COPPER MOUNTAIN®
TECHNOLOGIES

631 E New York Street | Indianapolis, IN 46202 USA
www.coppermountaintech.com

TR Series Vector Network Analyzer Specifications

Revision 25.00 02.09.2025

U.S.: +1.317.222.5400
Latin America: +1.9154.706.5920
Singapore: +65.63.23.6546
EMEA: +44 75 03 69 21 13

Contents

The Whole Solution

Warranty, Service, & Repairs - the Crown Service Package

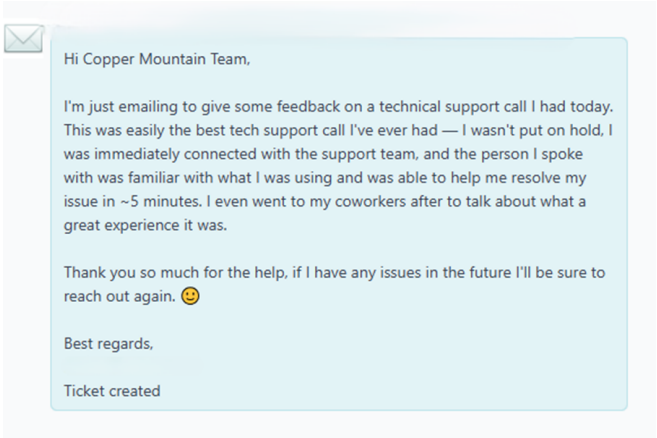
All our products come with a standard three-year warranty from date of shipment. During that time we will repair or replace any product malfunctioning due to defective parts or labor.

While we pride ourselves on quality of our instruments, should your VNA malfunction for any reason, we will gladly offer a loaner unit while we service yours. With our USB VNAs where all data is stored on your PC, a simple swap of the measurement module assures uninterrupted workflow and little or no downtime.

Our Engineers Are an Extension of Your Team

Our team of applications engineers, service technicians, and metrology scientists are here to help you with technical support, application-specific recommendations, annual performance testing, and troubleshooting or repair of your CMT instruments.

Our engineers will work with your team to augment your in-house capabilities. We can write custom applications and test software, develop test automation scripts and help with integrated RF system testing. We can design suitable test setups, assist with advanced calibration techniques such as fixture removal, and help achieve metrology-grade measurements with high accuracy. If the S-parameter measurement fixture involves challenging conditions for repeatability and accuracy we can assist with measurement uncertainty analysis.



An extensive library of technical materials including application notes, tips on performing VNA measurements, sample automation scripts, and how-to videos are available on our website www.coppermountaintech.com and YouTube channel, CopperMountainTech.

Periodic Verification

Copper Mountain Technologies' Indianapolis calibration laboratory is accredited in accordance with the recognized international standard ISO/IEC 17025:2017 and meets the requirements of ANSI/NCSL Z540-1994-1. All reference standards and equipment in the laboratory are traceable to National Institute of Standards and Technology (NIST) or international equivalent.

Should you prefer to perform the annual verificatiion yourself or use a third party, contact us for information on performing these procedures. Additionally, the VNA Performance Test (VNAPT) software application is available for third party laboratories without restriction. Use of VNAPT to execute performance tests is optional, but the software is designed to automate and streamline VNA performance testing, including automatic generation of test reports. Please contact Copper Mountain Technologies or your local CMT channel partner for recommended calibration options.

The Software Application is Part of the VNA

The software application takes raw measurement data from the data acquisition (measurement) module and recalculates into S-parameters in multiple presentation formats utilizing proprietary algorithms. These new and advanced calibration and other accuracy enhancing algorithms were developed by our metrology experts. Our 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 VNA integration with other software applications and measurement automation. The software application features a fully functioning Demo Mode, which can be used for exploring the VNAs' features and capabilities without an actual measurement module connected to your PC.

Standard Measurement Capabilities

Measurement Parameters

S11, S21

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

Frequency Range

VTR0102	50 MHz to 1.5 GHz
VTR0302	50 MHz to 3.5 GHz

Sweep Types

Linear frequency sweep and logarithmic frequency sweep are performed with fixed output power. Linear power sweep is a fixed frequency.

Dynamic Range

The typical dynamic range of 120 dB is achieved from 50 MHz through the top of the frequency range (at 10 Hz IF bandwidth).

Output Power Adjustment Range

Source power from -25 dBm to 0 dBm with a resolution of 0.05 dB. In frequency sweep mode power slope can be set up to 2 dB/GHz to compensate for high frequency attenuation in fixture cables.

Measurement Time Per Point

The measurement time per point for the VTR0102 and VTR0302 is typically 35 µs.

Number of Measured Points

The number of measured points for the VTR0102 and VTR0302 is up to 200,001.

CMT VNA Software

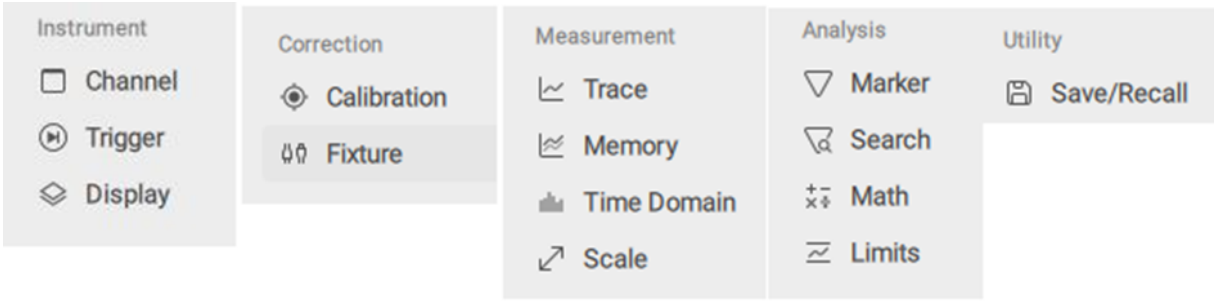
CMT VNA Software Included with Every VNA

TR Series VNAs include the CMTVNA Software for performing S-parameter measurements. It can be installed on as many computers as needed - allowing multiple users to share the same measurement module while storing measurement data on each individual PC. CMTVNA is able to run natively on Windows and Linux. CMTVNA runs on both x86-based or arm-based processors, which allows it to run on Raspberry pi (for example Raspberry pi with Ubuntu 24.04 LTS or Debian 13 Trixie).

Our Applications Engineering team offers support to answer any questions regarding software usage, measurements, or other concerns with CMT products.

Intuitive User Interface

The user interface of CMT VNA allows you to see all available options in each submenu without the need to go through many submenu layers. The main menu panel remains visible unless manually hidden, allowing for quick navigation between different functions.



Capabilities

CMT VNA can be used to perform many different types of measurements and tests such as Peak Limit Testing, , Port Extension, and more.

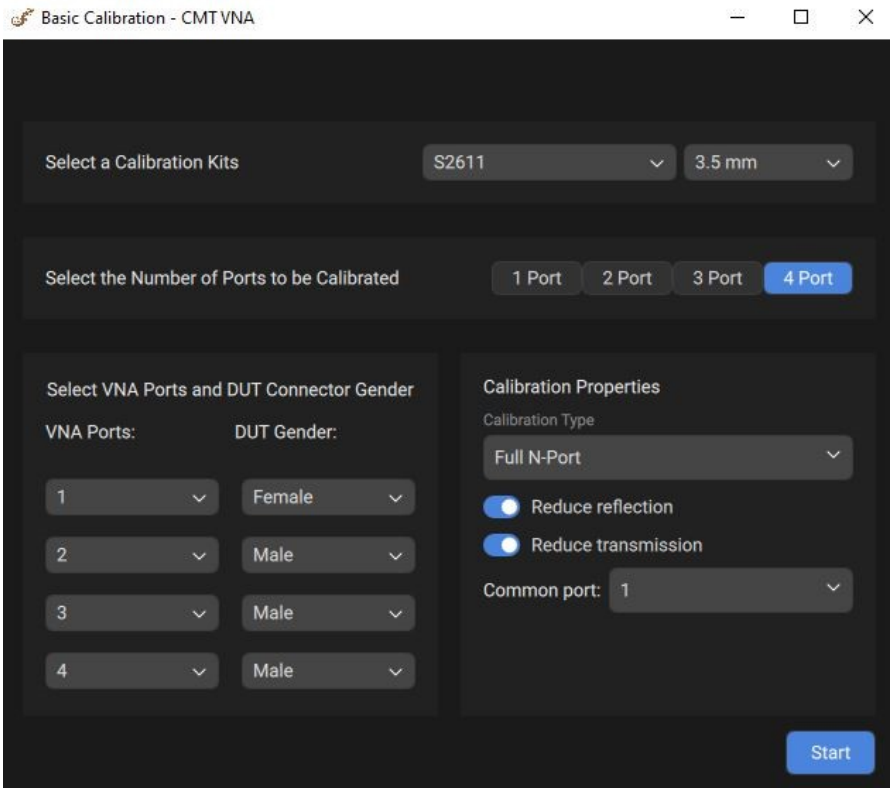
The following are some key measurements that CMT VNA allows users to perform using TR Series VNAs:

- Insertion Loss and Return Loss for Cables
- Insertion Loss and Return Loss for filter/diplexer tuning
- Gain/stability measurement for Amplifiers

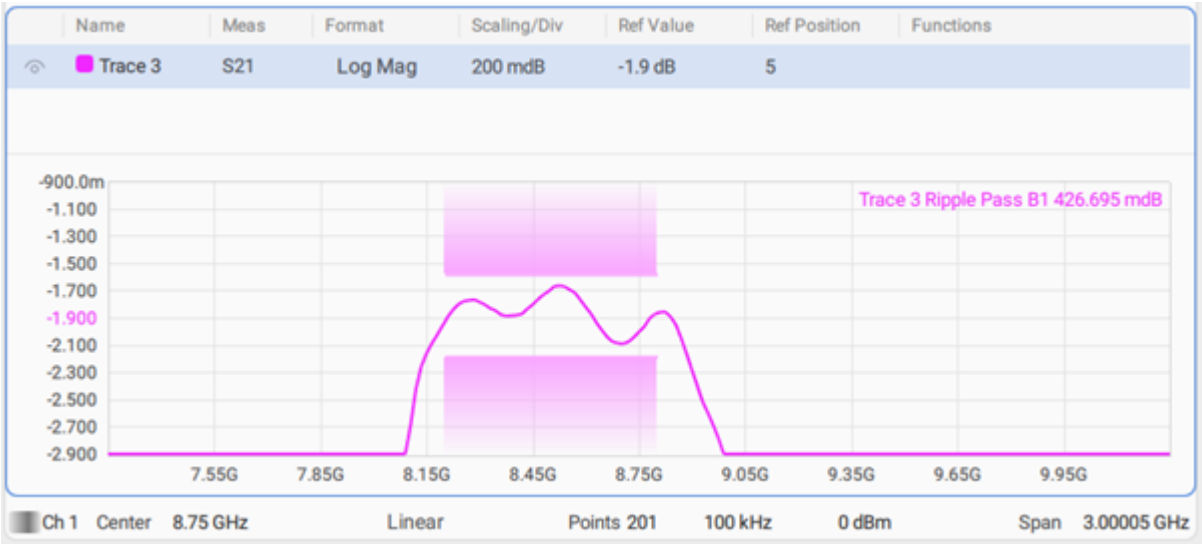
CMT VNA allows user to have as many channels as needed, allowing for precise customization of every measurement through the individualized settings and calibration of each channel. CMT VNA also has a new feature that allows user to zoom in on a portion of the trace by left-clicking over the graph to drag a box around the desired area.

Limit lines may be drawn using the mouse or entered into the limit table directly. The limit line can be drawn in with more than two points. Alternatively, choose the Limit Table button and enter the limit line frequencies and levels numerically.

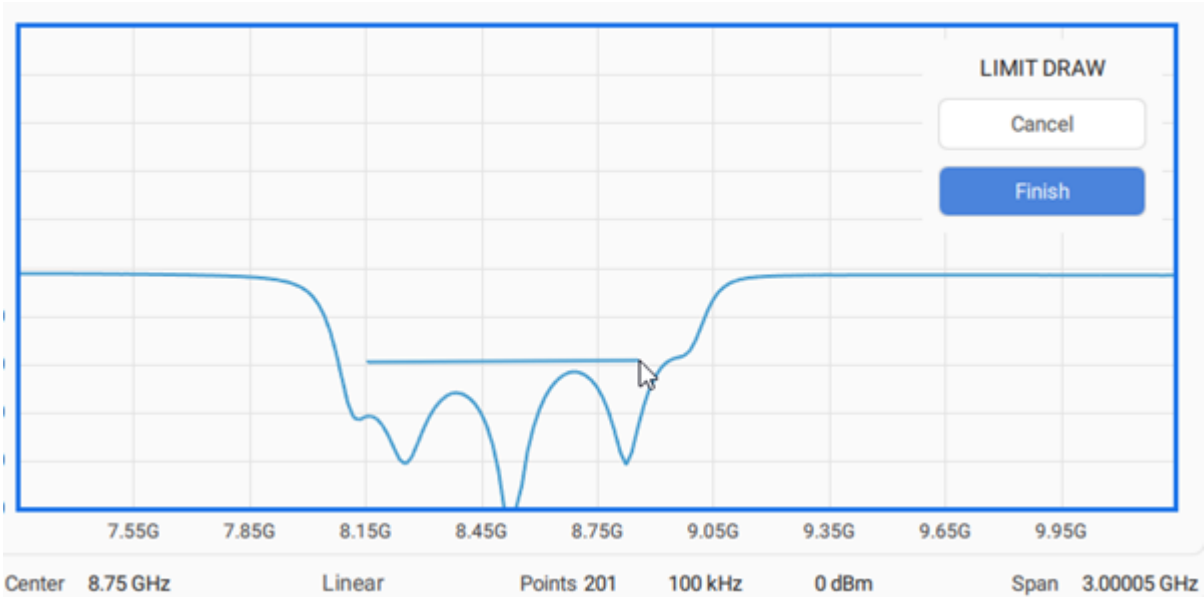
Calibration can be done using the new Basic Calibration Wizard, which allows for easy and intuitive calibration using enabled calibration kits.



Basic Calibration Wizard



Ripple Limit Test



Drawing a Limit Line

Software Capabilites Overview

Included Software Capabilities

Capability	Overview
Port Extension	This function is useful when a fixture is used to connect to the DUT but calibration cannot be performed at the DUT terminals.
Power Sweep	Allows the VNA to sweep the stimulus power from one level to another at a single frequency.
Mixer/Converter Measurements	Our analyzers allow users to perform measurements on mixers and other frequency converting devices using both scalar and vector methods.
Time Domain Gating	This function performs a time domain transformation, selects the region in the time domain, deletes the response (outside or inside) the selected region, and transforms the data back to the frequency domain.

Limit Testing	A function for automatic pass/fail based on measurement results.
Embedding	This function allows the user to mathematically simulate the DUT parameters after adding fixture circuits.
De-Embedding	This function allows the user to mathematically exclude the effect of the fixture circuit existing between the calibration plane and the DUT from the measurement results.
Trace Calculation	This function performs mathematical processing of measurement data according to the specified algebraic equation and displays the results on the trace calculator.

Available Software Options

Capability	Overview
AFR	Automatic Fixture Removal (AFR) is an intuitive software plug-in that is used to accurately measure hard to access devices, such as SMD sized components mounted on a fixture by de-embedding the fixture effects. The AFR VNA software plug-in enables the measurement of a wide range of components through comprehensive methods tailored to specific fixture properties.
Manufacturing Plug-In	The Manufacturing Test Plug-in supports incorporating VNA software into automated manufacturing and QA process.

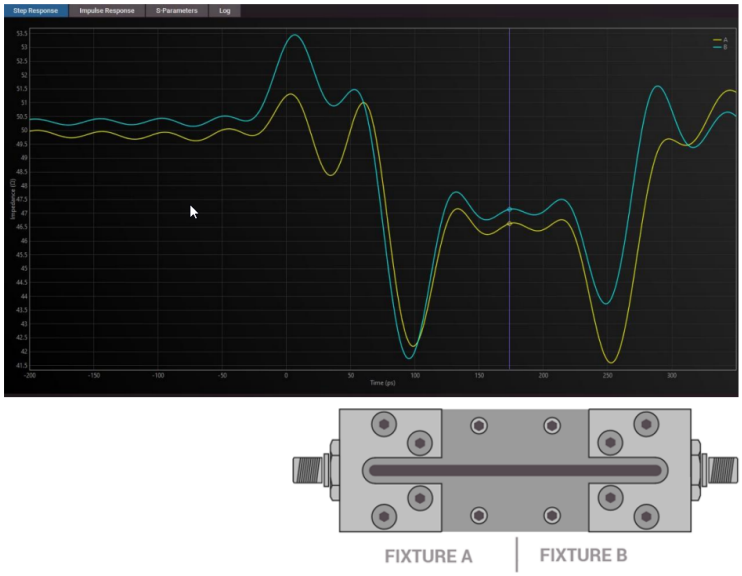
Available Software Options

Optionally Available Features

Software plug-ins can add wide ranges of functionality and can be developed upon request. Examples include streamlined production applications, functionality to trigger with external generators, and virtual circuit impedance match modeling.

Automatic Fixture Removal

Automatic Fixture Removal (AFR) VNA software option enables the measurement of a wide range of components through comprehensive methods tailored to specific fixture properties. The intuitive AFR software moves the calibration plane towards hard-to-access DUTs and guides the de-embedding process using either time-gating, filtering, or bisection methods. These methods eliminate the effects of fixture reflections and allow accurate measurement of the DUT alone. The AFR software option is easy to use and is compatible with most CMT VNAs.



Automatic Fixture Removal

The Automatic Fixture Removal (AFR) option uses metrology grade de-embedding algorithms to eliminate fixture effects on your DUT. AFR supports three methods of de-embedding methodologies:

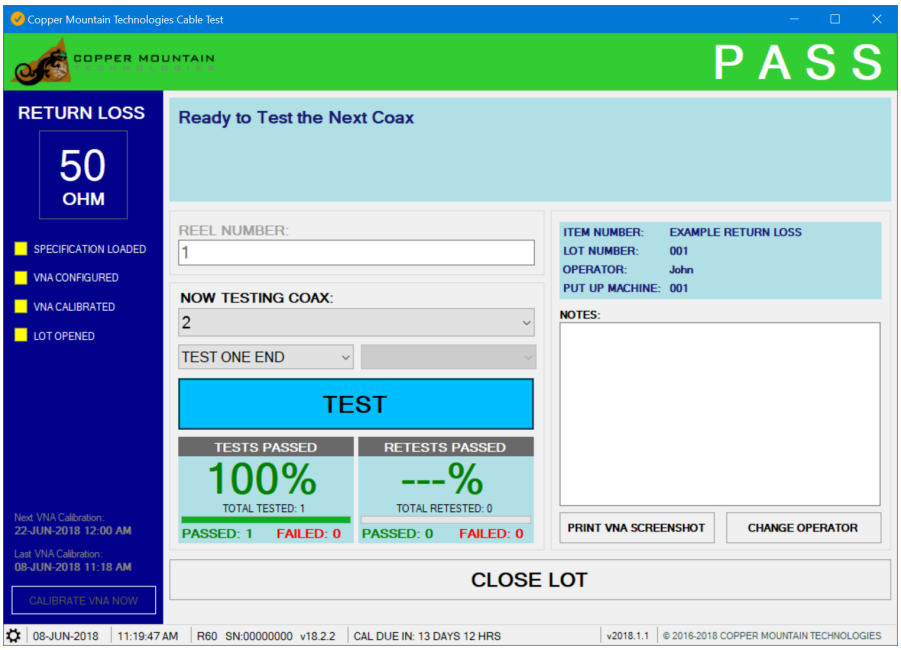
- Time-gating approach is ideal for fixtures with fixture lead-in and lead-out lengths long enough to support two or more wavelengths of the highest measurement frequency.
- Filtering algorithm is useful in cases where fixture lead-in and lead-out lengths are at the minimum for time domain gating.

- Bisect method covers instances with short electrical length of fixture lead-in and lead-out where there is not two or more wavelengths of the highest measurement frequency and the fixture has insufficient length to support time-domain gating.

Manufacturing Test Plug-in

The Manufacturing Test Plug-in automates VNA measurement for the manufacturing and QA process:

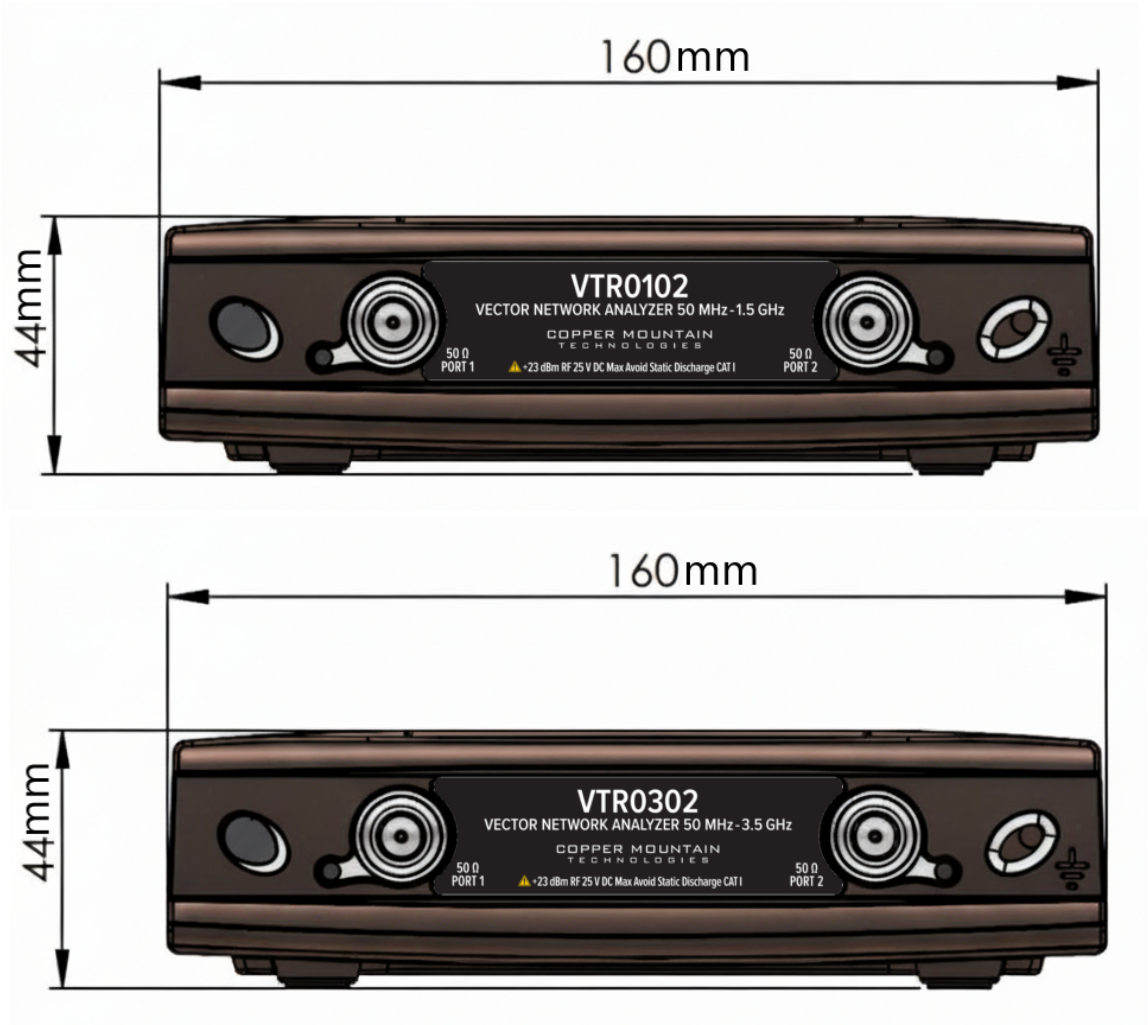
- Streamline production test processes in an intuitive wizard-like UI, built for non-technical users.
- Ensure consistency of test process across multiple operators and workstations.
- Easily create and manage pass/fail limits across multiple workstations. Pass/fail limits and instrument configuration are stored in a human-readable plaintext specifications file, which can be maintained by an authorized test engineer.
- Organize test results for subsequent retrieval and analysis.
- 20 hours of customization by our Engineering staff included
- Can adapt to any specific production test process and QMS requirements.



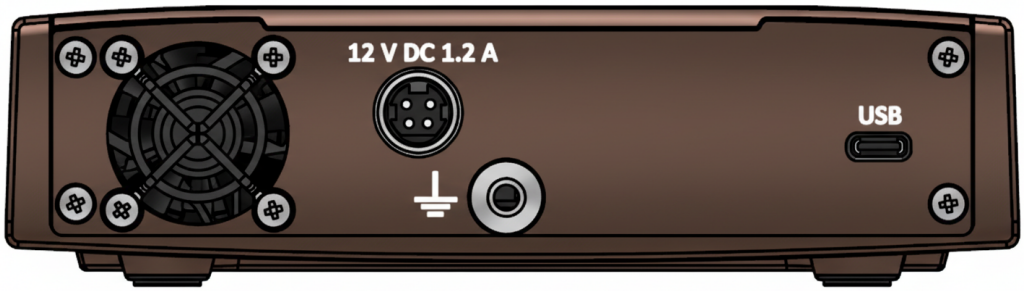
Manufacturing Test Plug-in

Hardware Specifications

Panels with Dimensions



VTR0102 and VTR0302 Front Panel



VTR0102 and VTR0302 Rear Panel

TR Series

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 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 40 minutes of warming-up,

with less than 1 °C deviation from the full two-port calibration temperature, at output power of 0 dBm. Frequency points have to be identical for measurement and calibration (no interpolation allowed).

[4] Transmission specifications are based on a matched DUT, and IF bandwidth of 1 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 5.5 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	35V

[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