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TR Series Vector Network Analyzer Datasheet and Specifications

VTR0102	50 MHz to 1.5 GHz
VTR0302	50 MHz to 3.5 GHz
Software	CMT VNA software, Windows and Linux, demo mode supported

Revision 25.00 11.12.2025

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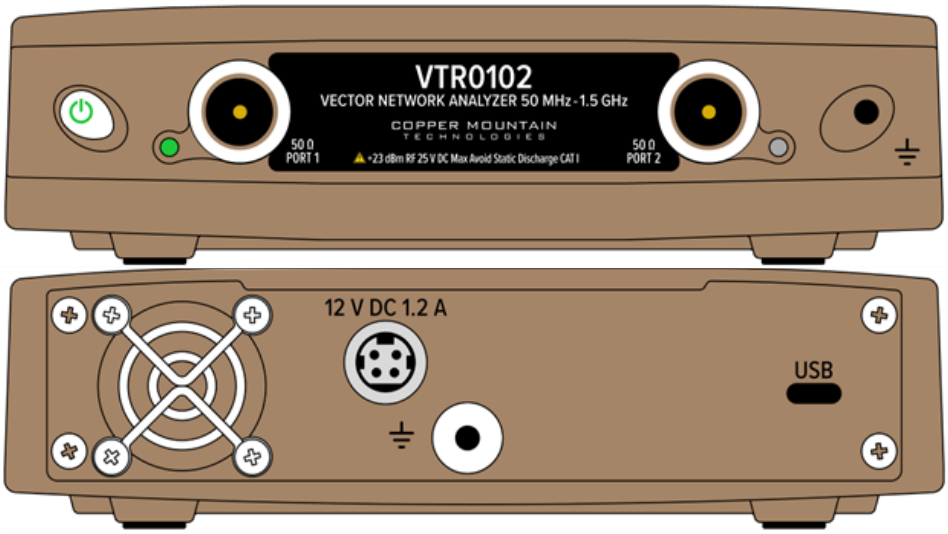
General Overview



VTR Vector Network Analyzer

Main Parameters

Configuration	2-port, 1-path, 50 Ohm
Measured parameters	S11, S21, RF Power
Frequency range	
VTR0102	50 MHz to 1.5 GHz
VTR0302	50 MHz to 3.5 GHz
Output power range	-25 dBm to 0 dBm
Receiver attenuator range	18 dB, 6 dB step
Dynamic range	110 dB at 10 Hz
Measurement bandwidths	1 Hz to 300 kHz
Measurement speed	35 µs typ.
Connection	USB
Software	CMT VNA, Windows or Linux

CMT VNA software runs natively on Windows and Linux. It can also be used on x86 or ARM processors on PCs, tablets, or simple-board computers including Raspberry Pi.

Functionality and Features Overview

- Intuitive software control through a two-level menu, quick access toolbar, channel status bar, and hot keys.
- Multi-channel mode. No limitations on the number of channels, diagrams, traces, or markers.
- Sweep by frequency: linear, logarithmic or segment mode, by power: linear, by time: CW mode.
- The software implements data, memory, and static traces. Available trace functions include trace hold, smoothing, statistical data calculation, and standard mathematical operations.
- Calibration wizard with workflow progress and step guidance. The wizard works in conjunction with the calibration kit and connector libraries. The libraries include numerous predefined items. Multiple calibration methods are supported.
- Fixture simulator includes the port extension feature, embedding and de-embedding functions, and impedance conversion.
- For post-processing of measurement data, markers and limit tests are available. Marker search and marker math functions are supported.
- The software supports time domain measurements with gating.
- All state, calibration and measurement data can be saved to a state file. The software allows the user to save S-parameters to a touchstone file, and an individual trace's data as a CSV file.
- A print function is provided. This function also supports saving data according to a predefined template, with the option to include supplementary information related to the operator, DUT, and experimental conditions.
- Automation programming in Python, LabVIEW, MATLAB, .NET, etc.

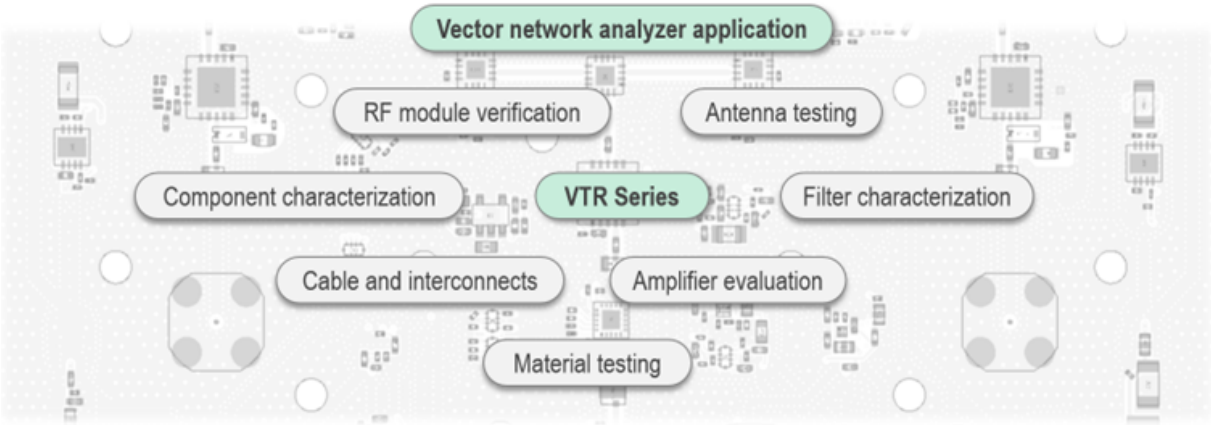
The VTR vector network analyzers are designed as cost-effective instruments, optimized for essential functionality with certain hardware limitations.

- Time-base Reference input/output and trigger signals are not supported.
- The analyzers are not equipped with internal pulse generators or modulators, and do not support pulsed mode.
- No direct receiver access configuration and no frequency extension capability.

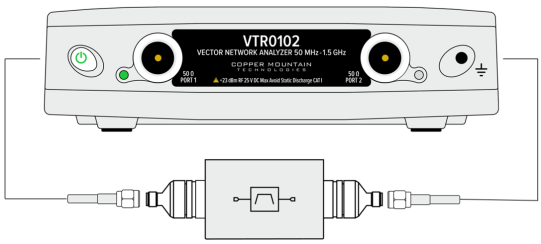
General Description

The VTR0102 and VTR0302 instruments are 2-port, 1-path vector network analyzers that deliver lab-grade performance in an affordable compact package, with all the features engineers have come to ex-pect included standard in our software.

These instruments are value-priced analyzers designed to perform the most essential S-parameter measurements. Supporting S11 (reflection) and S21 (transmission) measurements, they are ideally suited for the characterization and verification of RF modules and components such as antennas, filters, amplifiers, cables, and more. Whether in development, production, or quality assurance, they provide the right balance of functionality, cost efficiency, and ease of use, ensuring consistent product quality while keeping overall testing costs under control.



Applications	Typical use case
Antenna testing	Measurement of return loss across frequency bands and feedline characteristic impedance vs distance
Filter characterization	Verification of insertion loss, bandwidth, and out-of-band rejection
Amplifier evaluation	Gain and return loss testing under various conditions
Cable and interconnects	Measurement of insertion loss, phase stability, and reflection performance
Component characterization	Impedance, losses, and isolation testing in RF components
Material testing	Dielectric properties of RF materials using reflection and transmission measurements
RF module verification	Quick pass/fail testing of integrated RF assemblies before deployment



Filter Characterization

The software supports the segment sweep mode.

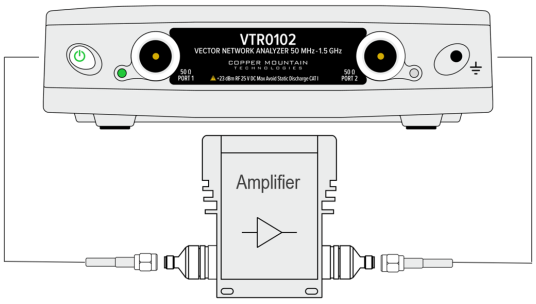
Segment sweep for filters = a balance between speed and accuracy:

- provides detailed measurement of the passband
- enables fast verification of the wide out-of-band region
- offers flexible control of both the frequency response shape and the out-of-band suppression

Built-in marker functions, bandwidth/notch search, and RF filter statistics, allow quick calculation of filter parameters.

High dynamic range optimization:

- narrow IF bandwidth → higher SNR, extended dynamic range; longer sweep time.
- averaging → higher SNR, extended dynamic range; final result after N sweeps.

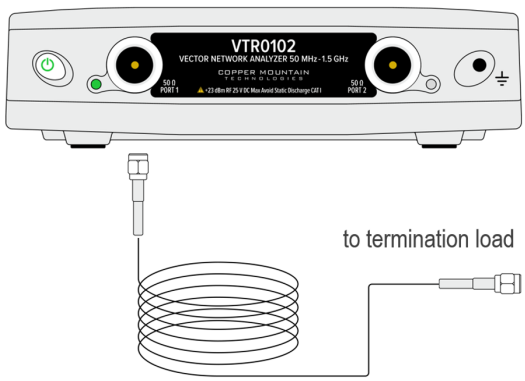


Amplifier Evaluation

The software supports power sweep mode.

In addition to key amplifier parameters such as gain and return loss, the software supports compression point recognition when varying the input power at a specified frequency point.

The slope evaluation function allows determination and display of the following trace parameters: gain, slope, and flatness.



Cable Testing

When testing cables or cable assemblies, time-domain transformation can be used to evaluate the characteristic impedance along the length of the cable.

The main advantages of this analysis are:

- allows locating defects and faults
- enables evaluation of assembly and connection quality without disassembling the cable
- convenient for long (or buried) lines where visual inspection is not possible

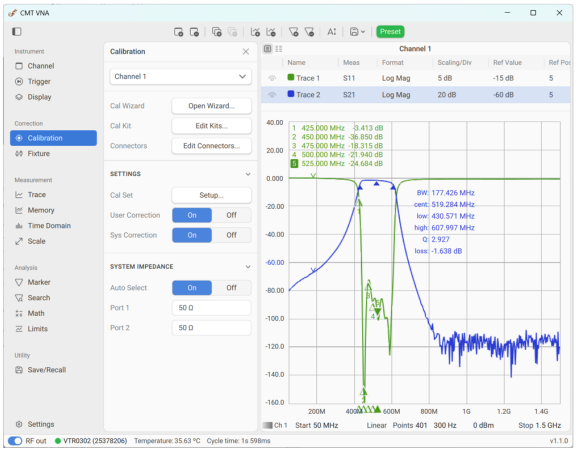
The software supports a velocity factor cable correction function, which allows measurement in feet or meters on the X axis.

CMT VNA Software

The Software Application is Part of the VNA

The analyzers include an RF measurement module, and a software application. The software application takes raw measurement data from the data acquisition (measurement) module and transforms into S-parameters in multiple presentation formats utilizing proprietary algorithms. The calibration and other accuracy enhancing algorithms were developed by our metrology experts.

The instruments use CMT VNA software, which can be installed on x86- or ARM-based processors and controlled via a USB interface. The software features an intuitive user interface with all available options organized in sub-menus, enabling quick and efficient navigation between different functions.



- Two-level menu
- Quick access toolbar
- Hot keys
- Calibration wizard
- Kits and connectors libraries
- Trace manager
- Trace and marker math
- Data analysis including markers and limit tests
- Save/recall files and states, print
- Automation
- Free demo mode

The CMT VNA software can be downloaded free from our website, used on an unlimited number of PCs using either Linux or Windows operating systems, and enables easy analyzer integration with other software applications and automation. The software application features a fully functioning Demo Mode, which can be used for testing automation scripts and exploring the analyzers' features and capabilities without an actual measurement module connected to your PC.

Our software offers flexible options for controlling the analyzers. Users can configure parameters through a **two-level menu**, the **quick access toolbar**, the **channel status bar**, or by pressing **hotkeys**. The quick access toolbar can be customized to individual preferences, ensuring maximum efficiency and a personalized workflow.

Standard Measurement Capabilities

Measurement Parameters

S11, S21

All models also measure absolute power of the reference and received signals at the port.

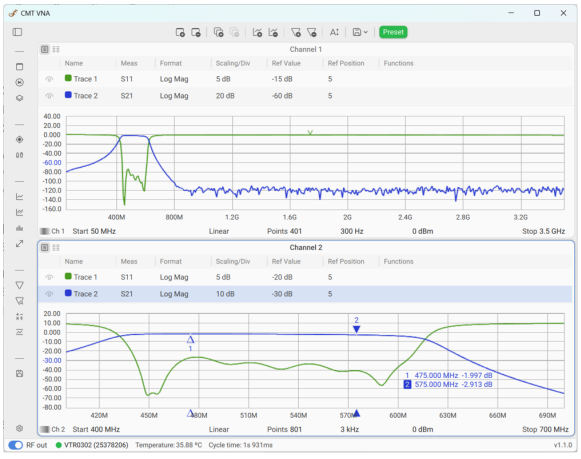
S-parameter conversion: this function allows for conversion of measured S-parameters to the following parameters: reflection impedance and admittance, transmission impedance and admittance for serial and shunt configuration, inverse S-parameters, and conjugate values.

Calibration data can also be displayed on the screen to verify the quality of the performed calibration.

Data Display Formats

Logarithmic magnitude, linear magnitude, phase, expanded phase, group delay, SWR, real and imaginary parts, and polar diagram.

Number of Channels, Diagrams, and Traces



Two Channels with Individual Settings

The software has no limitations on the number of channels, diagrams, or traces.

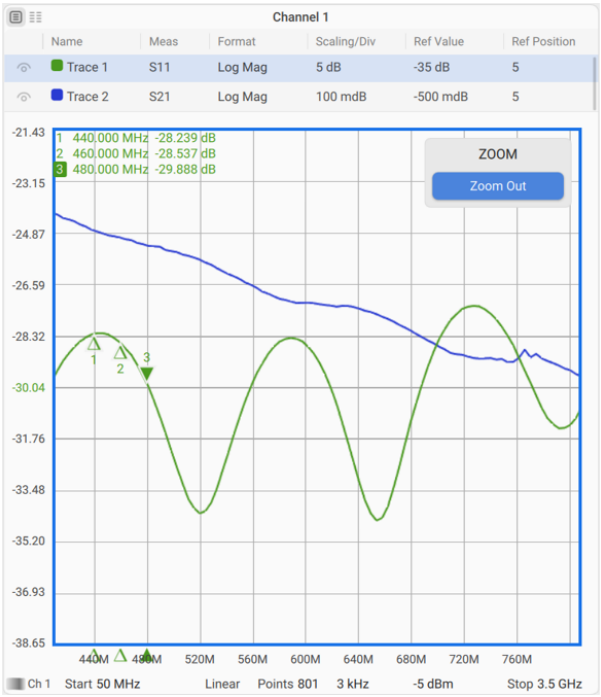
CMT VNA software allows users to create as many channels as needed, enabling precise customization of each measurement through individual channel settings and calibration.

A channel is considered to be a separate logical analyzer with its own unique settings.

To facilitate working with the numerous available parameters, the table below presents the instrument settings grouped into two categories: channel and trace.

Channel settings	Sweep range, number of points, power level, CW frequency, segment sweep table, IF bandwidth, averaging, trigger mode, calibration, fixture simulator.
Trace settings	Measured parameter along with conversions, display format, scale settings, electrical delay, phase offset, memory trace, math operation, smoothing, time domain, markers with search and math functions, limit test, ripple limit test, peak limit test.

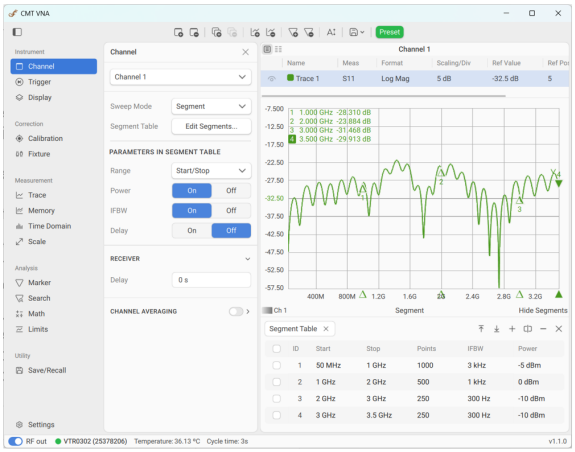
The software features a zoom function that allows you to easily focus on and analyze a specific part of the diagram in more detail.



Software Capabilities

Sweep Features

Sweep type	Sweep range, number of points, power level, CW frequency, segment sweep table, IF bandwidth, averaging, trigger mode, calibration, fixture simulator.
Trigger	Measured parameter along with conversions, display format, scale settings, electrical delay, phase offset, memory trace, math operation, smoothing, time domain, markers with search and math functions, limit test, ripple limit test, peak limit test.



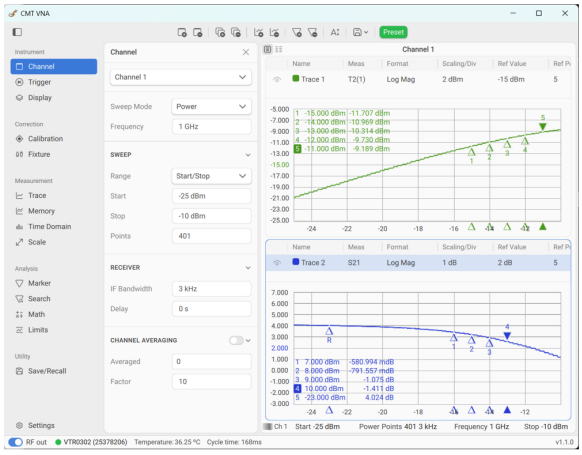
Segment Sweep Feature

Segment Sweep

In applications where a continuous sweep may be undesirable, this function allows the user to sweep frequency segments rather than the entire frequency span. This can lead to faster measurement results.

A frequency sweep can be made within several independent user-defined segments.

Frequency range, number of sweep points, IF bandwidth, source power, and delay can be set for each segment.



Power Sweep

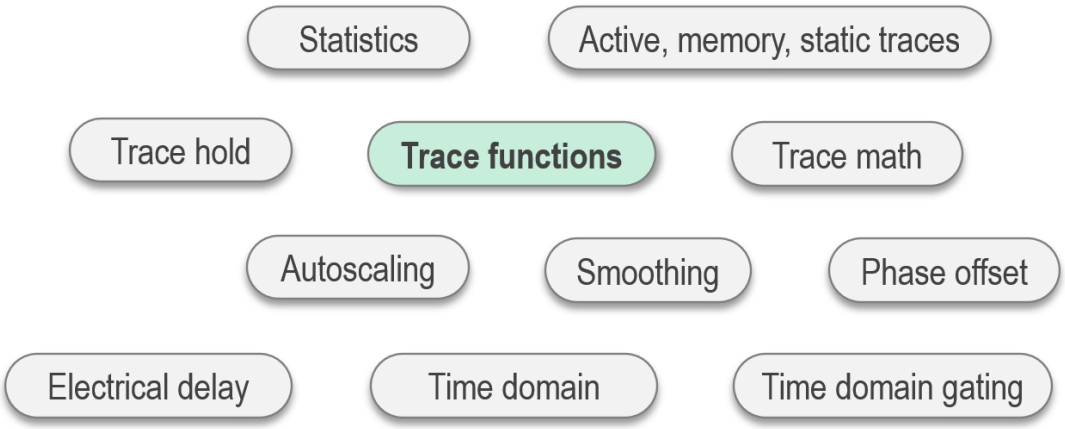
Power Sweep

The power sweep feature enables users to perform compression point recognition, one of the most fundamental and complex amplifier measurements, in a simple manner.

In this case, you can use either S21 transmission or the test receiver power measurements.

Trace Functions

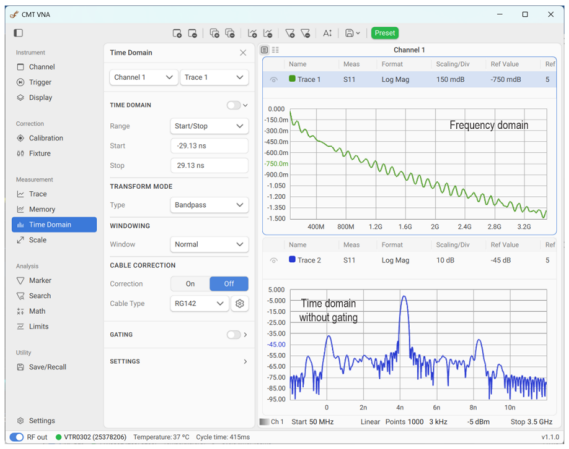
CMT VNA software incorporates many trace functions, such as:



Traces	Data trace, memory trace, or simultaneous indication of data and memory traces.
Static trace	You can recall data from a file and perform any calculation using the full range of functions available in the software.
Trace math	Data trace modification by math operations: addition, subtraction, multiplication or division (normalization) of measured complex values and memory data.
Smoothing	Smoothing averages the adjacent points of the trace by the moving window. Smoothing helps to reduce trace noises. Smoothing is set for each trace independently.
Statistics	The trace statistics feature allows to determine and view trace parameters, such as mean, standard deviation, and peak-to-peak.The range of trace statistics can be defined by two markers or band.
Trace hold	The trace hold function is used to hold the maximum or minimum values of the trace.
Autoscaling	Automatic selection of scale division and reference level value to have the trace most effectively displayed.
Electrical delay	The electrical delay function compensates for the delay of the trace measurement. This function is useful during measurements of phase deviations from linear.
Phase offset	The function applies a chosen constant phase offset to S-parameter measurements at all frequencies.

Time Domain Measurements

This function performs conversion of the DUT response from frequency domain to time domain.



Cable Measurement with Open at the End

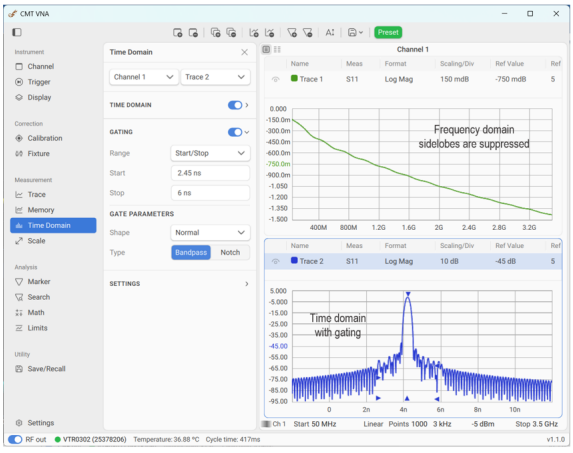
Modeled time domain stimulus types are bandpass, lowpass impulse, and lowpass step.

The time domain span is deter-mined by the frequency span and the number of measurement points.

Windowing functions of various shapes are used for tradeoff between resolution and levels of spurious sidelobes.

Time Domain Gating

This function mathematically removes unwanted responses in the time domain, allowing the user to obtain a frequency response without the effects of fixture elements.

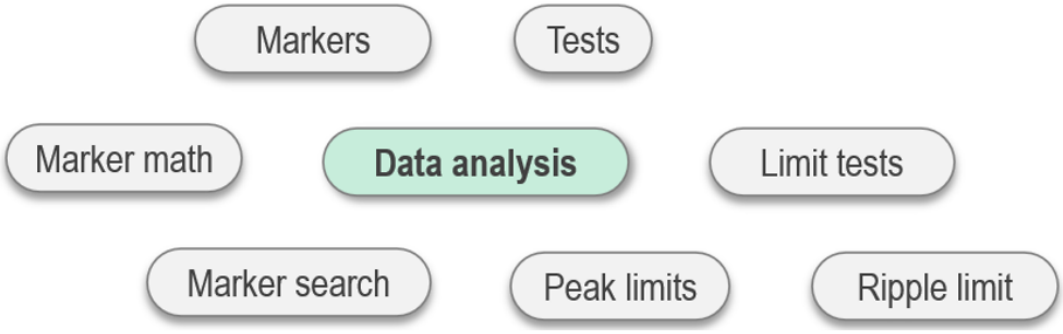


Cable Measurement with Open at the End

Reflections occurring within a chosen time span may be bandpass gated such that all other reflections are suppressed or notch gated such that reflections in the chosen time span are suppressed.

After time domain gating, the result with chosen reflections removed may be viewed in the frequency domain. Gating filter types are 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.

Data Analysis

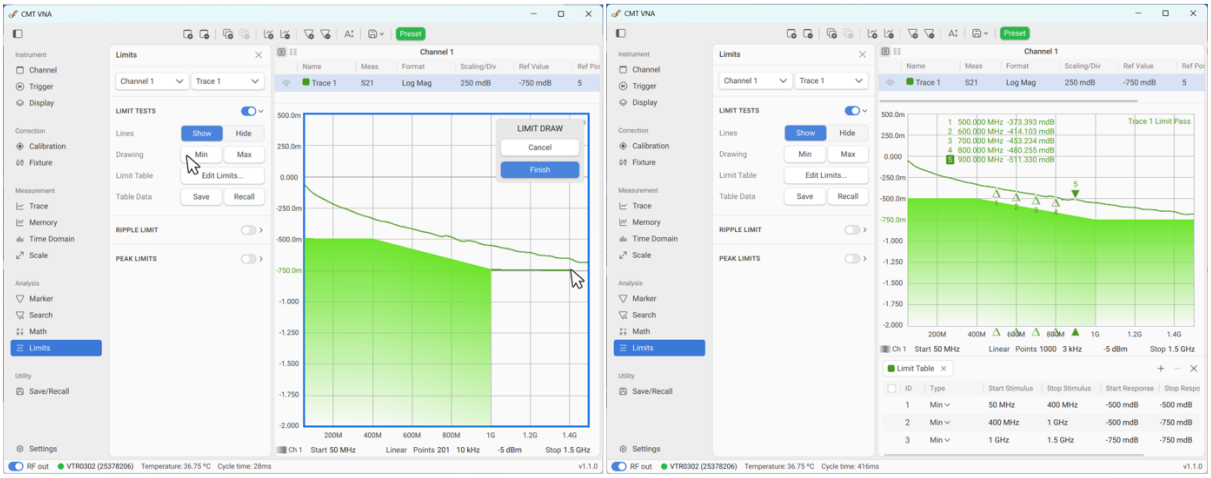


Markers	Marker tools are used to read and look up the numerical values of the stimulus and the measured value on selected points on the graph. The software has no limitations on the number of markers.
Marker search	The marker position search function allows the user to find the following values on a trace: maximum value, minimum value, peak value, target level.
Marker math	Marker math functions use markers to calculate various trace characteristics: trace statistics, bandwidth/notch search, flatness evaluation, RF filter statistics.
Limit tests	The limit test is a function of automatic pass/fail judgment for the trace of the measurement result.
Ripple limit	The ripple limit test is an automatic pass/fail check of the measured trace data. The trace is checked against the maximum ripple value. The ripple value is the difference between the maximum and minimum response of the trace in the trace frequency band.
Peak limits	The peak limits test function checks whether the trace point with the minimum or maximum value of the measured value falls within the specified limits of the frequency range and/or value range.

Limit Testing

Limit testing is a function that provides automatic pass/fail evaluation based on measurement results. The trace is compared against a user-defined limit line, which may consist of one or multiple segments. This function allow users to quickly verify compliance with specified requirements by comparing measurement traces against predefined thresholds. This ensures efficient quality control, accelerates testing, and reduces the risk of overlooking deviations from specifications.

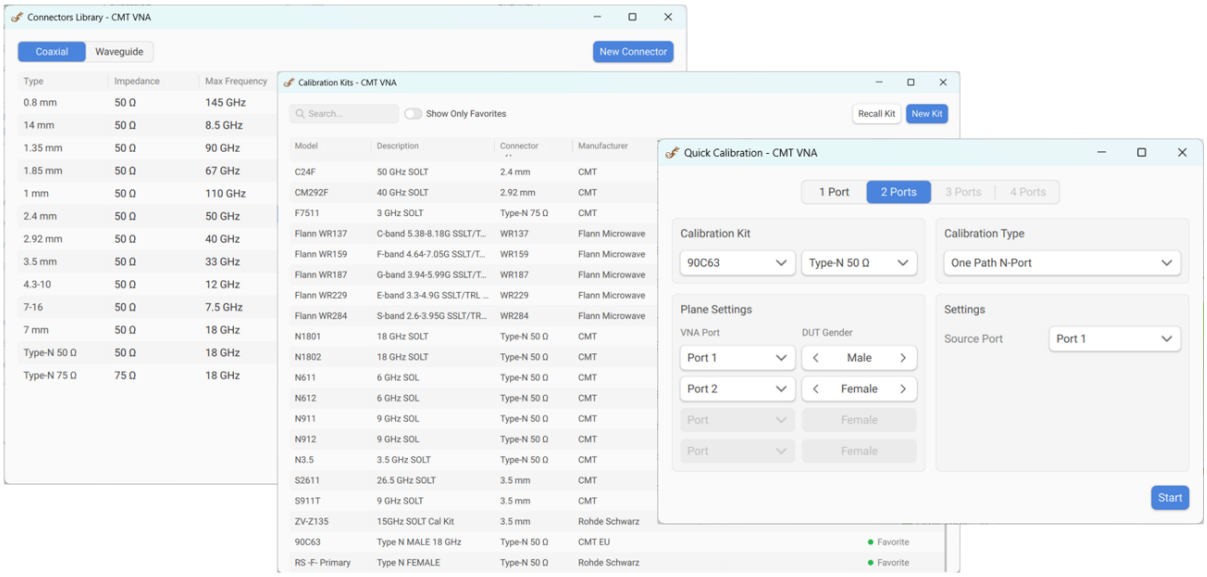
Each segment verifies whether the measurement value exceeds the upper limit, falls below the lower limit, or both. A limit line segment is defined by specifying the start coordinates (X0, Y0) and stop coordinates (X1, Y1), along with the limit type. The MAX and MIN limit types check whether the trace re-mains below or above the defined limit line, respectively.



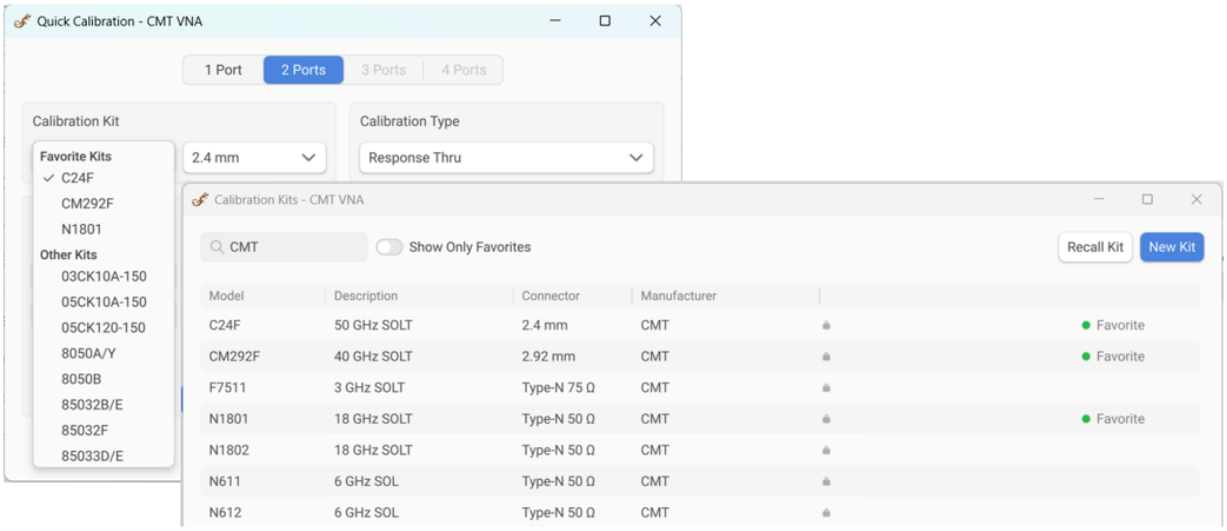
Limit lines can be created either interactively using the mouse or by entering values directly into the limit table. The limit line can be drawn in with more than two points. Alternatively, choose the limit table button and enter the limit line values.

Calibration

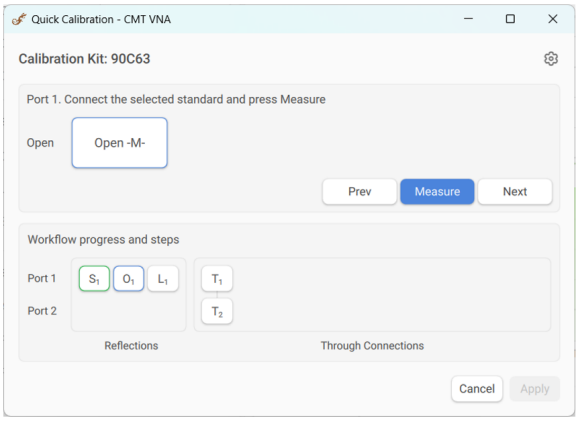
Calibration can be done using the new **Basic calibration wizard**, which allows for easy and intuitive calibration using enabled calibration kits.



Calibration wizard	The basic calibration wizard is a simple and intuitive tool for performing analyzer calibration. It guides the user through the calibration process, indicating which standards need to be connected and how many steps are required.
Calibration methods	The following calibration methods of various sophistication and accuracy are available: reflection (open, short, both open and short) and transmission response, full 1-port calibration, 1-path 2-port calibration.
Error correction interpolation	Interpolation or extrapolation of the calibration coefficients will be applied 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. Extrapolation is not recommended for accurate measurements.
Kit library	This library stores definitions of calibration kits, both predefined and user-created. A search function can be used to locate the required definition. Definitions can be saved to a file and later used at different workstations. Definitions marked as “Favorite” will appear first in the list of available kits during calibration.
Calibration standard definition	Different methods of calibration standard definition are available: standard definition by polynomial model and standard definition by Touchstone data file (S-parameters).
Connector library	This library is designed to store connectors, categorized into coaxial and waveguide types. By default, the library contains a comprehensive set of standardized connectors.

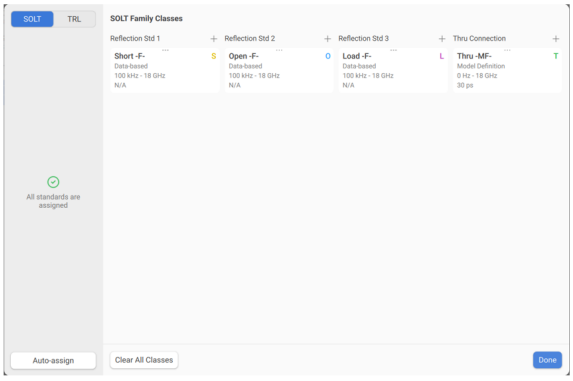


Kit Library with "Favorites" Marked



Basic Calibration Wizard

Calibration of a test setup (which includes the analyzers, cables, and adapters) significantly increases the accuracy of measurements.



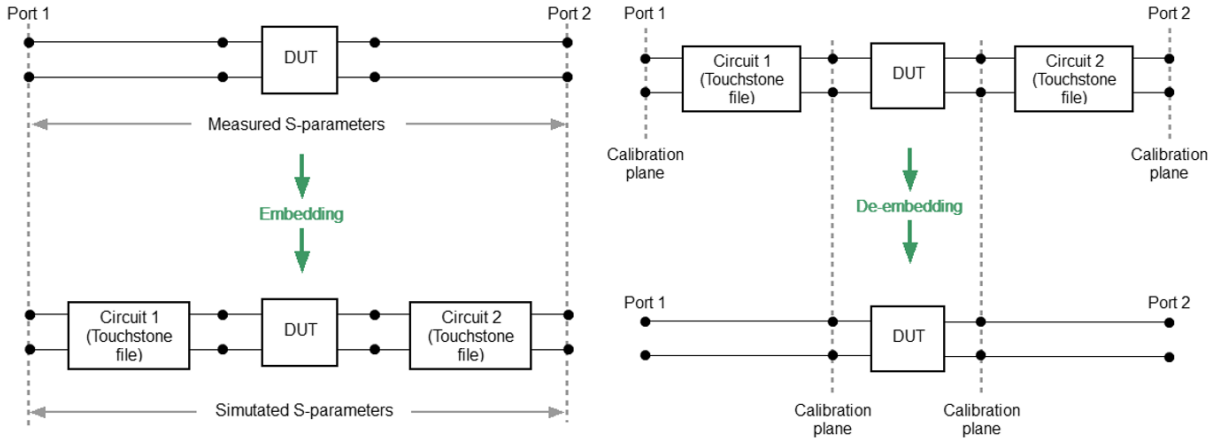
Creating the Kit Definition and Class Assignment

The software allows for class assignment to be done automatically to simplify user kit creation. The assignment is carried out after adding a new standard and selecting its type.

The standards are arranged in a sequence that makes it easy to identify which type of calibration they support. For example, in the figure, the letters SOLT are clearly visible, indicating that the Short, Open, Load, and Thru standards will need to be connected during calibration.

Fixture

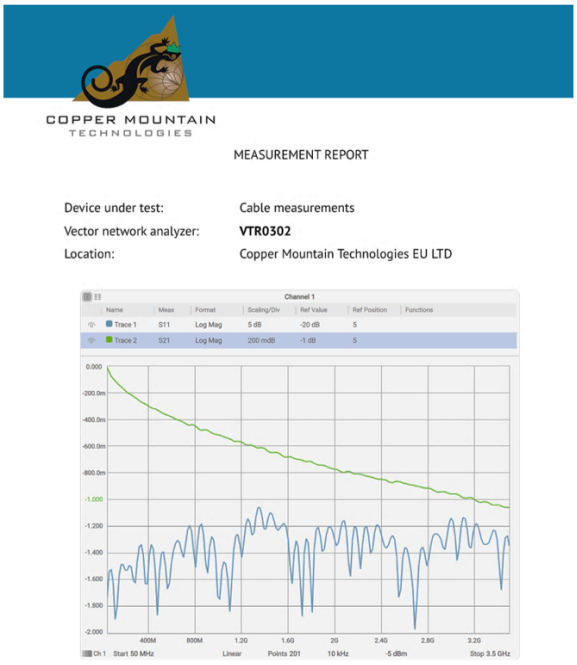
This section includes a set of functions that either modify the position of the calibration plane or recalculate the scattering matrix parameters.



Embedding	Embedding is a function of the S-parameter transformation via integration of some virtual circuit into the real network. The function allows the user to mathematically simulate the DUT parameters after adding the fixture circuits.
De-embedding	De-embedding is a function of transforming the S-parameter by eliminating some circuit effect from the measurement results. The function allows the user to mathematically exclude the effect of the fixture circuit existing between the calibration plane and the DUT in the real network from the measurement results.
Port impedance conversion	Port reference impedance conversion is a function that mathematically converts the matrix of S-parameters measured at the reference impedance of port Z0 to the matrix of S-parameters measured at an arbitrary impedance of port Z1.

Data Output

Analyzer state	All state, calibration and measurement data can be saved to a state file on the hard disk and later recalled into the software. The software supports the Quick Save to List function for storing analyzer settings and quickly switching between saved configurations.
Touchstone files	This selection allows users to save S-parameters to a Touchstone file, which contains frequency values along with the corresponding S-parameters. Touchstone files are an industry-standard format supported by most circuit simulation programs. The .s2p files are used to store all S-parameters of a device, while .s1p files are used to store either the S11 or S22 parameter of a one-port device. Additionally, the software can function as a Touchstone file viewer, enabling users to graphically display and analyze previously saved Touchstone files.
CSV files	This selection allows users to save an individual trace's data as a CSV file (comma separated values).



Template of a Report Generated by CMT VNA Software

Screenshot capture

Screenshots can be printed using three different applications: MS Word, Image viewer for Windows, or the Print wizard.

Each screenshot can be printed in color, grayscale, or inverted for visibility or to save ink.

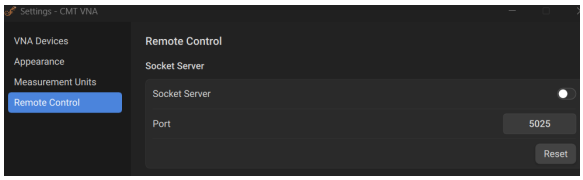
The current date and time can be added to each capture before it is transferred to the printing application, resulting in quick and easy test reporting.

A Word template file can be customized to change the appearance of the MS Word file output.

This function enables users to save measurement data in accordance with a predefined template, with the capability to incorporate supplementary information regarding the operator, the device under test (DUT), and the experimental conditions.

Automation

We maintain code examples and guides in the following languages:



Remote Control in the Settings

SCPI via TCP Socket

Alternatively a TCP socket is provided for automation from either localhost - the same machine running the analyzer software application - or from a second PC connected by an IP network. The SCPI commands are largely compatible with legacy instruments, maximizing code reuse for existing test automation platforms

SCPI via TCP Socket can be used with either Windows or Linux operating systems.

LabVIEW Compatible

The instrument and its software are fully compatible with LabVIEW applications, for ultimate flexibility in user-generated programming and automation. LabVIEW can be used with Windows OS only.

Hardware Specifications

VTR0102 and VTR0302

All specifications subject to change without notice.

Measurement Range

Impedance	50 Ohm
Test port connector	type N, female
Configuration	2-port, 1-path
Number of transmitter ports	1
Number of receiver ports	1
Frequency range	
VTR0102	50 MHz to 1.5 GHz
VTR0302	50 MHz to 3.5 GHz
Full frequency accuracy	$\pm 10 \cdot 10^{-6}$
Frequency resolution	1 Hz
Number of measurement points	2 to 200,001
Measurement bandwidths (with 1/1.5/2/3/5/7 steps)	1 Hz to 300 kHz
Dynamic range[2] (receiver att = 12dB)	110 dB (120 dB typ.)

[2] The dynamic range is defined as the difference between the specified maximum transmitter power level and the specified noise floor.

The specification applies at 10 Hz IF bandwidth.

Measurement Accuracy[3]

Accuracy of transmission measurements[4]	Magnitude / Phase (S_{11} = S_{22} = 0)	Magnitude / Phase (S_{11} = S_{22} = 0.1)
0 dB to 10 dB	±0.30 dB / ±2.5°	±0.40 dB / ±3.0°
-30 dB to 0 dB	±0.20 dB / ±2.0°	±0.30 dB / ±2.5°
-50 dB to -30 dB	±0.30 dB / ±2.5°	±0.40 dB / ±3.0°
-70 dB to -50 dB	±1.2 dB / ±8.0°	±1.3 dB / ±8.5°
Accuracy of reflection measurements[5]	Magnitude/Phase	
-10 dB to 0 dB	±0.5 dB / ±4.5°	
-20 dB to -10 dB	±1.1 dB / ±8.0°	
-30 dB to -20 dB	±3.5 dB / ±20.5°	
Trace noise magnitude	0.004 dB rms	
Temperature dependence	0.03 dB/°C	

[3] Reflection and transmission measurement accuracy applies over the temperature range of (73 ± 9) °F or (23 ± 5) °C after 60 minutes of warming-up, with less than 1 °C deviation from the calibration temperature, at output power of -10 dBm. Frequency points have to be identical for measurement and calibration (no interpolation allowed).

[4] Transmission specifications are based on a matched DUT and DUT with S11=S22=0.1, IF bandwidth of 10 Hz.

[5] Reflection specifications are based on an isolating DUT.

Effective System Data

50 MHz to 3.5 GHz	
Directivity	40 dB
Source match	36 dB
Load match	20 dB
Reflection tracking	±0.15 dB
Transmission tracking	±0.20 dB

Uncorrected System Performance

50 MHz to 2.5 GHz	
Directivity	15 dB (18 dB typ.)
Source match	15 dB
Load match	20 dB (25 dB typ.)
2.5 GHz to 3.5 GHz	
Directivity	8 dB (10 dB typ.)
Source match	12 dB
Load match	20 dB (25 dB typ.)

Transmitter Output

Power range	-25 dBm to +0 dBm
Power accuracy	±2 dB
Harmonic distortion[6]	
50 MHz to 1.0 GHz	-9 dBc
1.0 GHz to 3.5 GHz	-15 dBc

[6] Specification applies over full frequency range, at max output power.

Receiver Input

Receiver max input power (receiver att = 12 dB)	0 dBm
Noise floor[7]	-120 dBm/Hz
Receiver attenuator range	18 dB
Damage level	+23 dBm
Damage DC voltage	25V

[7] Receiver noise floor specification includes crosstalk effect.

Measurement Speed

Time per point	35 µs typ.

System and Power

CMT VNA software:	
Operating system (min requirements)	Windows 10, Ubuntu 24.04
CPU	4 core 2.0 GHz (x64 or arm64)
RAM	8 GB
Interface	USB 2.0
Connector type	Type C
Input power	
Voltage range	9 V DC to 15 V DC
Power consumption	10 W
Connector designation	12 V DC 1.2 A
Connector type	KPJX-4S-S

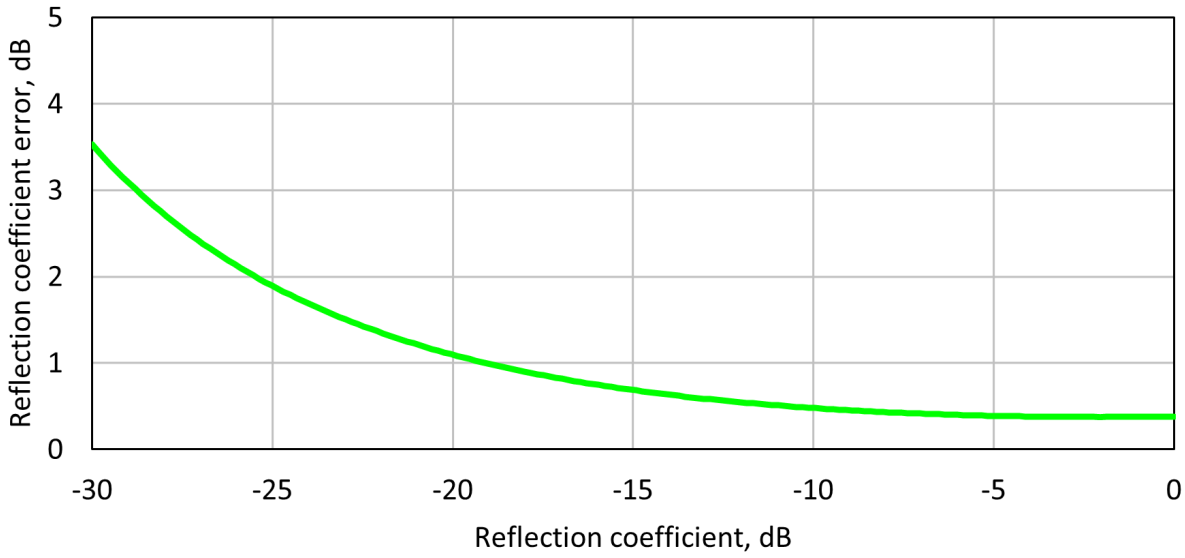
Dimensions

Length	160 mm
Width	297 mm
Height	44 mm
Weight	1.5 kg (53 oz)

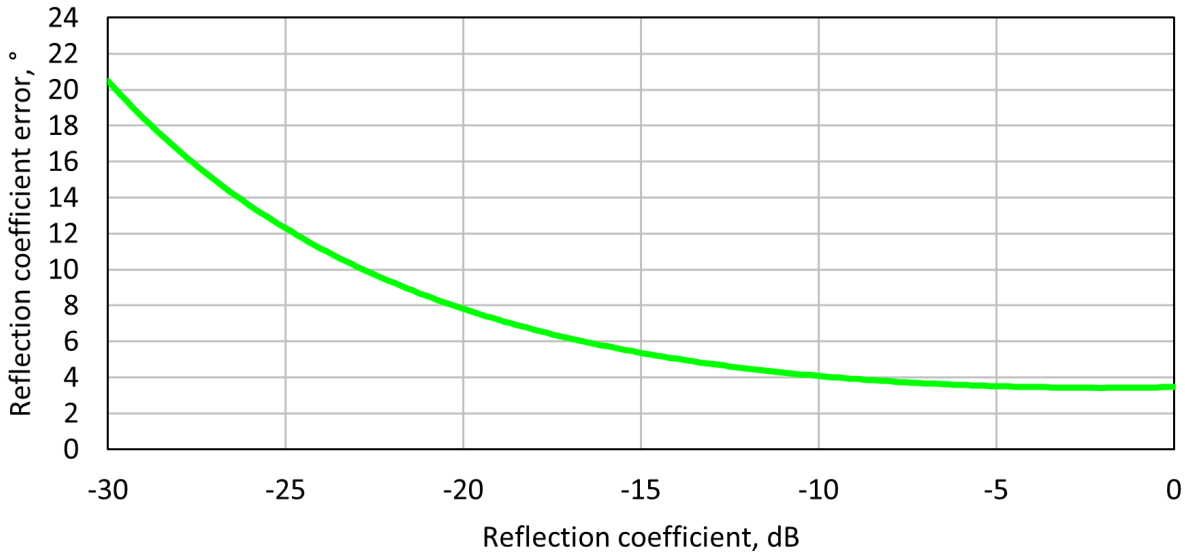
Environmental Specifications

Operating condition	
Temperature	+5 °C to +40 °C (41 °F to 104 °F)
Humidity	90 % at 25 °C (77 °F)
Storage	
Temperature	+0 °C to +40 °C (32 °F to 104 °F)
Humidity	80 % at 35 °C (95 °F)
Non-operating temperature	-50 °C to +70 °C (-58 °F to 158 °F)
Atmospheric pressure	70.0 kPa to 106.7 kPa

Reflection Magnitude Errors

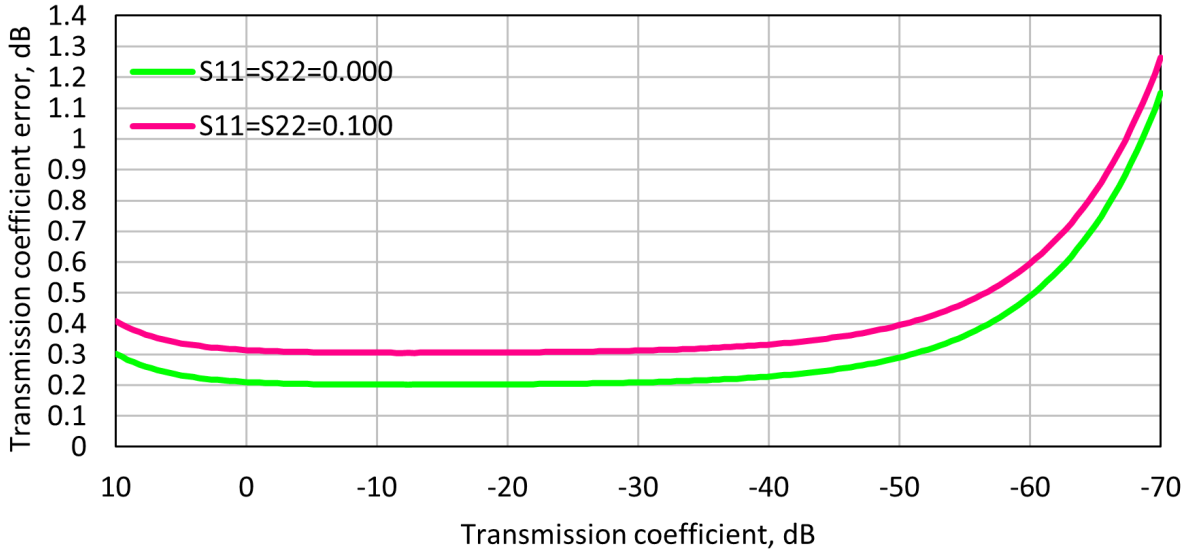


Reflection Phase Errors

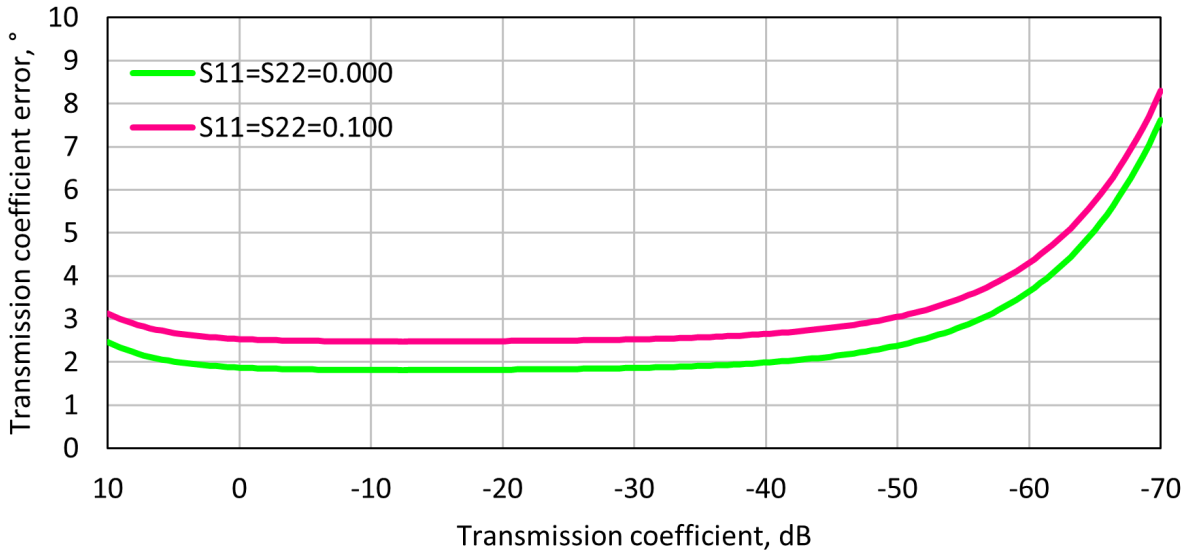


Specifications are based on isolating DUT (S21 = S12 = 0)

Transmission Magnitude Errors



Transmission Phase Errors



Specifications are based on a matched DUT and DUT with S11=S22=0.1, IF bandwidth of 10 Hz