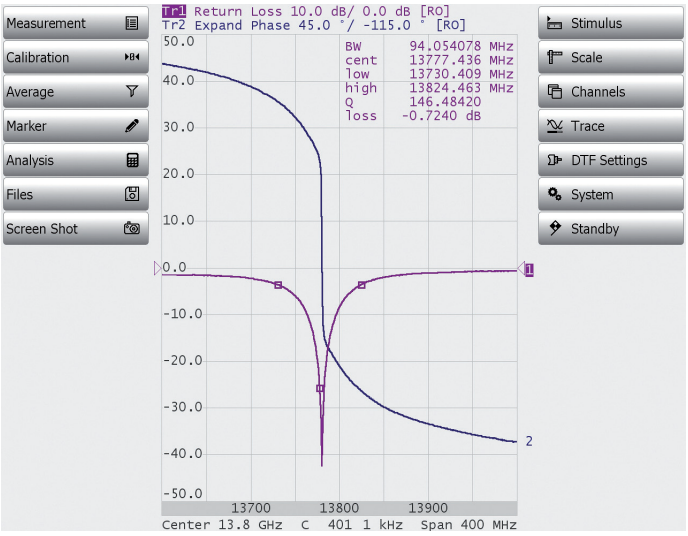


Data traces

Up to 4 data traces can be displayed in each channel window. A data trace represents one parameter of the DUT such as magnitude and phase of S_{11}, DTF, cable loss.

Memory traces

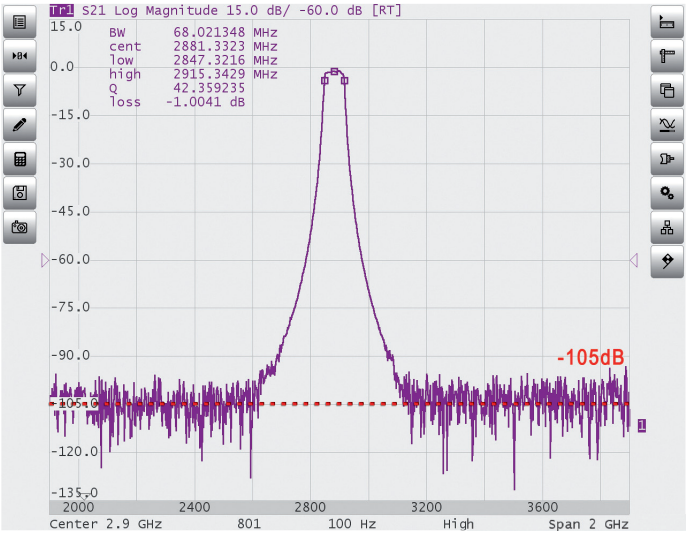
Each of the 4 data traces can be saved into memory for further comparison with the current values.



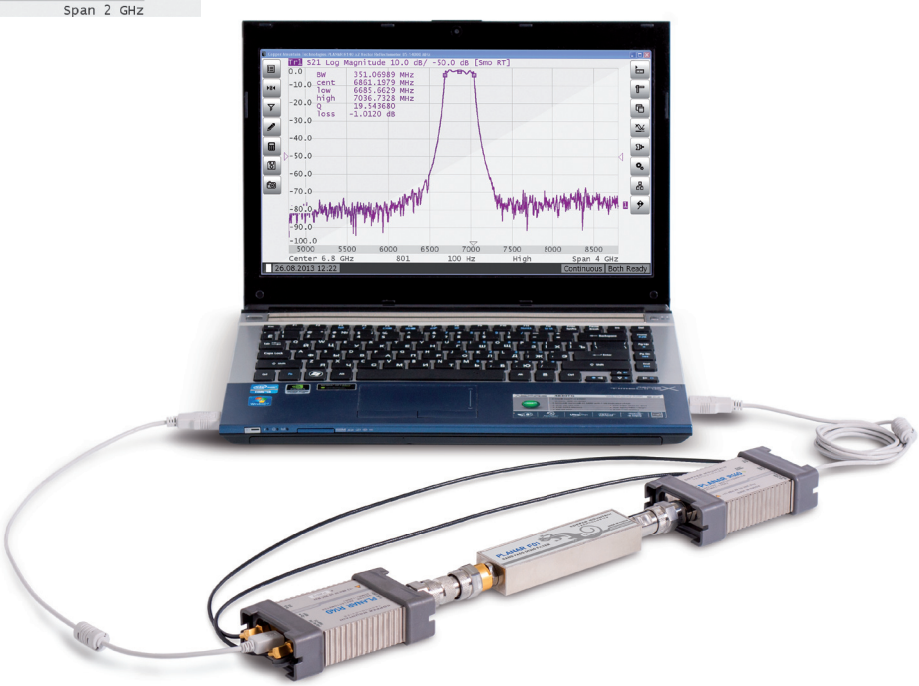
Data display formats

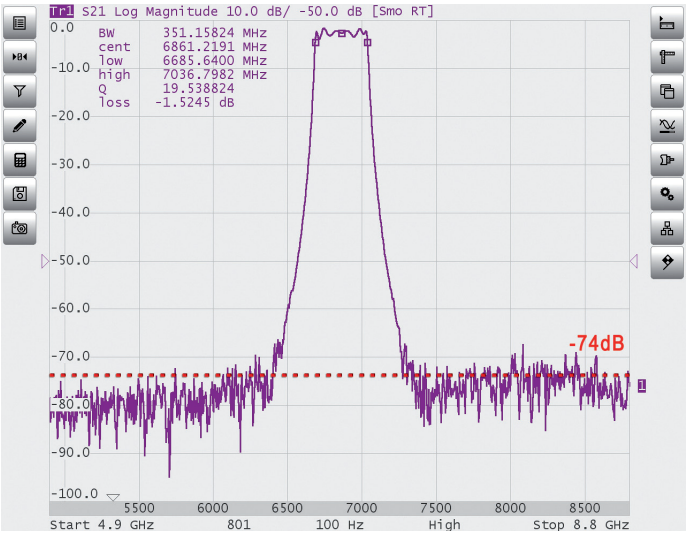
SWR, Return loss, Cable loss, Phase, Expand phase, Smith chart diagram, DTF SWR, DTF return loss, Group delay, Lin Magnitude.

Dynamic Range



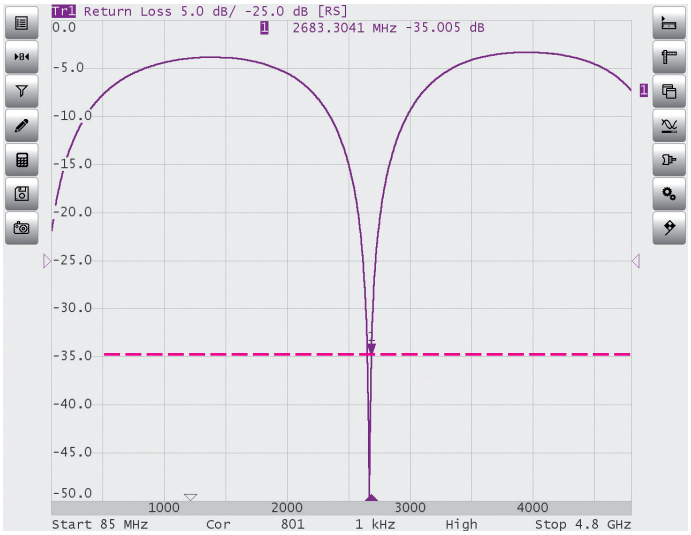
Typical dynamic range of measurement $|S_{21}|$ using two reflectometers is 105 dB in the frequency range 85 MHz - 4.8 GHz (100 Hz IF bandwidth)





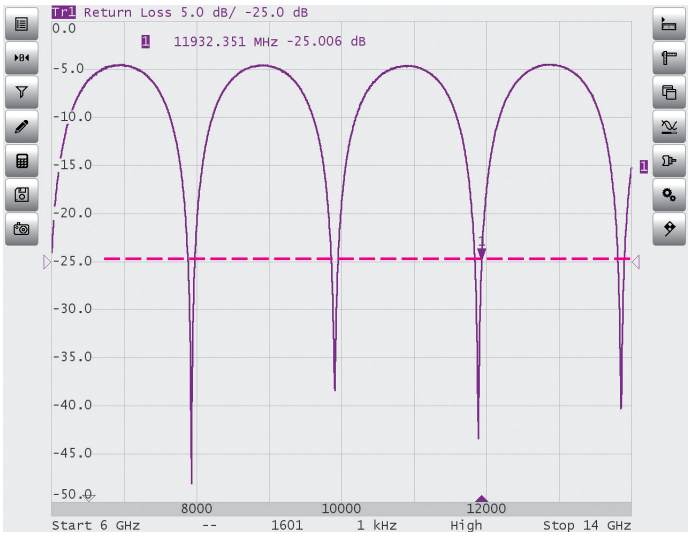
Typical dynamic range of measurement $|S_{21}|$ using two reflectometers is 74 dB in the frequency range 4.8 GHz - 14 GHz (100 Hz IF bandwidth).

Measurement Range



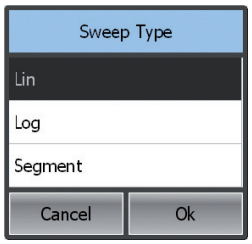
The return loss function measures the power lost in the reflection of the transmission. Planar R140 has a high accuracy and can measure return loss up to 35 dB in frequencies up to 4.8 GHz, and up to 25 dB in the frequency range 4.8 GHz to 14 GHz, which is a specification typical of benchtop instrumentation.

Testing in the frequency range up to 4.8 GHz, the return loss is shown at 35 dB



Testing in the frequency range 4.8 GHz to 14 GHz, the return loss is shown at 25 dB

Sweep Features



Sweep type
Linear frequency sweep, logarithmic frequency sweep, and segment frequency sweep.

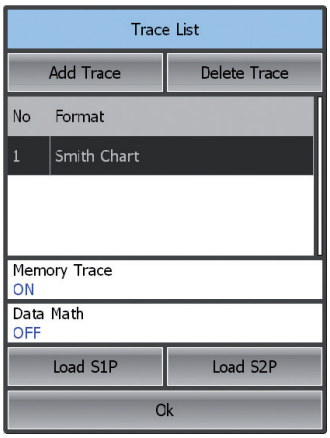
Measured points per sweep
Set by the user from 2 to 16,001.

Segment sweep features
A frequency sweep within several independent user-defined segments. Frequency range, number of sweep points and IF bandwidth should be set for each segment.

Output Power
High: -10 dBm and low: -30 dBm.

Sweep trigger
Trigger modes: continuous, single, or hold.
Trigger sources: internal, bus.

Trace Functions

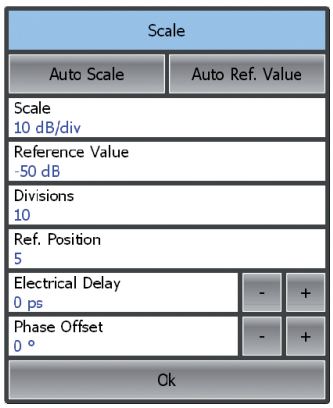


Trace display
Data trace, memory trace, or simultaneous indication of data and memory traces.

Trace math
Data trace modification by math operations: addition, subtraction, multiplication or division of measured complex values and memory data.

S-parameters display
The program allows to load into data memory Touchstone file(*.s1p and *.s2p).

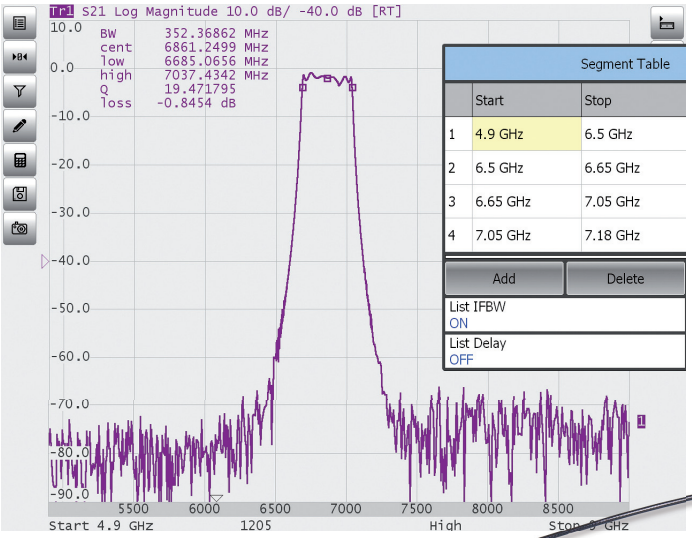
Autoscaling
Automatic selection of scale division and reference level value to have the trace most effectively displayed.



Electrical delay
Calibration plane moving to compensate for the delay in the test setup. Compensation for electrical delay in a DUT during measurements of deviation from linear phase.

Phase offset
Phase offset is defined in degrees.

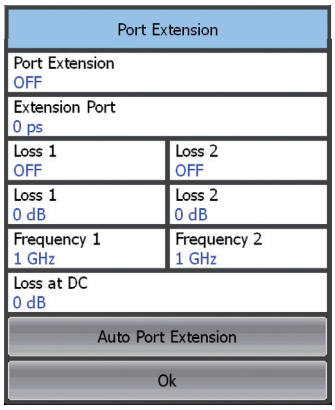
Frequency Scan Segmentation



Planar R140 has a large frequency range with the option of frequency scan segmentation. This allows the user an opportunity to use the reflectometer, for example, to realize the maximum dynamic range while maintaining high measurement speed.

Two reflectometers are shown with a demo filter as a 2-port network analyzer

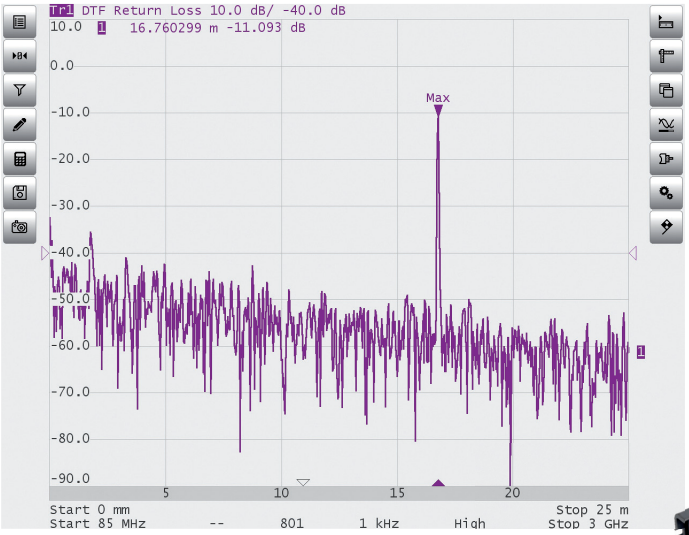
Port Extension



Port Extension is a feature that allows for moving the calibration reference plane of the port by specifying the electrical delay to the new reference plane position. Additionally, it is possible to account for loss in the extended port.

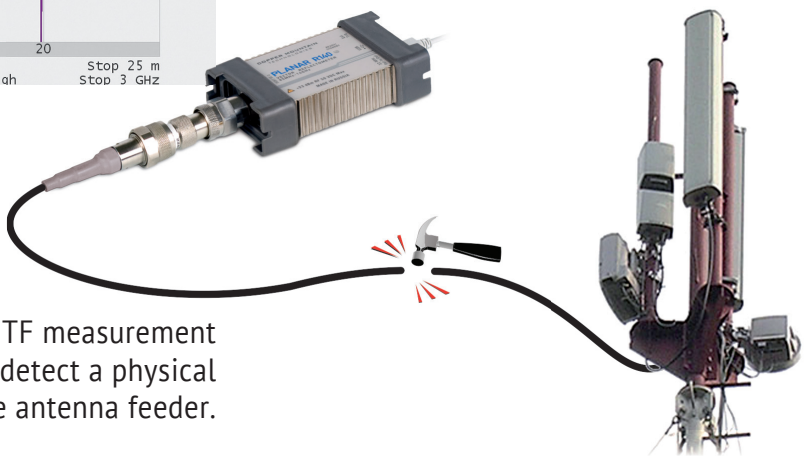
Automatic Port Extension is a feature that allows for automatic calculation of the electrical delay of the extended port and its loss by attaching an Open and/or a Short calibration standard at the new calibration reference plane position.

Time Domain Measurements

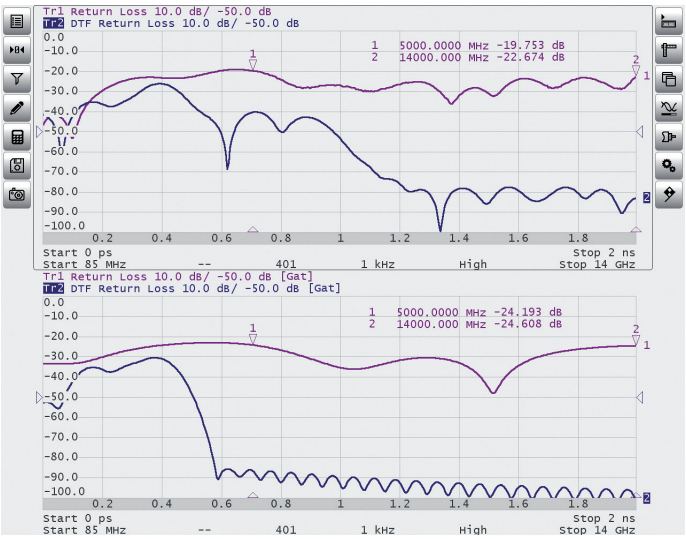


Distance to Fault (DTF)

DTF mode is enabled by selecting either the DTF SWR or DTF return loss format. The instrument will automatically transform measured data from the frequency domain to time domain, and then to distance based on the velocity of propagation. DTF easily finds fault points in cables or connectors. Distance resolution can be maximized by selecting a wide measurement frequency range. Likewise, the maximum measured distance is proportional to the number of stimulus points.



Here, built-in DTF measurement allows the user to detect a physical impairment in the antenna feeder.

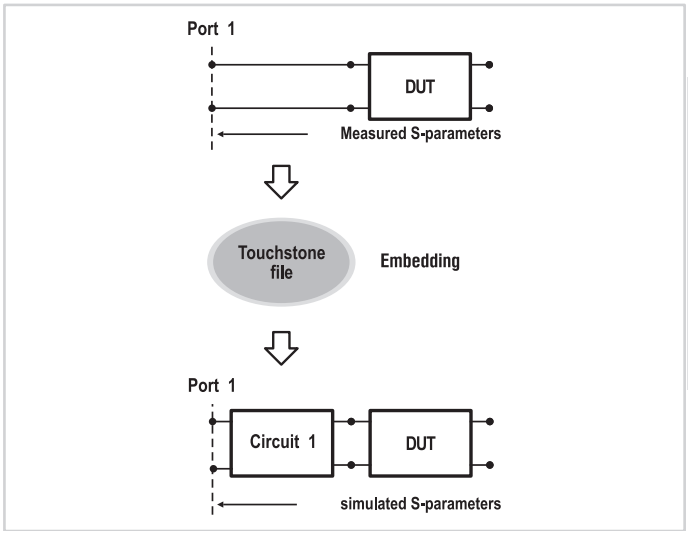


Gating

This function mathematically removes unwanted responses in the time domain, which allows the user to obtain frequency response without influence from the fixture elements. The function applies reverse transformation back to frequency domain after cutting out the user-defined span in time domain.

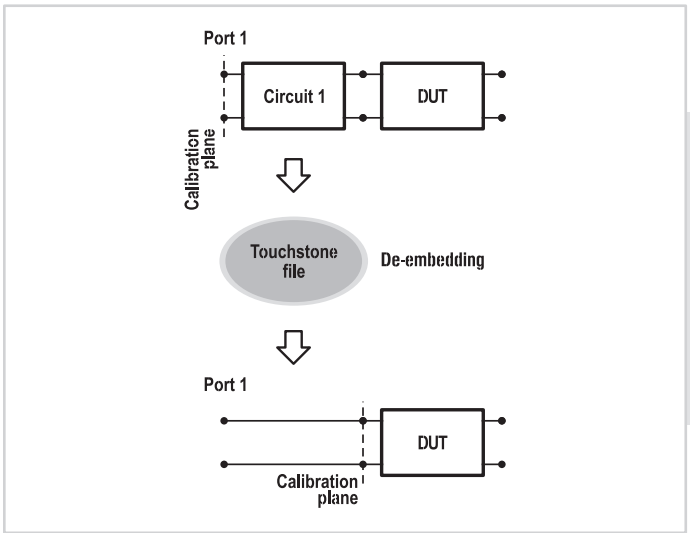
Gating filter types: bandpass or notch. For a better tradeoff between gate resolution and level of spurious sidelobes the following filter shapes are available: maximum, wide, normal and minimum.

Embedding



This function allows the user to mathematically simulate the DUT parameters after virtual integration of a fixture circuit between the calibration plane and the DUT. This circuit can be described by an S-parameter matrix in a Touchstone file.

De-Embedding



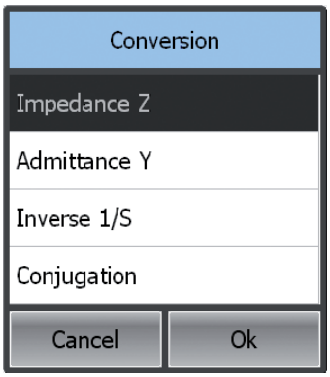
The function allows to mathematically exclude from the measurement result the effect of the fixture circuit connected between the calibration plane and the DUT. This circuit should be described by an S-parameter matrix in a Touchstone file.

Port Impedance Conversion

Port ZConversion OFF
Port Z0 50 Ohm

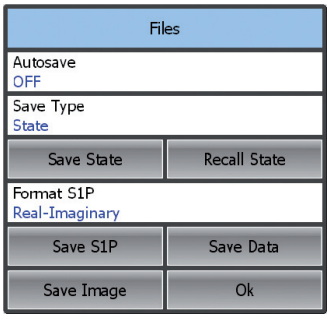
This is the function converts the S-parameters measured at 50 port into values, which could be determined if measured at a test port with arbitrary impedance.

S-Parameter Conversion



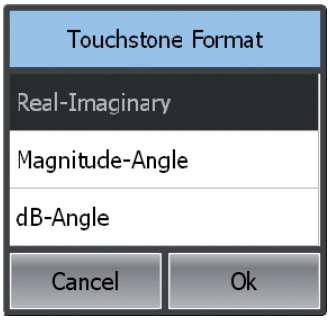
The function allows conversion of the measured S-parameters to the following parameters: reflection impedance and admittance, inverse S-parameters and conjugation.

Data Output



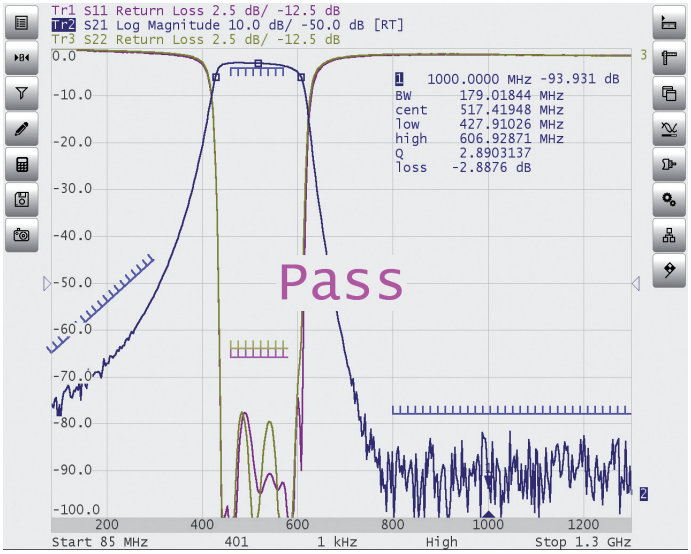
Analyzer State
All state, calibration and measurement data can be saved to an Analyzer state file on the hard disk and later uploaded back into the software program. The following four types of saving are available: State, State & Cal.

Trace Data CSV File
The VNA allows the user to save an individual trace data as a CSV file (comma separated values). The active trace stimulus and response values in the current format are saved to *.CSV file. Only one trace data are saved to the file.



Trace Data Touchstone File
Planar R140 allows the user to save S-parameters to a Touchstone file. The Touchstone file contains the frequency values and S-parameters. The files of this format are typical for most of circuit simulator programs. S_{11} parameters are saves using *.s1p files. Only one (active) trace data are saved to the file.

Limit Testing

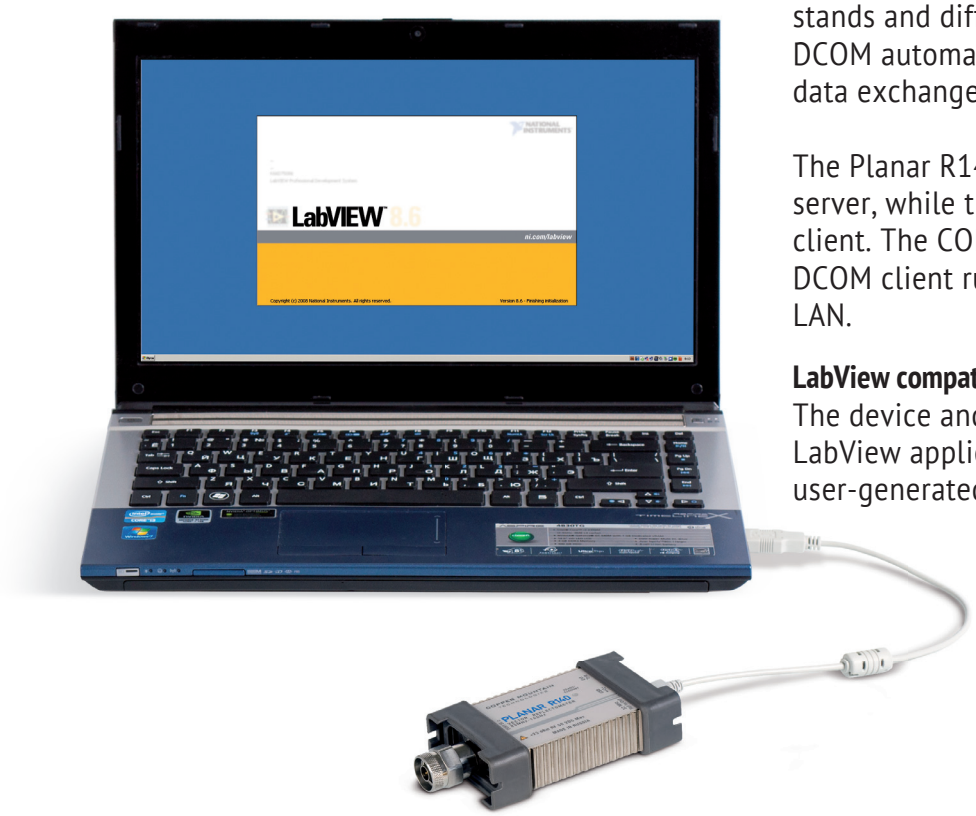


Setting Pass-Fail Tests

The limit test is a function of automatic pass/fail judgment for the trace of the measurement result. The judgment is based on the comparison of the trace to the limit line set by the user.

The limit line can consist of one or several segments. Each segment checks the measurement value for failing whether upper or lower limit. The limit line segment is defined by specifying the coordinates of the beginning (X0, Y0) and the end (X1, Y1) of the segment, and type of the limit. The MAX or MIN limit types check if the trace falls outside of the upper or lower limit, respectively.

Measurement Automation



COM/DCOM compatible

Planar R140 software is COM/DCOM compatible allowing the unit to be used as a part of measuring stands and different special applications. COM/DCOM automation is used for remote control and data exchange with the user software.

The Planar R140 program runs as a COM/DCOM server, while the user program runs as COM/DCOM client. The COM client runs on the VNA PC, and the DCOM client runs on a separate PC connected via LAN.

LabView compatible

The device and its software are fully compatible with LabView applications, for ultimate flexibility in user-generated programming and automation.

Accuracy Enhancement

Calibration

Calibration of a test setup (which includes the VNA, cables, and adapters) significantly increases the accuracy of measurements. Calibration allows for correction of the errors caused by imperfections in the measurement system: system directivity, source match and tracking.

Calibration methods

The following calibration methods of various sophistication and accuracy enhancement level are available:

- reflection normalization
- transmission normalization (when using two reflectometers)
- full one-port calibration

Reflection and transmission normalization

This is the simplest calibration method; however, it provides reasonably low accuracy compared to other methods.

Full one-port calibration

Method of calibration performed for one-port reflection measurements. It ensures high accuracy.

Mechanical Calibration Kits

The user can select one of the predefined calibration kits of various manufacturers or define a new calibration kit.

Electronic Calibration Modules

Electronic, or automatic, calibration modules offered by CMT make calibration faster and easier than traditional mechanical calibration.

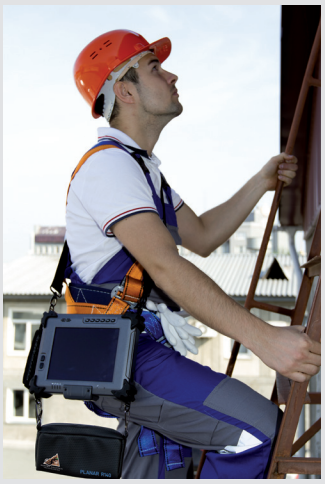
Defining of calibration standards

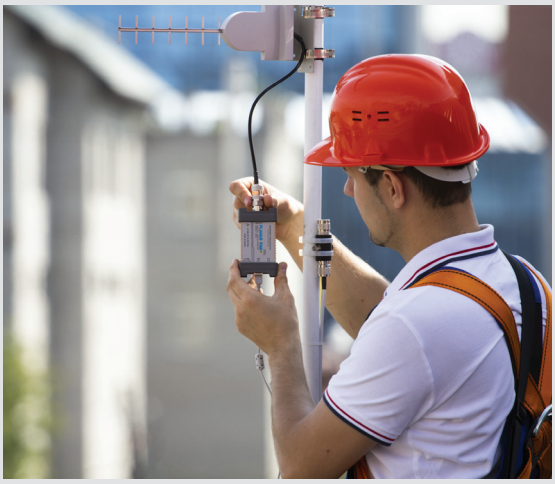
Different methods of calibration standard defining are available: standard definition by polynomial model standard definition by data (S-parameters)

Error correction interpolation

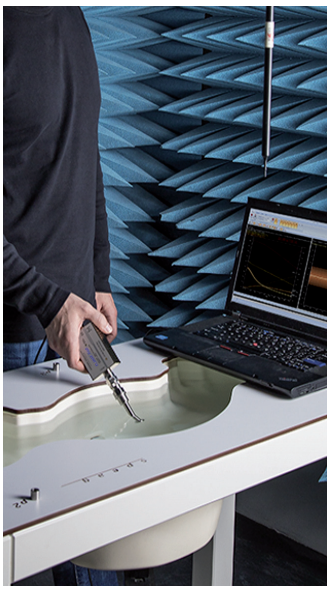
When the user changes any settings such as the start/stop frequencies or the number of sweep points, compared to the settings at the moment of calibration, interpolation or extrapolation of the calibration coefficients will be applied.

Applications





Antenna testing
Planar R54 easily fits into many field test applications. It can be used with a ruggedized laptop to perform critical measurements in the field, such as antenna feeder systems. Because no test cable is needed, calibration stability is higher in the test setup and the cost of accessory replacement is significantly decreased.



Materials Test
The Planar R140 allows the user perform measurement of material properties, such as dielectric constant and dielectric loss tangent. Its compact size and lack of test cables allowed SPEAG to use R140 with a probe to perform materials testing.

Other Applications
For more information on the uses of Planar R140, view the videos on our web site, www.coppermountaintech.com.

Technical Specifications

MEASUREMENT RANGE

Impedance	50 Ω (75 Ω connectors via adapters)	
Test port connector	N-type, male	
Number of test ports	1	
Frequency range	85 MHz to 14 GHz	
Full CW frequency accuracy	±2.5x10^{-6}	
Frequency setting resolution	From 85 MHz to 4.8 GHz: 10 Hz	
	From 4.8 GHz to 14 GHz: 25 Hz	
Number of measurement points	2 to 16,001	
Measurement bandwidths	100 Hz to 30 kHz (with 1/3 step)	
Cable loss measurement range	**From 85 MHz to 4.8 GHz**	**From 4.8 GHz to 14 GHz**
	35 dB	30 dB
Dynamic range of $\|S_{21}\|$ [1] (IF bandwidth 100 Hz)	107 dB, typ.	74 dB, typ.

MEASUREMENT ACCURACY

Accuracy of reflection measurements (magnitude / phase)[2]		
	From 85 MHz to 4.8 GHz	**From 4.8 GHz to 14 GHz**
-15 dB to 0 dB	0.4 dB / 4°	1.0 dB / 7°
-25 dB to -15 dB	1.5 dB / 7°	3.0 dB / 17°
-35 dB to -25 dB	4.0 dB / 22°	
Accuracy of transmission magnitude measurements[1]		
	From 85 MHz to 4.8 GHz	**From 4.8 GHz to 14 GHz**
-50 dB to 0 dB	1.0 dB	
-25 dB to 0 dB		1.0 dB
Trace stability		
Trace noise magnitude		
(high output power, IF bandwidth 1 kHz)	0.005 dB rms	0.050 dB rms
Temperature dependence		
(per one degree of temperature variation)	0.015 dB	0.030 dB

[1] Measurement of $|S_{21}|$ using two reflectometers, 32 MHz Ref Out, one of which is connected to 32 MHz Ref In of the other, both connected to the same USB hub. Applies over the temperature range 23°C ±5°C after 30 minutes of warming up, with less than 1°C deviation from the calibration temperature at high output power and 100 Hz IF bandwidth.

[2] Applies over the temperature range 23°C ±5°C after 30 minutes of warming up, with less than 1°C deviation from full one-port calibration temperature at high output power and 100 Hz IF bandwidth.

EFFECTIVE SYSTEM DATA

	From 85 MHz to 4.8 GHz	From 4.8 GHz to 14 GHz
Effective directivity	45 dB	36 dB
Effective source match	40 dB	30 dB

TEST PORT

Directivity (without system error correction)	15 dB	
Match (without system error correction)	15 dB	
Output power	**From 85 MHz to 4.8 GHz**	**From 4.8 GHz to 14 GHz**
High level	0 dBm, typ.	-10 dBm, typ.
Low level	-35 dBm, typ.	
Interference immunity	+17 dBm	
Damage level	+23 dBm	
Damage DC voltage	50 V	

MEASUREMENT SPEED

Measurement time per point	200 µs

GENERAL DATA

External reference frequency	32 MHz
Input level	2 dBm ± 2 dB
Input impedance at «32 MHz Ref» input	50 Ω
Connector type	female
Output reference signal level at 50 Ω impedance	3 dBm ± 2 dB
«32 MHz Ref» connector type	SMA, female
External trigger source	TTL compatible inputs of 3 V to 5 V magnitude
Pulse width	More than 1 µs
Input impedance at «Ext Trig»	At least 10 kΩ
Input connector type	SMA, female

Operating temperature range	-10°C to +50°C
Storage temperature range	-40°C to +55°C
Humidity	90% at 25°C
Atmospheric pressure	84 to 106.7 kPa
Calibration interval	3 years
External PC system requirements:	
Operating system	WINDOWS XP, VISTA, 7, 8
CPU frequency	1 GHz
RAM	512 MB
Connection to PC	
Connector type	Mini USB B
Interface	USB 2.0
Power consumption	3 W
Dimensions (L x W x H)	4.5 x 2.0 x 0.9 in
Weight	10.6 oz

Copper Mountain Technologies is changing the way VNAs are used in the industry. Our unique VNAs deliver highly accurate measurements at a fraction of the price of traditional instrumentation. Leveraging breakthrough advances in RF technology, CMT manages to compress an advanced feature set and high performance into a compact form factor. We specialize in making affordable high performance analyzers for many environments and applications, with a wide variety of solutions from 20 kHz to 14 GHz.

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