Cobalt: C1209 C1220 & C2220

Meet the new face of faceless VNAs

Frequency Range:

C1209 • 0.1 MHz - 9 GHz • 2-port
C1220 • 0.1 MHz - 20 GHz • 2-port
C2220 • 0.1 MHz - 20 GHz • 2-port Direct Receiver Access

Dynamic range: 145 dB typ. (1 Hz IF)

Wide output power range: -60 dBm to +15 dBm

Measurement time per point: 10 μs min typ.

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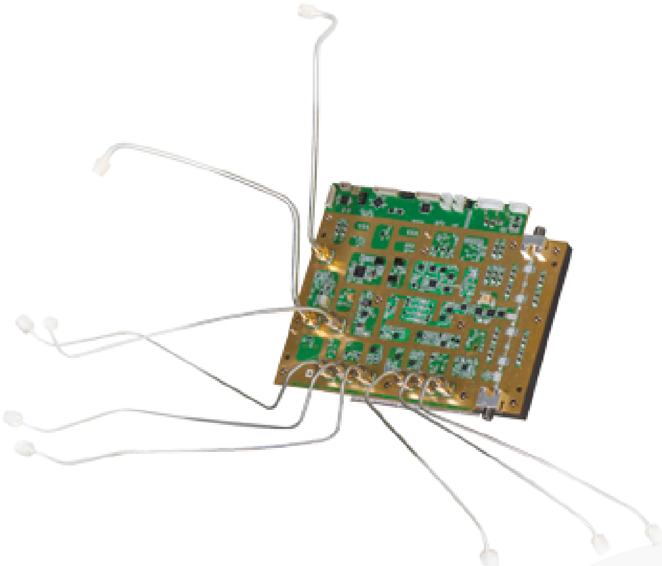
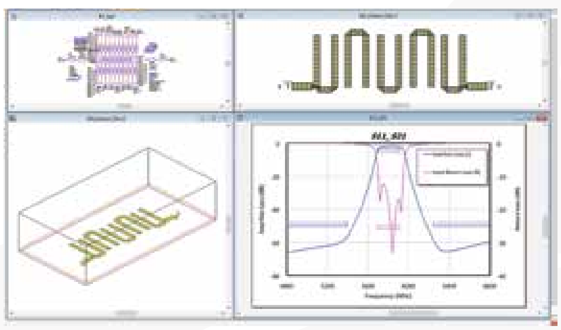
Discover Cobalt.

0.1 MHz to 9 GHz C1209

0.1 MHz to 20 GHz C2220

0.1 MHz to 20 GHz C1220





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TECHNOLOGIES

The new face of faceless VNAs

Copper Mountain Technologies (CMT) is changing the face of modern VNAs with its new product line, Cobalt. Cobalt incorporates multiple technological innovations to achieve an unmatched price-performance combination for S-parameter measurement between 100 kHz and 20 GHz

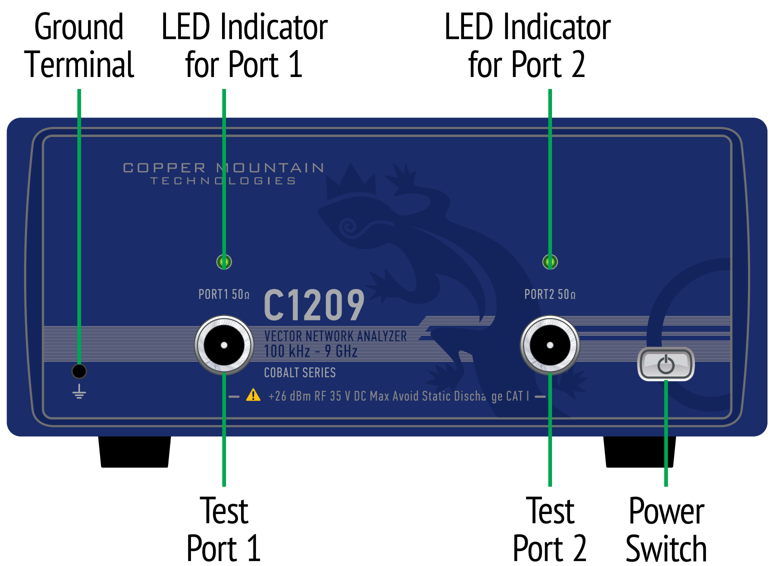
CMT has perfected an innovative new test grade coaxial connector technology for internal interconnect of the Cobalt analyzer. The connectors' tighter tolerances were achieved using new proprietary manufacturing and test approaches, contributing to Cobalt's exceptional metrological accuracy.

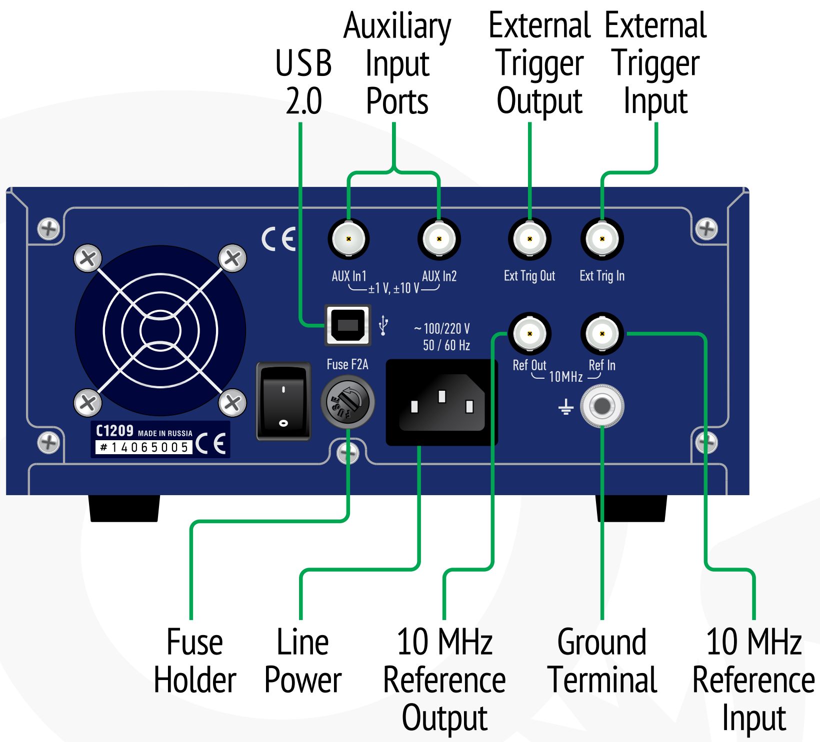
Advanced electromagnetic modelling was used to optimize the 20 GHz Cobalt's ultra-wideband directional coupler design. Because CMT incorporated new production methods for precision air strip lines, these directional couplers have extraordinary stability, both over temperature and over very long intervals of time.

Cobalt's hybrid dual-core DSP+FPGA signal processing engine, combined with new frequency synthesizer technologies, propel Cobalt's measurement speed to among the most advanced instruments in the industry, and well past the achievements of any cost-competitive products.

visit **www.coppermountaintech.com** for more information.

C1209 Front

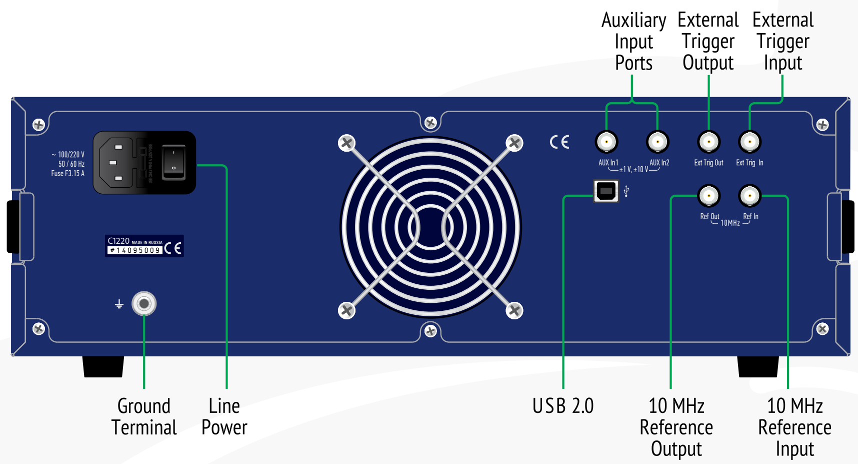




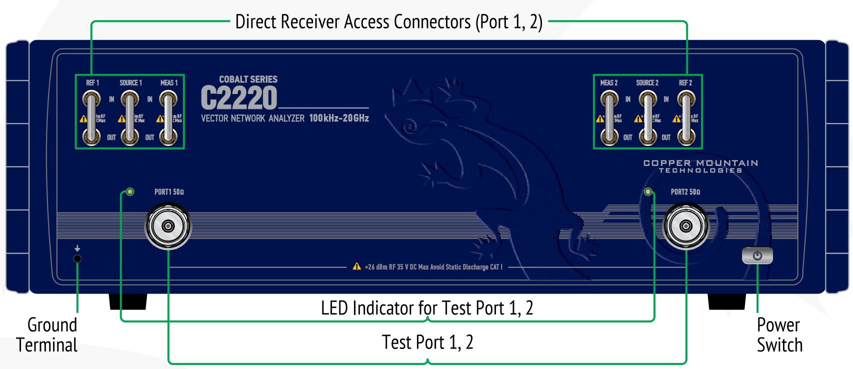
C1209 Back

C1220 Front

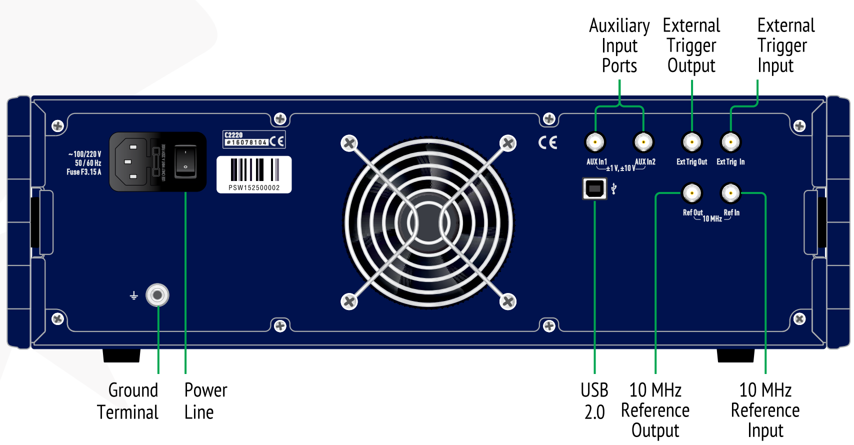
C1220 Back



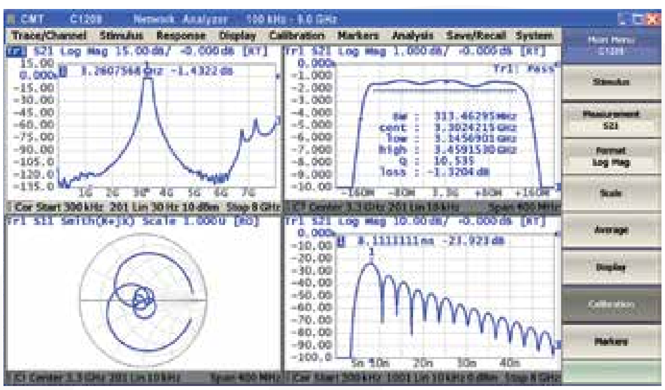
C2220 Front

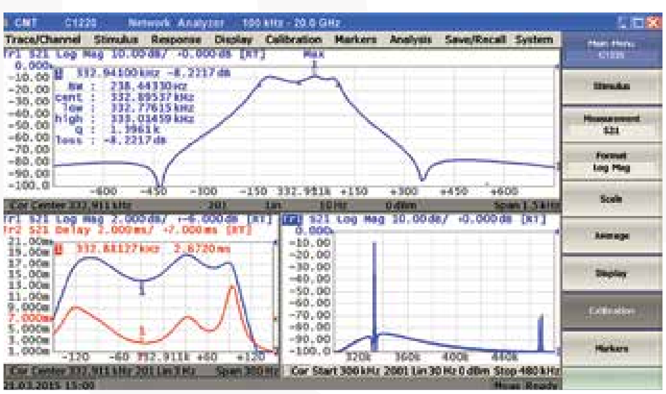


C2220 Back



Measurement Capabilities





Measured parameters

S_{11}, S_{21}, S_{12}, S_{22} and absolute power of the reference and received signals at the port.

Number of measurement channels

Up to 16 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, or power level.

Data traces

Up to 16 data traces can be displayed in each channel window. A data trace represents one of such parameters of the DUT as S-parameters, response in time domain, input power response.

Memory traces

Each of the 16 data traces can be saved into memory for further comparison with the current values.

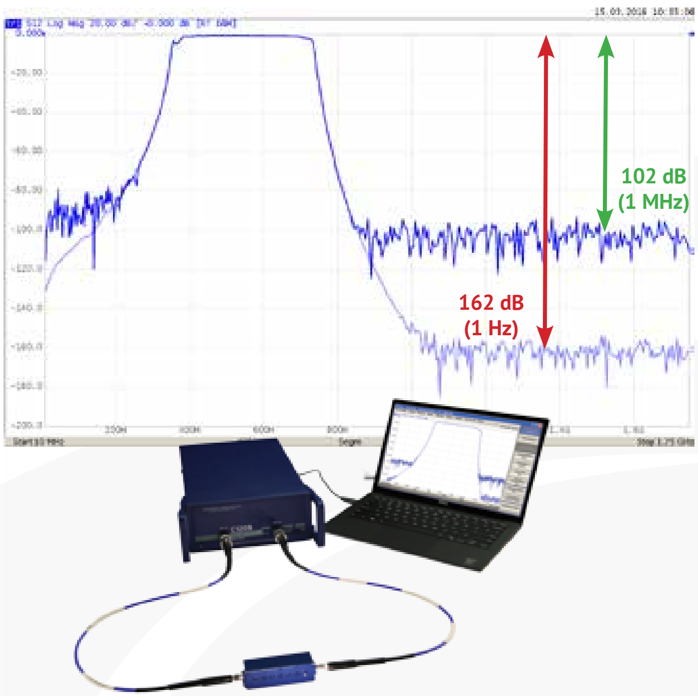
Data display formats

Logarithmic magnitude, linear magnitude, phase, expanded phase, group delay, SWR, real part, imaginary part, Smith chart diagram and polar diagram display formats are available.

Dynamic Range and Speed

Dynamic range and speed

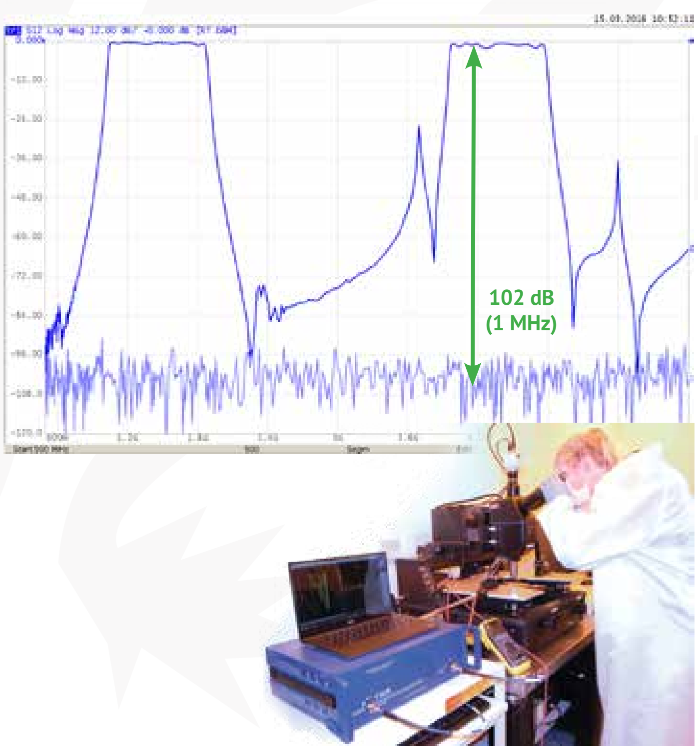
Cobalt's combination of a wide dynamic range and high measurement speed make it an ideal VNA for measuring and tuning high performance filters.



BTS Filter Tuning

BTS filter tuning

Cobalt VNAs have more than 162 dB dynamic range at 1 Hz IFBW, which allows them to maintain a wide measurement range at a high measurement speeds. Measurement of all S-parameters of a BTS filter with full two-port calibration and 801 measurements points with 1 MHz IFBW takes only 17.5ms while maintaining a measurement range of over 100 dB. This time is almost completely determined by the IFBW of the VNA. This measurement speed allows for real time tuning of high isolation BTS filters.



SAW Filters

Measurement of the SAW filters in a high speed production environment

162 dB of the dynamic range of Cobalt VNAs combined with high measurement speed per point allows measurement of SAW filters' S-parameters with full 2-port calibration and 1601 measurement points in less than 32 ms while still maintaining more than 100 dB of the measurement range (IFBW at 1 MHz). This measurement speed corresponds to the performance of the most advanced handlers used in the process of automatic verification of the mass-produced SAW filters.

Sweep Features

Sweep type

Linear frequency sweep, logarithmic frequency sweep, and segment frequency sweep occur when the stimulus power is a fixed value. Linear power sweep occurs when frequency is a fixed value.

Measurement points per sweep

Set by the user from 2 to 500,001

Segment sweep features

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

Power

Source power from -60 dBm to +15 dBm with resolution of 0.05 dB. In frequency sweep mode, the power slope can be set up to 2 dB/GHz for compensation of high frequency attentuation in connection wires.

Sweep trigger

Trigger modes: continuous, single, or hold. Trigger sources: internal, manual, external, 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.

Autoscaling

Automatic selection of scale division and reference level value allow the most effective display of the trace.

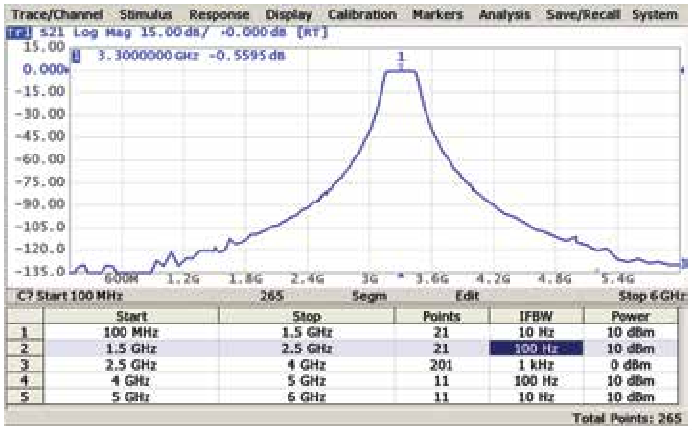
Electrical delay

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

Phase offset

Phase offset is defined in degrees.

Frequency Scan Segmentation



Frequency scan segmentation

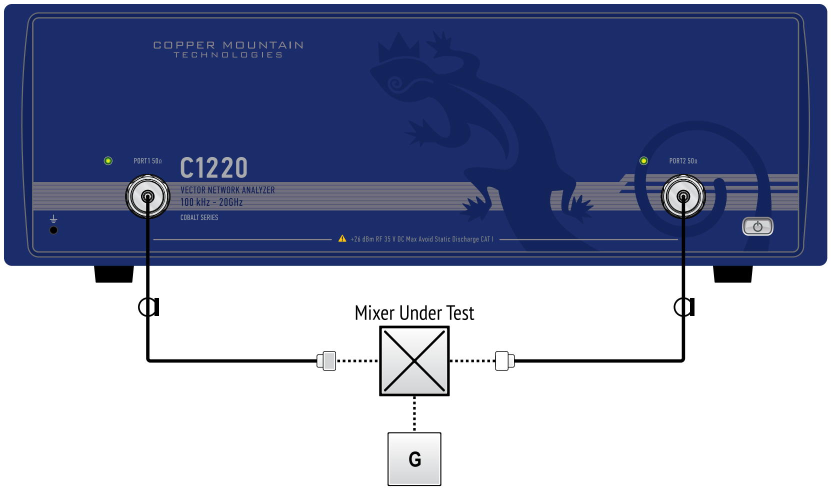
The VNA has a large frequency range with the option of frequency scan segmentation. This allows optimal use of the device, for example, to realize the maximum dynamic range while maintaining high measurement speed.

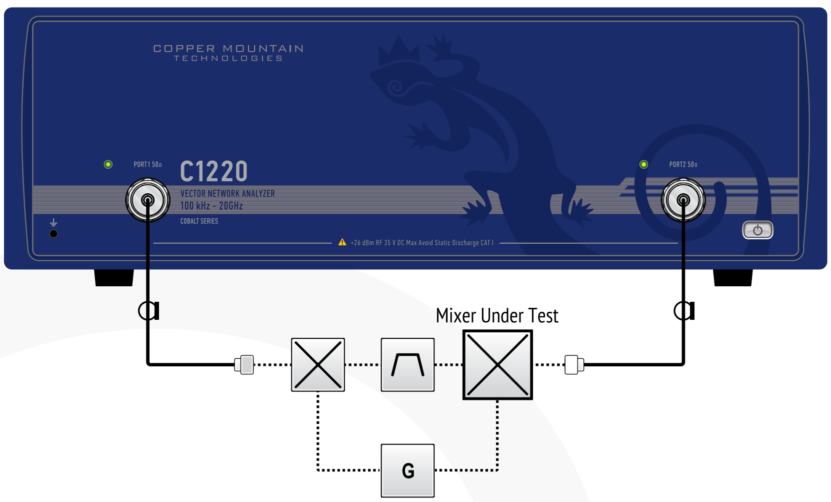
Power Scaling & Compression Point Recognition

Power scaling & compression point recognition

The power sweep feature turns compression point recognition, one of the most fundamental and complex amplified measurements, into a simple and accurate operation.

Mixer/Converter Measurements





Scalar mixer/converter measurements

The scalar method allows the user to measure only the magnitude of the transmission coefficient of the mixer and other frequency translating devices. No external mixers or other devices are required. The scalar method employs port frequency offset when there is a difference between the source port frequency and the receiver port frequency.

Scalar mixer/converter calibration

This is the most accurate method of calibration applied for measurements of mixers in frequency offset mode. The OPEN, SHORT, and LOAD calibration standards are used. An external power meter should be connected to the USB port directly or via USB/GPIB adapter.

Vector mixer/converter measurements

The vector method allows the measurement of both the magnitude and phase of the mixer transmission coefficient. This method requires an external mixer and an LO common for both the external mixer and the mixer under test.

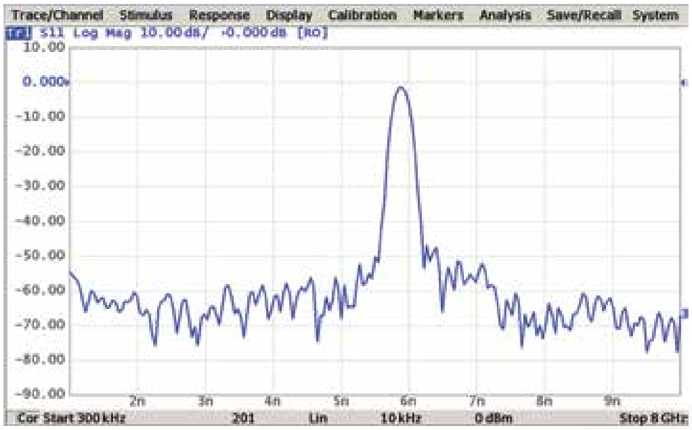
Vector mixer/converter calibration

This method of calibration is applied for vector mixer measurements. OPEN, SHORT, and LOAD calibration standards are used.

Automatic frequency offset adjustment

This function performs automatic frequency offset adjustment when the scalar mixer/converter measurements are performed to compensate for internal LO setting inaccuracy in the DUT.

Time Domain Measurements

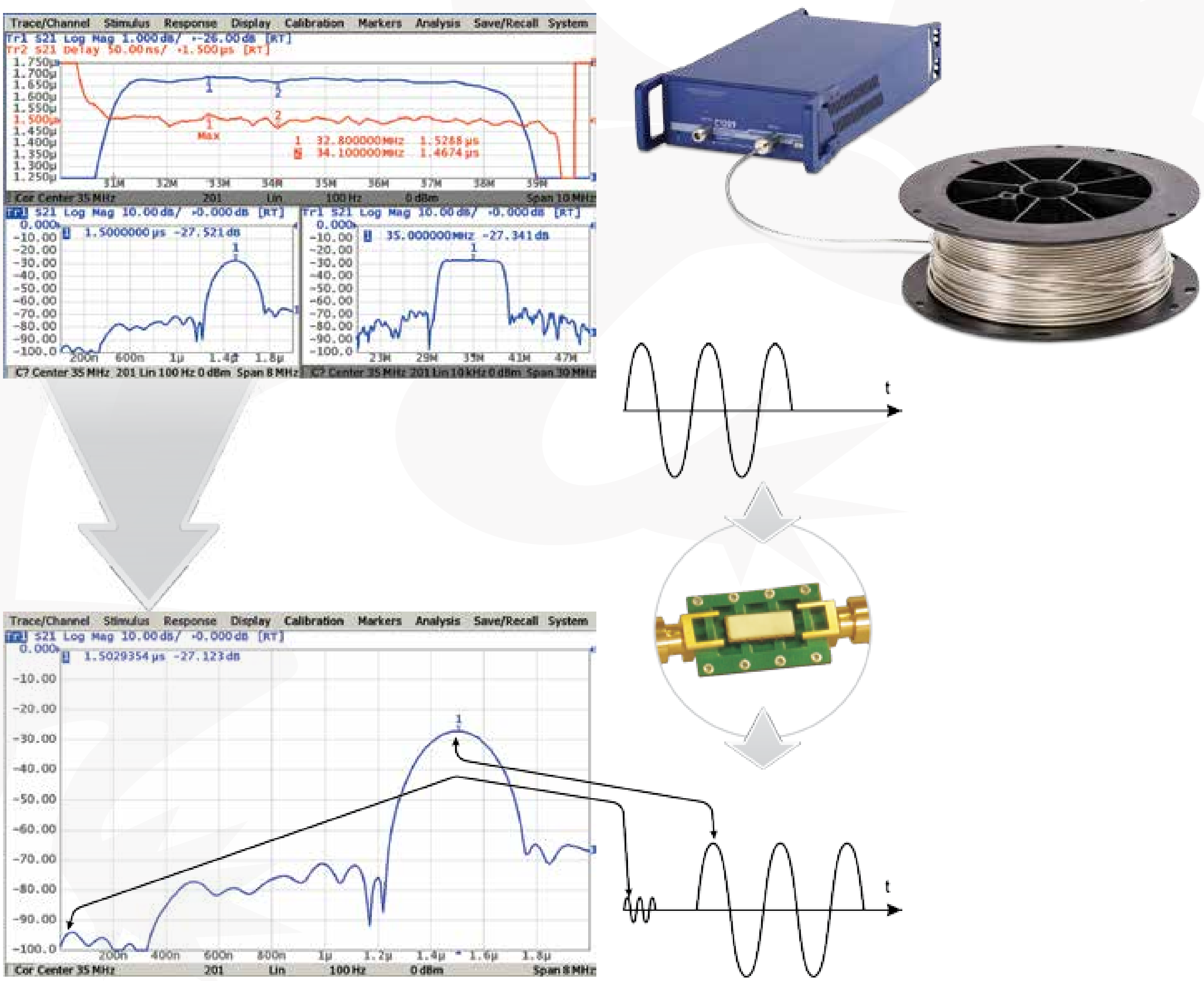


Time domain measurements

This function performs data transmission from frequency domain into response of the DUT to various stimulus types in time domain. Modeled stimulus types: bandpass, lowpass impulse, and lowpass step. Time domain span is set by the user arbitrarily from zero to maximum, which is determined by the frequency step. Windows of various forms are used for better tradeoff between resolution and level of spurious sidelobes.

Here, built in time domain analysis allows the user to detect a physical impairment in a cable.

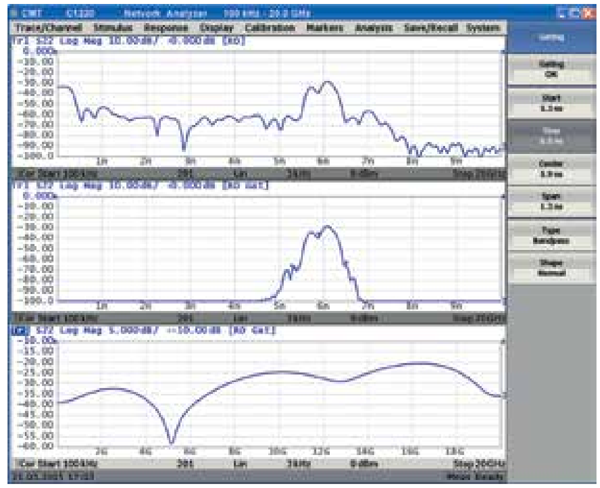
Time domain analysis allows measurements of parameters of SAW filters such as the signal time delay, feedthrough signal suppression.



Time Domain Gating

Time domain gating

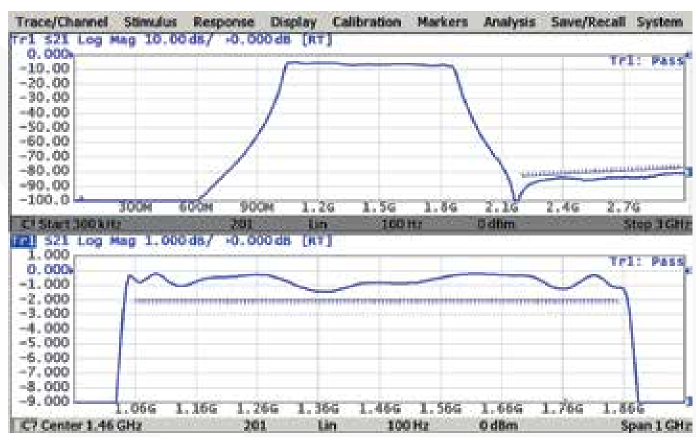
This function mathematically removes unwanted responses in the time domain, which allows the user to obtain frequency response without influence from fixture elements.



This function applies reverse transformation back to the 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.

Applications of these features include, but are not limited to: measurements of SAW filter parameters, such as filter time delay or forward transmission attenuation.

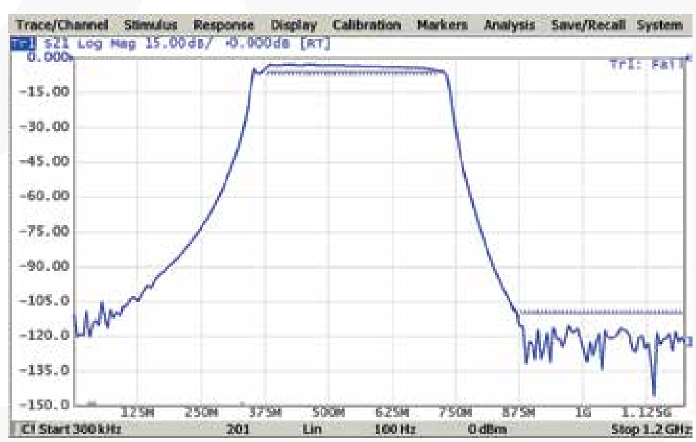
Limit Testing



Limit testing

Limit testing is a function of automatic pass/fail judgement for the trace of the measurement results. The judgement is based on the comparison of the trace to the limit line set by the user and can consist of one or several segments.

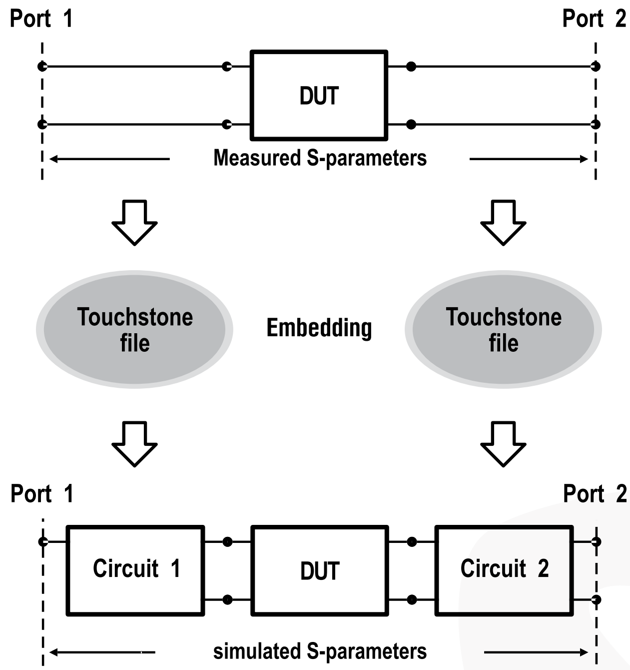
Each segment checks the measurement value for failing either the upper or lower limit, or both. The limit line segment is defined by specifying the coordinates of the beginning (X0, Y0) and the end (X1, Y1) of the segment, and type of the limit. The MAX or MIN limit types check if the trace falls outside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



Embedding

Embedding

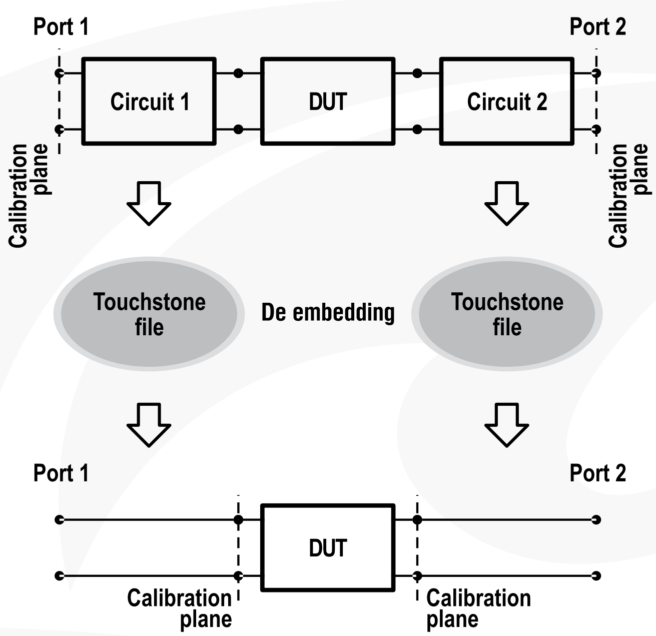
This function allows the user to mathematically simulate DUT parameters by virtually integrating a fixture circuit between the calibration plane and the DUT. This circuit should be described by an S-parameter matrix in a Touchstone file.



De-Embedding

De-Embedding

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



AUX Port

AUX Port (optional)

In some measurement applications for example characterization of a log amplifier, involve measurement of the detector's output voltage or an amplifier DUT's efficiency over frequency or input power, necessitate voltage measurements be made in addition to standard S-parameters. Cobalt series analyzers configured with option HW-C-AUX incorporate two general-purpose analog voltage input ports to measure system or DUT voltages synchronously with the VNA sweep. Either input may be configured for +/- 1.0 VDC or +/- 10.0 VDC operation and voltage measurements viewed directly in the VNA's Windows application.

Port Impedance Conversion

Port impedance conversion

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

S-Parameter Conversion

S-parameter conversion

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

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, Stat & Trace, or All.

Channel State

A channel state can be saved into tha Analyzer memory. The channel state saving procedure is similar to saving of the Analyzer state saving, and the same saving types are applied to the channel state saving. Unlike the Analyzer state, the channel state is saved into the Analyzer inner volatile memory (not to the hard disk) and is cleared when the power to the Analyzer is turned off. For channel state storage, there are four memory registers A, B, C, D. The channel state saving allows the user to easily copy the settings of one channel to another one.

Trace Data CSV File

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

Trace Data Touchstone File

The Analyzer 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 simluator programs. The *.s2p files are used for saving all the four S-parameters of a 2-port device. The *.s1p files are used for saving S_{11} and S_{22} parameters of a 1-port device. Only one (active) trace data are saved to the file. The Touchstone file saving function is applied to individual active channels.

Screenshot capture

The print function is provided with the preview feature, which allows the user to view the image to be printed on the screen, and/or save it to a file. Screenshots can be printed using three different applications: MS Word, Image Viewer for Windows, or the Print Wizard of the Analyzer. Each screenshot can be printed in color, grayscale, black and white, or inverted for visibility or ink use. The current date and time can be added to each capture before it is transferred to the printing application, resulting in wuick and easy test reporting.

Measurement Automation

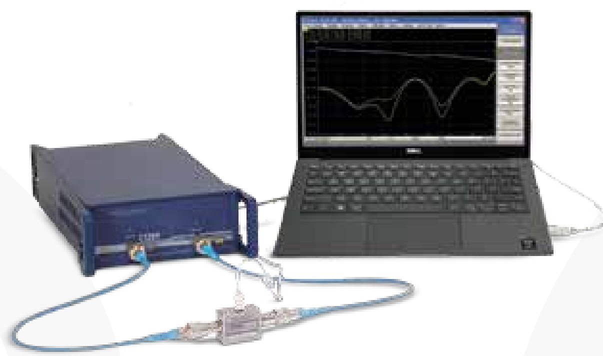
COM/DCOM compatible

Cobalt's software is COM/DCOM compatible, which allows the unit to be used as a part of an ATE station and other special applications. COM/DCOM automation is used for remote control and data exchange with the user software. The Analyzer program runs as COM/DCOM client. The COM client runs on Analyzer PC. The DCOM client run 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 and load match, tracking and isolation.

Calibration methods

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

- reflection and transmission normalization
- full one-port calibration
- one-path two-port calibration
- full two-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.

One-path two-port calibration

Method of calibration performed for reflection and one-way transmission measurements, for example for measuring S_{11} and S_{21} only. It ensures high accuracy for reflection measurements, and mean accuracy for transmission measurements.

Full two-port calibration

This method of calibration is performed for fill S-parameter matrix measurement of a two-port DUT, ensuring high accuracy.

Accuracy Enhancement Cont.

TRL calibration

Method of calibration performed for full S-parameter matrix measurement of a two-port DUT. It ensures higher accuracy than two-port calibration. LRL and LRM modifications of this calibration method are available.

Mechanical calibration kits

The user can select one of the predefined calibration kits of various manufacturers or define own calibration kits.

Electronic calibration modules

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

Sliding load calibration standard

The use of sliding load calibration standard allows significant increase in calibration accuracy at high frequencies compared to the fixed load calibration standard.

“Unknown” thru calibration standard

The use of a generic two-port reciprocal circuit instead of a Thru in full two-port calibration allows the user to calibrate the VNA for measurement of “non-insertable” devices.

Defining off calibration standards

Different methods of calibration standard defining are available:

- standard defining by polynomial model
- standard defining by data (S-parameters)

Error correction interpolation

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

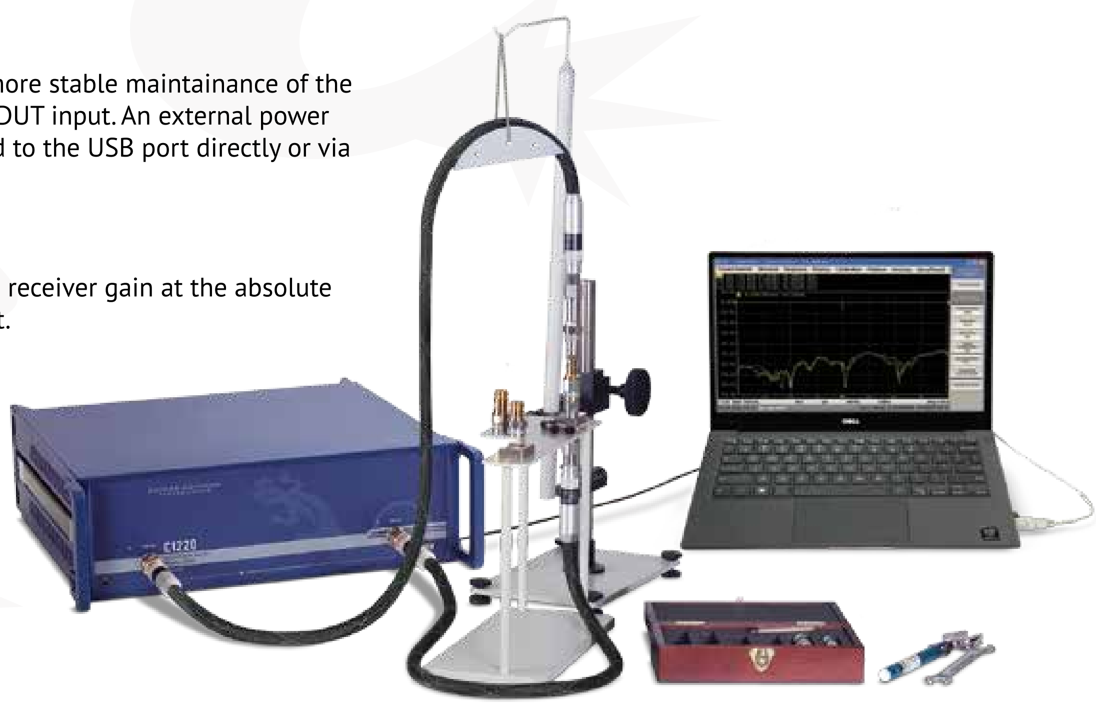
Supplemental Calibration Methods

Power calibration

Power calibration allows more stable maintainance of the power level setting at the DUT input. An external power meter should be connected to the USB port directly or via USB/GPIB adapter

Receiver calibration

This method calibrates the receiver gain at the absolute signal power measurement.



CobaltFx

EXTEND YOUR REACH

50 - 75 GHz | 60 - 90GHz | 75 - 110 GHz

COBALT Fx

Extend Your Reach

Farran Technology and Copper Mountain Technologies, globally recognized innovators, with a combined 50 years' experience in RF test and measurement systems have partnered to create CobaltFx; your new millimeter-wave frequency extension solution.

CobaltFX is the first mmWave frequency extension solution that utilizes a 9 GHz VNA. CobaltFx's high dynamic range and directivity allow for highly accurate and stable millimeter-wave S-parameter measurements in three dedicated waveguide bands 50-75 GHz, 60-90 GHz, and 75-110 GHz. CobaltFx offers an unparalleled combination of price, performance, flexibility and size.

C4209, the VNA used in this system, is from Copper Mountain Technologies' industry leading Cobalt Series. It features fast sweep speeds down to 10 microseconds per point and a dynamic range of up to 160 dB, all comprised in a compact, USB form factor. C4209 works seamlessly with Farran Technology's millimeter-wave FEV frequency extenders.

The extenders are packaged in small and versatile enclosures, that allow for flexible port arrangements with respect to the waveguide. Waveguide ports are manufactured in accordance to the new IEEE 1785-2a standard and ensure industry best alignment and repeatability of connection, allowing for long interval times between calibration. The system comes with a precision calibration kit containing flush short, offset piece and broadband load and allows for full 12-term port calibration.

visit **www.coppermountaintech.com or www.farran.com** for more information.

from:

COPPER MOUNTAIN TECHNOLOGIES

Farran Technology

Technical Specifications

Measurement Range

	C1209	C1220	C2220
Impedance	50 Ω	50 Ω	50 Ω
Test port connector	N-type female	NMD 3.5 mm male	NMD 3.5 mm male
Number of test ports	2	2	2
Frequency Range	0.1 MHz to 9 GHz	0.1 MHz to 20 GHz	0.1 MHz to 20 GHz
Full CW Frequency	$\pm 2x10^{-6}$	$\pm 2x10^{-6}$	$\pm 2x10^{-6}$
Frequency Setting Resolution	1 Hz	1 Hz	1 Hz
Number of Measurement Points	1 to 500,001	1 to 500,001	1 to 500,001
Measurement Bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 1 MHz	1 Hz to 1 MHz	1 Hz to 1 MHz
Dynamic Range	*1 MHz to 8 GHz* / *8 GHz to 9 GHz* *(IF bandwidth 1 Hz)* 162 dB typ. / 152 dB typ. *(IF bandwidth 10 Hz)* 148 dB / 138 dB	*100 kHz-1 MHz* / *1 MHz-20 GHz* *(IF bandwidth 10 Hz)* 110 dB / 133 dB	*100 kHz to 1 MHz* / *1 MHz to 20 GHz* *(IF bandwidth 10 Hz)* 110 dB / 130 dB

Technical Specifications

Measurement Accuracy

	C1209	C1220	C2220
Accuracy of transmission measurements (magnitude/phase)			*100 kHz to 1 MHz*
-30 dB to +0 dB			0.1 dB / 1°
-50 dB to -30 dB			0.2 dB / 2°
-70 dB to -50 dB			1.0 dB / 6°
	1 MHz to 9 GHz	*1 MHz to 5 GHz*	
+5 dB to +15 dB	0.2 dB / 2°	0.2 dB / 2°	
-50 dB to +5 dB	0.1 dB / 1°	0.1 dB / 1°	
-70 dB to -50 dB	0.2 dB / 2°	0.2 dB / 2°	
-90 dB to -70 dB	1.0 dB / 6°	1.0 dB / 6°	
		5 GHz to 14 GHz	*1 MHz to 20 GHz*
+5 dB to +10 dB		0.2 dB / 2°	0.2 dB / 2°
-50 dB to +5 dB		0.1 dB / 1°	0.1 dB / 1°
-70 dB to -50 dB		0.2 dB / 2°	0.2 dB / 2°
-90 dB to -70 dB		1.0 dB / 6°	1.0 dB / 6°
		14 GHz to 20 GHz	
-50 dB to +5 dB		0.1 dB / 1°	
-70 dB to -50 dB		0.2 dB / 2°	
-90 dB to -70 dB		1.0 dB / 6°	
Accuracy of reflection measurements (magnitude/phase)	*1 MHz to 9 GHz*	*1 MHz to 10 GHz*	*100 kHz to 10 GHz*
-15 dB to 0 dB	0.4 dB / 3°	0.4 dB / 3°	0.4 dB / 3°
-25 dB to -15 dB	1.0 dB / 6°	1.0 dB / 6°	1.0 dB / 6°
-35 dB to -25 dB	3.0 dB / 20°	3.0 dB / 20°	3.0 dB / 20°
		10 GHz to 20 GHz	*10 GHz to 20 GHz*
-15 dB to 0 dB		0.5 dB / 4°	0.5 dB / 4°
-25 dB to -15 dB		1.5 dB / 10°	1.5 dB / 10°
-35 dB to -25 dB		5.5 dB / 30°	5.5 dB / 30°
Trace Stability	*1 MHz to 9 GHz*	*1 MHz to 20 GHz*	*1 MHz to 20 GHz*
Trace noise magnitude (IF bandwidth 3 kHz)	1 mdB rms	1 mdB rms	1 mdB rms
Temperature dependence (per one degree of temperature variation)	0.02 dB (0.01 dB typ.)	0.02 dB (0.01 dB typ.)	0.02 dB (0.01 dB typ.)

Effective System Data[1]

	C1209	C1220	C2220
	1 MHz to 9 GHz	*10 MHz to 10 GHz*	*100 kHz to 10 GHz*
Effective directivity	46 dB	46 dB	46 dB
Effective source match	40 dB	40 dB	40 dB
Effective load match	46 dB	46 dB	46 dB
		10 GHz to 20 GHz	*10 GHz to 20 GHz*
Effective directivity		42 dB	42 dB
Effective source match		38 dB	38 dB
Effective load match		42 dB	42 dB

Test Port

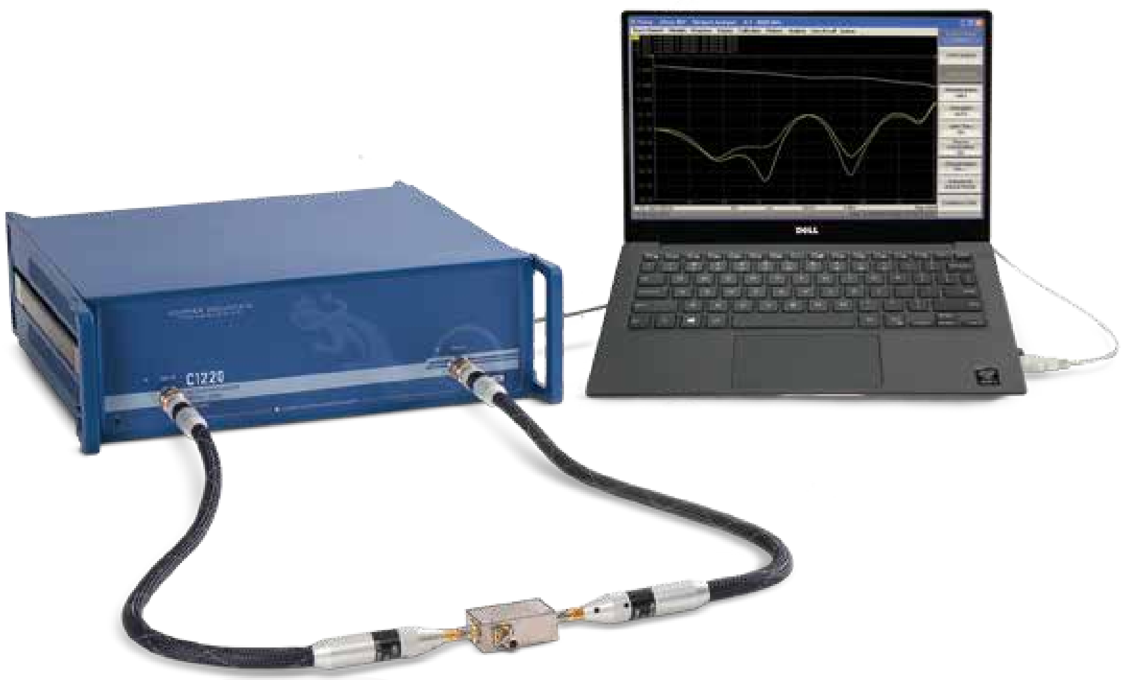
	C1209	C1220		C2220		
	1 MHz to 9 GHz	*1 MHz to 18 GHz*	*18 GHz to 20 GHz*	*100 kHz to 1 MHz*	*1 MHz to 10 GHz*	*10 GHz to 20 GHz*
Directivity (without system error correction)	20 dB	20 dB	18 dB	10 dB	20 dB	15 dB

Test Port Output

	C1209	C1220	C2220	
	1 MHz to 9 GHz	*10 MHz to 20 GHz*	*100 kHz to 1 MHz*	*1 MHz to 20 GHz*
Match (without system error correction)	20 dB	17 dB	10 dB	15 dB
	1 MHz to 9 GHz	*1 MHz to 5 GHz*	*100 kHz to 20 GHz*	
Power Range	-60 dBm to +15 dBm	-60 dBm to +10 dBm	-60 dBm to +10 dBm	
		5 GHz to 14 GHz		
		-60 dBm to +5 dBm		
		14 GHz to 20 GHz		
		-60 dBm to 0 dBm		
Power Accuracy	±1.5 dB	±1.5 dB	±1.5 dB	
Power Resolution	0.05 dB	0.05 dB	0.05 dB	
	Power out 0 dBm	*Power out -5 dBm*	*Power out -5 dBm*	
Harmonics Distortion	-25 dBc	-25 dBc	-25 dBc	
Non-harmonic Spurious	-30 dBc	-30 dBc	-30 dBc	

[1] applies over the temperature range of 73°F ± 9 °F (23°C ± 5 °C) after 40 minutes of warming-up, with less than 1 °C deviation from the one-path two-port calibration temperature, at output power of -5 dBm, and 10 Hz IF bandwidth

Technical Specifications



Test Port Input

	C1209		C1220		C2220	
	1 MHz to 9 GHz		*1 MHz to 20 GHz*		*100 kHz to 1 MHz*	*1 MHz to 20 GHz*
Match (without system error correction)	20 dB		18 dB		10 dB	15 dB
Damage Level	+26 dBm		+26 dBm		+26 dBm	
Damage DC Voltage	35 V		35 V		35 V	
	1 MHz to 8 GHz	*8 GHz to 9 GHz*	*100 kHz to 1 MHz*	*1 MHz to 20 GHz*	*100 kHz to 1 MHz*	*1 MHz to 20 GHz*
Noise Floor	-143 dBm/Hz	-133 dBm/Hz	-110 dBm/Hz	-133 dBm/Hz	-110 dBm/Hz	-130 dBm/Hz

Measurement Speed

	C1209		C1220		C2220	
	Typical cycle time versus number of measurement points					
	Start 0.1 MHz to 9.0 GHz		*Start 0.1 MHz to 20 GHz*		*Start 0.1 MHz to 20 GHz*	
Number of points (IF bandwidth 1 MHz)	Uncorrected	2-port Calibration	Uncorrected	2-port Calibration	Uncorrected	2-port Calibration
51	1.0 ms	2.0 ms	7.3 ms	4.4 ms	7.3 ms	4.4 ms
201	2.6 ms	5.0 ms	4.2 ms	8.2 ms	4.2 ms	8.2 ms
401	4.6 ms	9.0 ms	6.5 ms	12.8 ms	6.5 ms	12.8 ms
1601	16.7 ms	33.3 ms	20.5 ms	40.8 ms	20.5 ms	40.8 ms

General Data

	C1209	C1220	C2220
External reference frequency	10 MHz	10 MHz	10 MHz
Input level	2 dBm ± 2 dB	2 dBm ± 2 dB	2 dBm ± 2 dB
Input impedance at «Ref IN 10 MHz»	50 Ω	50 Ω	50 Ω
Connector type	BNC female	BNC female	BNC female
Output reference signal level at 50 Ω impedance	3 dBm ± 2 dB	3 dBm ± 2 dB	3 dBm ± 2 dB
«OUT 10 MHz» connector type	BNC female	BNC female	BNC female

External Trigger Input Connector

	C1209	C1220	C2220
Type	BNC, Female	BNC, Female	BNC, Female
Input Level	Low threshold voltage: 0.5 V High threshold voltage: 2.7 V	Low threshold voltage: 0.5 V High threshold voltage: 2.7 V	Low threshold voltage: 0.5 V High threshold voltage: 2.7 V
Input level range	0 to + 5 V	0 to + 5 V	0 to + 5 V
Pulse Width	2 μsec	2 μsec	2 μsec
Polarity	Positive or Negative	Positive or Negative	Positive or Negative

External Trigger Output Connector

	C1209	C1220	C2220
Type	BNC, Female	BNC, Female	BNC, Female
Maximum output current	20 mA	20 mA	20 mA
Output level	Low level voltage: 0 V High level voltage: 3.5 V	Low level voltage: 0 V High level voltage: 3.5 V	Low level voltage: 0 V High level voltage: 3.5 V
Polarity	Positive or Negative	Positive or Negative	Positive or Negative

Other

	C1209	C1220	C2220
Operating temperature range	+41 °F to +104 °F (+5 °C to +40 °C)	+41 °F to +104 °F (+5 °C to +40 °C)	+41 °F to +104 °F (+5 °C to +40 °C)
Storage temperature range	-49 °F to +131 °F (-45 °C to +55 °C)	-49 °F to +131 °F (-45 °C to +55 °C)	-49 °F to +131 °F (-45 °C to +55 °C)
Humidity	90% at 77 °F (25 °C)	90% at 77 °F (25 °C)	90% at 77 °F (25 °C)
Atmospheric pressure	84 to 106.7 kPa	84 to 106.7 kPa	84 to 106.7 kPa
Calibration interval	3 years	3 years	3 years
Power supply	110-240 V, 50/60 Hz	110-240 V, 50/60 Hz	110-240 V, 50/60 Hz
Power consumption	40 W	110 W	110 W
Dimensions (L x W x H)	377 x 210 x 95 mm	376 x 415 x 140 mm	376 x 415 x 140 mm
Weight	4.8 kg	12 kg	12 kg

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