NanoVNA  Introduction
Welcome

KH6DAK in Hawaii 1957

Charter member Raleigh Amateur Radio Society

W4DW Repeater 146.64 MHz

Retired after 40 years in high tech systems

Currently in Marietta, Spouse “Mary Deane”

HF, VHF, SDR, home brew & antennas

N4WYE
NanoVNA

- Introduction
- NanoVNA enters the market
- How I acquired the NanoVNA
- NanoVNA technical description/specs
- Architecture
- Operation
- Application Examples
- Q & A
40 Meter coverage
OCF dipole vs dipole

Antenna 40 meters data 2019 N4WYE

<table>
<thead>
<tr>
<th>Call</th>
<th>Azimuth</th>
<th>OCF dipole advantage</th>
<th>40 Meter dipole advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCSVC</td>
<td>0</td>
<td>3 db</td>
<td></td>
</tr>
<tr>
<td>KGSGK</td>
<td>70</td>
<td>7 db</td>
<td></td>
</tr>
<tr>
<td>N4HIE</td>
<td>90</td>
<td>2 db</td>
<td></td>
</tr>
<tr>
<td>K5CHL</td>
<td>154</td>
<td>8 db</td>
<td></td>
</tr>
<tr>
<td>K54PC</td>
<td>159</td>
<td>20 db</td>
<td></td>
</tr>
<tr>
<td>K58BS</td>
<td>160</td>
<td>15 db</td>
<td></td>
</tr>
<tr>
<td>KD4TY</td>
<td>166</td>
<td>7 db</td>
<td></td>
</tr>
<tr>
<td>WA2Z/UI</td>
<td>2</td>
<td>2 db</td>
<td></td>
</tr>
<tr>
<td>K4QQY</td>
<td>239</td>
<td>1 db</td>
<td></td>
</tr>
<tr>
<td>KZNE</td>
<td>277</td>
<td>10 db</td>
<td></td>
</tr>
<tr>
<td>K1MAX</td>
<td>285</td>
<td>2 db</td>
<td></td>
</tr>
<tr>
<td>W0BIV</td>
<td>296</td>
<td>10 db</td>
<td></td>
</tr>
<tr>
<td>K54I</td>
<td>326</td>
<td>7 db</td>
<td></td>
</tr>
<tr>
<td>W54EH</td>
<td>350</td>
<td>10 db</td>
<td></td>
</tr>
<tr>
<td>WS4IL</td>
<td>351</td>
<td>1 db</td>
<td></td>
</tr>
<tr>
<td>KB9HMJ</td>
<td>7</td>
<td>even</td>
<td></td>
</tr>
<tr>
<td>KZLAX</td>
<td>40</td>
<td>even</td>
<td></td>
</tr>
<tr>
<td>K57PHF</td>
<td>63</td>
<td>even</td>
<td></td>
</tr>
<tr>
<td>WB4MKD</td>
<td>197</td>
<td>even</td>
<td></td>
</tr>
<tr>
<td>K59FPT</td>
<td>206</td>
<td>even</td>
<td></td>
</tr>
</tbody>
</table>
Looking for an antenna Analyzer?
Geek-Toy of the Year

Handheld low cost Vector Network Analyzer “RF-multimeter” capable of measuring electrical parameters of antennas, filters & components to >900 MHz for less than $50!
Vector Network Analyzers

How much do you need to spend?

$50K

$5K

$50
My Amazon NanoVNA

AURSINC Vector Network Analyzer 50KHz -900MHz HF VHF UHF Antenna Analyzer Measuring 5 Parameters, Voltage Standing Wave Ratio, Phase, Delay, Smith Chart

Price: $72.39

Pros:
- This is a TH product that provides perfect vector network measurement capabilities.

Cons:
- The screen is relatively small compared to other similar products.
- The network analyzer can be used in the 0.1-0.9GHz frequency range.

Features:
- The VSWR method can measure the impedance S11 and S12 parameters. If you need to obtain S12 and S11, you need to manually replace the open-circuit port using the insertion method.
- The instrument is equipped with a USB power input and can be used for maintenance or calibration.
- The NanoVNA has a 3-bit input for calibration.
Original NanoVNA 300MHz kit design “edy555” in 2017
Japanese ham published 2016 via open-source HW & FW at GitHub
Based on a German kit VNWA3 by Tom Baier DG8SAQ Mar/Apr 2007 QEX
“A Low Budget Vector Network Analyzer for AF to UHF”

Productized & marketed by “hugen79” a Chinese ham in 2019
Extended to 900 MHz,
open-source HW & FW at GitHub

Clone manufacturing took off in China 2019

Product extensions being developed
Larger 4 inch screens
Extension to 3GHz
Time Domain Reflectometers

Third Party Software
In 2016 “edy555” created the open source NanoVNA project on GitHub.

In early 2019 “hugen79” cloned the NanoVNA open source schematic, manufactured the device with frequency range expansion and NanoVNA Sharp software.

Hugen79's product is the black NanoVNA with shields on CH0 and CH1.

Noting the successful and positive feedback from buyer's of hugen79's product, other Chinese manufacturers soon started selling clones of the clone.

Hugen79's clone NanoVNA-H and most others use the same edy555 schematic design

Two hardware versions being sold: The NanoVNA (-H) and the NanoVNA-F.

Version 2 device - Both edy555 and hugen79 in development.

* [https://groups.io/g/nanovna-users](https://groups.io/g/nanovna-users)
NanoVNA specifications

**Frequency Range:** 50kHz to 900MHz

**RF output:** -13dbm (-9dbm maximum), or ~0.1 mW

**Dynamic Range:** 70dB (50kHz - 300MHz), 60dB (300MHz - 600MHz), 50dB (600MHz - 900MHz)

**Display:** 2.8 inch TFT (320x240)

**USB Interface:** USB Type C (power + data)

**Power:** USB 5V 120mA, internal LiPo battery 400 mAh

**Scanning Points:** 101 (fixed)

**Display:** 4 traces, 4 markers + 5 memories for calibration

**Frequency deviation:** <0.5 ppm (e.g., 50 Hz error at 100 MHz.)

Vector Network Analyzer, 2-Port S-Parameters
NanoVNA

Si5351A Clock Generator
SA612AD Mixer-Oscillator
TLV320 AIC3204
I2S/PCM interface
audio codec
STM32 Microcontroller
LCD
Tip: P3 is connected to STM32F072, you can modify the firmware and connect the expansion module.

When the expansion module obtains a 3.3V power supply from P3, adding appropriate tantalum capacitors to C3 and C4 can reduce ripple interference. Once C3 is added, the battery must be connected to U2 (F99688) to work. Due to the maximum power consumption of U2 (F99688) and U3 (IC5206), the current output of P3 should be less than 100mA.
How to use it

NanoVNA Top-Level Menu (Touchscreen)
If calibration is available, the CAL status will be displayed. Otherwise, it is hidden. C* is in the state where an unsaved calibration is applied (it disappears from memory when the power is turned off). C0 to C4 indicates that the saved calibration values are applied to one of the save locations. Saved or Unsaved will change when calibration data is properly saved. The letters below C indicate that the following error terms have been applied. D: Directivity, R: Reflection Tracking, S: Source Match, T: Transmission Tracking and X: Isolation.
NanoVNA
“Getting Started Manual”

• NanoVNA Device

• Stand-Alone Operation

• Operation with PC and “NanoVNA Saver V.2.0”

• Author: Gunthard Krause, DG8GB
  January 13, 2020
  http://www.gunthard-kraus.de/fertig_NanoVNA/English_NanoVNA_V1.5_final.pdf
S-parameters

Complex matrix that show Reflection/Transmission characteristics (Amplitude/Phase) in frequency domain.
NanoVNA

Handheld, low cost Vector Network Analyzer “RF-multimeter” capable of measuring electrical parameters of antennas, filters & components to 1 GHz

S11
- Antenna measurements-VSWR
- Complex load impedance
- Power splitters, diplexers
- Filter return loss
- Amplifier return loss
- Cable impedance

S21
- Filter response
- Attenuators (flatness, delay)
- Power splitters
- Baluns
- Phasing networks
- Crystals, resonances, impedances
- Amplifier gain, delay
- Cable electrical length, velocity factor
SWR
OCF Dipole Antenna
SWR
40 Meter Dipole Antenna
Filter & Amplifier Characteristics

88-108 MHz Bandstop filter
Set up antenna with NanoVNA outside the near field

Connect the Yagi to the TX ChO port of the NanoVNA via a long coax cable, and connect an omnidirectional whip antenna to the RX Ch1 port of the NanoVNA

Measure collect S21 reading over multiple rotations of Yagi

Data then plotted revealing two dimensional radiation pattern for the Yagi
Time Domain Reflectometer
Distance & Impedance

Measures on the Vertical Axis the ‘Amount of Reflection’ & Calculates the Impedance of What is Connected to NanoVNA vs. Distance from NanoVNA on the Horizontal Axis

Example: A Four Foot Section of 50 ohm Type Coax Followed by a Four Foot Section of 93 ohm Type Coax

Far End of Coax is Left Open
NanoVNA PC Software

There are several great companion PC tools from third-parties

**NanoVNASaver** by mihtjel (recommended)
https://groups.io/g/nanovna-users/wiki/home#NanoVNASaver

**NanoVNASharp Windows software** by hugen79

**NanoVNA WebSerial/WebUSB** by cho45

**Android NanoVNA app** by cho45

**TAPR VNAR4** supports NanoVNA by erikkaashoek
NanoVNASaver
A multi-platform tool to save Touchstone files from the NanoVNA, sweep frequency spans in segments to gain more than 101 data points, and generally display and analyze the resulting data.
Copyright 2019 Rune B. Broberg

Introduction
This software connects to a NanoVNA and extracts the data for display on a computer, and for saving to Touchstone files.

Current features:
Reading data from a NanoVNA
Splitting frequency range into multiple segments to increase resolution (up to >10k points)
Averaging data for better results particularly at higher frequencies
Displaying data on multiple chart types, such as Smith, LogMag, Phase and VSWR-charts, for both S11 and S21
Displaying markers, and the impedance, VSWR, Q, equivalent capacitance/inductance etc. at these locations
Displaying customizable frequency bands as reference, for example amateur radio bands
Exporting and importing 1-port and 2-port Touchstone files
TDR function (measurement of cable length) - including impedance display
Filter analysis functions for low-pass, high-pass, band-pass and band-stop filters
Display of both an active and a reference trace
Live updates of data from the NanoVNA, including for multi-segment sweeps
In-application calibration, including compensation for non-ideal calibration standards
Customizable display options, including "dark mode"
Exporting images of plotted values

https://github.com/mihtjel/nanovna-saver/blob/master/README.md
Sources & Links

NanoVNA Introduction video
https://www.youtube.com/watch?v=8kx9SWbEcXI

NanoVNA groups.io Forum:
Documentation & Update Files: https://groups.io/g/nanovna-users/files
Knowledge-based Wiki: https://groups.io/g/nanovna-users/wiki
Group Home: https://groups.io/g/nanovna-users

NanoVNA “Manual”
http://www.gunthard-kraus.de/fertig_NanoVNA/English_NanoVNA%20V1.5._final.pdf

Smith Chart intro video
http://www.antenna-theory.com/tutorial/smith/chart.php#introduction

NanoVNA Saver by Rune B. Broberg / 5Q5R
https://zs1sci.com/blog/nanovnasaver/

NanoVNA Saver GitHub link - download
https://github.com/mihtjel/nanovna-saver/releases

NanoVNA Sharp and more!
https://www.youtube.com/watch?v=zw7Dp1nwvD8 & https://drive.google.com/drive/folders/1-JViWLBQzaHTdwdONX2RP8S4EqWxoND

NanoVNA WebApp (Android)
Test Question
Name of this antenna type?
Q & A

• What kind of pig tails can be used to connect NanoVNA?

• How can you transfer data from NanoVNA?

  "Pause Sweep", and the data is saved in the nanovna nice trick, but it will works until power off…or Use PC SW to store data
Notes for sourcing

3.4 version 650mAh battery Original Hugen NanoVNA-H 2.8" Touchscreen Vector Network Analyzer HF VHF UHF Antenna Analyzer
https://www.alibaba.com/product-detail/3-4-version-650mAh-battery-Original_62342877955.html?spm=a2700.7724838.2017115.1.506b1b80T9cUaF&fullFirstScreen=true

4.2 version 1950mAh battery Original Hugen NanoVNA-H4 4.0" Touchscreen Vector Network Analyzer HF VHF UHF Antenna Analyzer
https://www.alibaba.com/product-detail/4-2-version-1950mAh-battery-Original_62455845943.html?spm=a2700.galleryofferlist.0.0.51cb5a4bLLLaU8

Very good review, by hwalker, of the newest Hugen version 4 NanoVNA
https://groups.io/g/nanovna-users/message/10012
My NanoVNA

OCF dipole 80-10 meters
Smith Chart

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES

Courtesy of Microwaves101.com