



COPPER MOUNTAIN
TECHNOLOGIES

Vector Network Analyzers

Performance Test Procedure Equipment Summary

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1 INTRODUCTION

Vector network analyzers (VNA) are designed for measuring S-parameters of RF and microwave devices. Except as noted, all models are referred to interchangeably in this document as “the analyzer”.

THIS DOCUMENT DESCRIBES COMMONLY-USED TEST EQUIPMENT REQUIRED FOR PERFORMING VNA PERFORMANCE TEST PROCEDURE BY CONVENTIONAL DIRECT METHODS.

THE DOCUMENT CAN BE USED BY THIRD-PARTY CALIBRATION LABORATORIES.

The document is intended to familiarize with:

- All groups of the vector network analyzers provided.
- All test equipment required.
- Common recommendations.

2 SUPPORTING

Copper Mountain Technologies (CMT) provides a variety of vector network analyzers to accommodate a wide range of test and measurement needs. All instruments are combined into 4 main groups depending on its purpose, specification and functional capabilities: Cobalt series, Full Size VNAs, Compact series, as well as 1 Port VNAs (cable and antenna analyzers).

The product line is also divided into 4 types: R, TR, S2 and S4. The R instruments are 1-port VNAs, and the S4 group contains 4-port VNAs. The S2 and TR groups both contain 2-port VNAs. S2 instruments are capable of 2-port, 2-path measurements while TR instruments are capable of 2-port 1-path measurements (S11 and S21 only).

Each product group (R, TR, S2, and S4) is supported by its own VNA software application, named RVNA, TRVNA, S2VNA, and S4VNA respectively. Each of these applications contains a COM server that enables other programs to access its functionality. Automation of the VNA requires that the COM server be registered with Windows.

Detailed information on specifications and software applications for all supported instruments is available at:

www.coppermountaintech.com

3 PERFORMANCE TEST LIST

Table 1 - Analyzer performance tests

Test description	COBALT	FULL SIZE	COMPACT	1-PORT ANALYZERS
Visual inspection	☑	☑	☑	☑
Gaging connectors	☑	☑	☑	☑
Frequency accuracy test	☑	☑	☑	☑
Output power level accuracy test	☑	☑	☑	☒
Harmonic distortion test	☒	☑	☑	☒
Non-harmonic spurious test	☒	☑	☑	☒
Receiver noise floor test	☑	☑	☑	☒
Trace noise magnitude test	☑	☑	☑	☒
Uncorrected parameters test	☑	☑	☑	☑
Transmission coefficient magnitude and phase accuracy test	☑	☑	☑	☒
Reflection coefficient magnitude and phase accuracy test	☑	☑	☑	☑

4 TEST EQUIPMENT

Table 2 – Summary list of main test equipment for performing each test across the verification procedure

Test description	Main test equipment
Visual inspection	–
Gaging connectors	Gauging kit
Frequency accuracy test	Frequency counter or spectrum analyzer
Output power level accuracy test	Power sensor
Harmonic distortion test	Spectrum analyzer
Non-harmonic spurious test	Spectrum analyzer
Receiver noise floor test	Matched loads
Trace noise magnitude test	Open or short standard from calibration kit
Uncorrected parameters test	Calibration kit
Transmission coefficient magnitude and phase accuracy test	Calibration kit Verification kit: Attenuators
Reflection coefficient magnitude and phase accuracy test	Calibration kit Verification kit: Stepped air line Mismatched loads for 1-port and TR analyzers

Table 3 – Recommended equipment list

Test description	COBALT type N (50 Ω)	COBALT 3.5 mm	FULL SIZE type N (50 Ω)	COMPACT S type N (50 Ω)	COMPACT TR type N (50 Ω)	COMPACT S type N (75 Ω)	COMPACT TR type N (75 Ω)	1-PORT ANALYZERS type N (50 Ω)	1-PORT ANALYZERS 3.5 mm
Gaging connectors ¹⁾	05GK0KS-010 03GK0KS-010	03GK0KS-010	05GK0KS-010 03GK0KS-010	05GK0KS-010	05GK0KS-010	P5GK0KS-010	P5GK0KS-010	05GK0KS-010	03GK0KS-010
Frequency accuracy test ²⁾	53150A	53150A	53150A	53150A	53150A	53150A	53150A	53150A	53150A
Output power level accuracy test ³⁾	NRP-Z51	NRP-Z52	NRP-Z51	NRP-Z51	NRP-Z51	NRP-Z51	NRP-Z51	–	–
Harmonic distortion test ⁴⁾	–	–	E4407B	E4407B	E4407B	E4407B	E4407B	–	–
Non-harmonic spurious test ⁴⁾	–	–	E4407B	E4407B	E4407B	E4407B	E4407B	–	–
Receiver noise floor test ⁵⁾	05S150-C10S3	03K150-C10S3	05S150-C10S3	05S150-C10S3	05S150-C10S3	P5S170-C1AS3	P5S170-C1AS3	–	–
Trace noise magnitude test ⁶⁾	85054D	85052D	85054D	85054D	85054D	85036B	85036B	–	–
Uncorrected parameters test ⁷⁾	85054D	85052D	85054D	85054D	85054D	85036B	85036B	85054D	85052D

Test description	COBALT type N (50 Ω)	COBALT 3.5 mm	FULL SIZE type N (50 Ω)	COMPACT S type N (50 Ω)	COMPACT TR type N (50 Ω)	COMPACT S type N (75 Ω)	COMPACT TR type N (75 Ω)	1-PORT ANALYZERS type N (50 Ω)	1-PORT ANALYZERS 3.5 mm
Transmission coefficient magnitude and phase ac- curacy test ^{7), 8), 10)}	85054D 85055A	85052D 85053B	85054D 85055A	85054D 85055A	85054D 85055A	85054D 85055A	85054D 85055A	–	–
Reflection coefficient mag- nitude and phase accuracy test ^{7), 9), 10)}	85054D 85055A	85052D 85053B	85054D 85055A	85054D 85055A	85054D 2561C, 2561G 2562C, 2562G	85054D 85055A	85054D 2561C, 2561G 2562C, 2562G	85054D 2561C, 2561G 2562C, 2562G	85052D 8033A1.20 8033A2.00 8033B1.20 8033B2.00

- 1) For **gaging connectors**, any gauging kit with appropriate gender that has scale graduation 1 µm and accuracy not larger than ±6 µm can be used.
- 2) For **frequency accuracy test**, any frequency counter or spectrum analyzer with accuracy $\pm 1 \times 10^{-7}$ can be used.
- 3) For **output power level accuracy test**, any power sensor with accuracy 0.15 dB at 0 dBm that covers operating frequency range of the analyzer under test can be used.
- 4) For **harmonic distortion and non-harmonic spurious tests**, any spectrum analyzer with relative power measurement accuracy ±2 dB can be used.
- 5) As matched loads, any general purpose loads with VSWR not larger than 1.1 can be used. Quantity of the loads should be equal to the quantity of test ports of the analyzer under test.
- 6) For **trace noise magnitude test**, one should use short (or open) standard from calibration kit.

- 7) It's recommended to use calibration kit with data-based standard definitions that covers operating frequency range of the analyzer under test.
- 8) For ***transmission coefficient magnitude and phase accuracy test***, two attenuators with known S-parameters should be used. These attenuators contain in verification kit.
- 9) For ***reflection coefficient magnitude and phase accuracy test***, stepped air line with known S-parameters should be used. This line contains in verification kit. For 1-port and TR analyzers, one should use mismatched loads instead stepped line.
- 10) It's allowed to use verification devices with type N (50 Ω) connectors for verification of analyzers with type N (75 Ω) connectors. In the case, corresponding adapters should be connected to test ports of the analyzer under test.

Table 4 – Links to recommended equipment

Test description		Equipment
Gaging connectors	Gauging kit	05GK0KS-010 (type N, 50 Ω)
		P5GK0KS-010 (type N, 75 Ω)
		03GK0KS-010 (3.5 mm)
Frequency accuracy test	Frequency counter	53150A
Output power level accuracy test	Power sensor	NRP-Z51 (type N, 50 Ω),
		NRP-Z52 (3.5 mm)
Harmonic distortion test	Spectrum analyzer	E4407B
Non-harmonic spurious test	Spectrum analyzer	E4407B
Receiver noise floor test	Matched loads	05S150-C10S3 (type N, 50 Ω)
		P5S170-C1AS3 (type N, 75 Ω)
		03K150-C10S3 (3.5 mm)
Trace noise magnitude test	Calibration kit	85054D (type N, 50 Ω)
Uncorrected parameters test		85036B (type N, 75 Ω)
		85052D (3.5 mm)
Transmission coefficient magnitude and phase accuracy test	Attenuators	85055A (type N, 50 Ω)
		85053B (3.5 mm)
Reflection coefficient magnitude and phase accuracy test	Stepped air line	85055A (type N, 50 Ω)
		85053B (3.5 mm)
	Mismatched loads	8033A1.20 , 8033A2.00 (3.5 mm)
		8033B1.20 , 8033B2.00 (3.5 mm)
		2561C , 2561G (type N, 50 Ω)
		2562C , 2562G (type N, 50 Ω)

Table 5 – Additional equipment

Equipment	Description
Phase- and amplitude-stable test cable	The cable allows to reach more stability and repeatability effects during reflection and transmission measurement.
Metrology or instrument grade adapters	These adapters are used if power sensor connector does not correspond to test port of the analyzer under test, as well as it's recommended to use them along with phase- and amplitude-stable test cable.
Impedance matching pad	50 Ω to 75 Ω matching adapter. It should be connected to power sensor during power measurement of 75 Ω analyzers.
50 Ω to 75 Ω adapters	It should be connected to test ports of 75 Ω analyzers during reflection and transmission measurement, if 50 Ω standards are chosen as verification devices.
General purpose coaxial adapters and RF cable	It can be required for connection during frequency measurement.
Torque wrench	Size 20 mm, torque range 1.1 to 1.7 Nm; Size 8 mm, torque range 0.8 to 1.0 Nm.
Wrench (spanner)	Sizes which fit devices to be connected.
Personal computer	Windows 7 and above, interface USB 2.0.
Temperature and humidity data logger	Monitoring of environmental parameters during measurements.

For more information refer to USR.CAL.01. Vector network analyzers. Performance test manual:

<http://www.coppermountaintech.com/12/Annual-Calibration/>

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