Why You Need a NanoVNA

Lee Johnson N4WYE

Gwinnett Amateur Radio Society - January 2021

Thanks for the Invitation

KH6DAK in Hawaii 1957

Founding Member - Raleigh Amateur Radio Society 1969

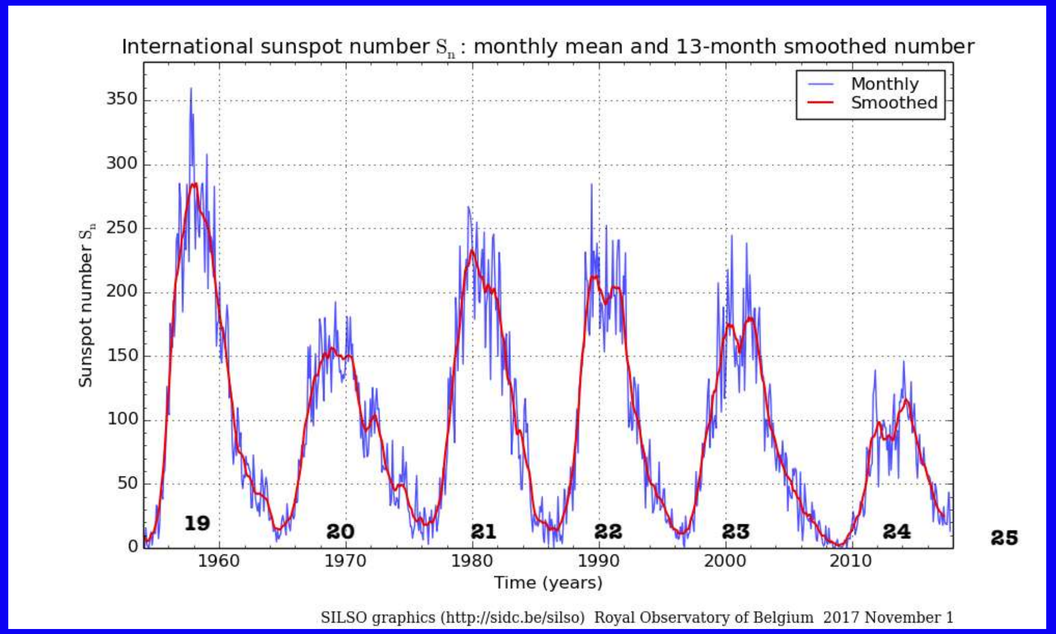
W4DW Repeater 146.64 MHz in Raleigh

Retired after 40 years in high tech systems

Currently in Marietta, Spouse “Mary Deane”

HF, VHF, SDR, home brew & antennas

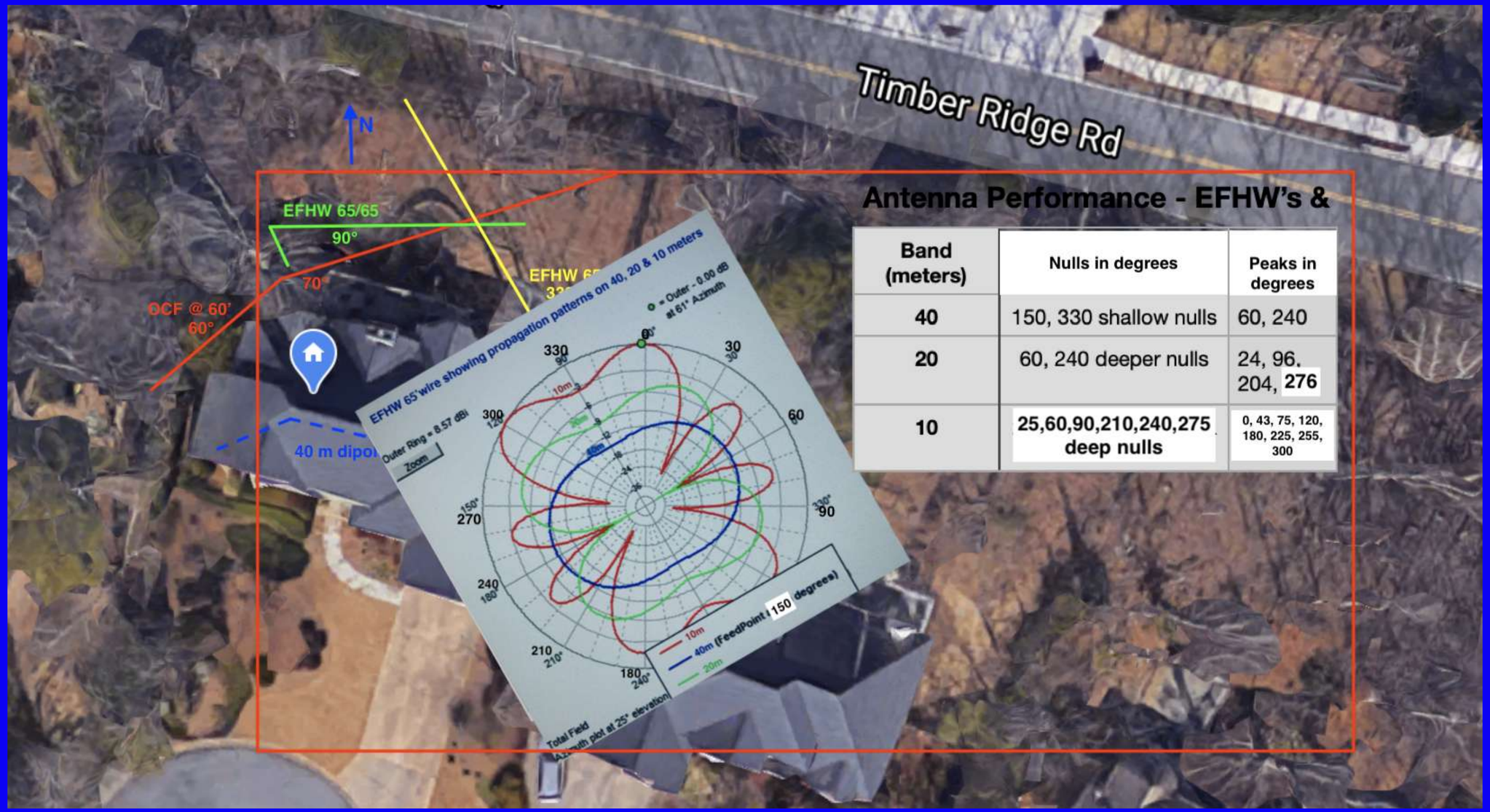
N4WYE Lee



NanoVNA

- Introduction
- Vector Network Analyzer
- NanoVNA enters the market
- NanoVNA technical description/specs
- Operation/Demo
- Application Examples
- Reference Sources
- Q & A

My HF Antennas



Band (meters)	Nulls in degrees	Peaks in degrees
40	150, 330 shallow nulls	60, 240
20	60, 240 deeper nulls	24, 96, 204, 276
10	25,60,90,210,240,275 deep nulls	0, 43, 75, 120, 180, 225, 255, 300

Looking for an Antenna Analyzer

VNA is….

Vector Network Analyzer

Measures the magnitude and phase of the reflection and transmission properties of the ports of a device vs. frequency.

Vector Network Analyzer = Instrument used to characterize RF devices

Vector Network Analyzers

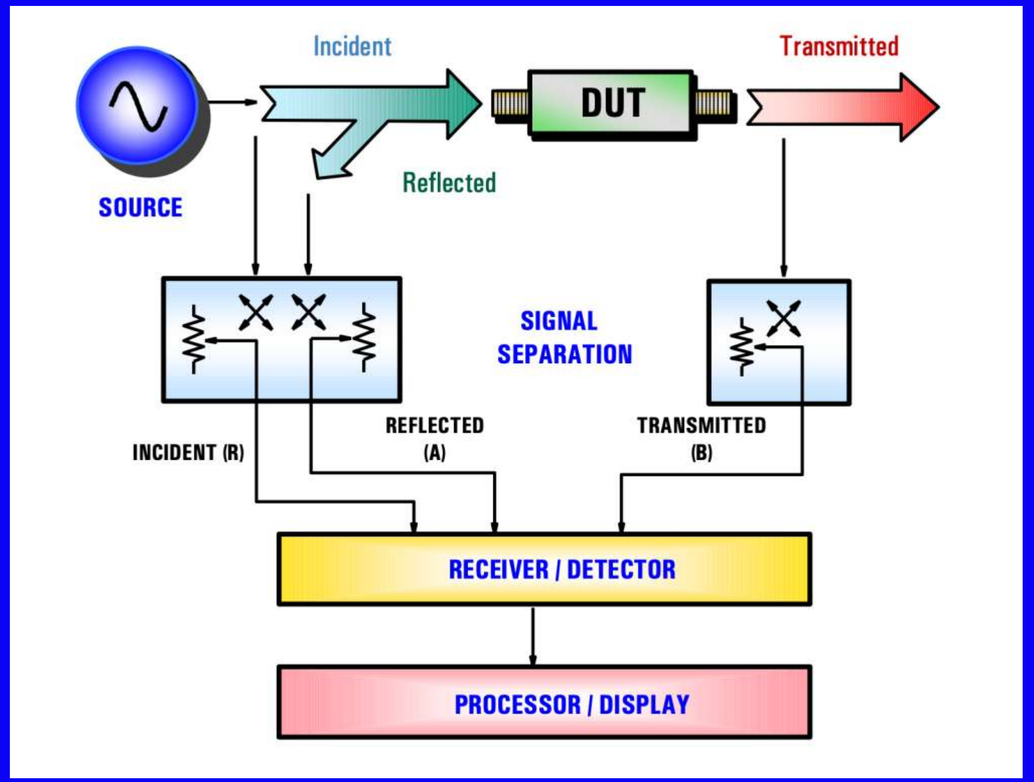
How much do you need to spend?

$50K

$5K

$50

Vector Network Analyzer Block Diagram



NanoVNA Measurements

Handheld, low cost Vector Network Analyzer “RF-multimeter” capable of measuring electrical parameters of antennas, filters & components to 3 GHz

S11 Reflection

– Antenna measurements-VSWR

– Complex load impedance

– Power splitters, diplexers

– Filter return loss

– Amplifier return loss

– Cable impedance

– Feed line length

– Distance to fault

S21 Transmission

– Filter response

– Attenuators (flatness, delay)

– Power splitters

– Baluns

– Phasing networks

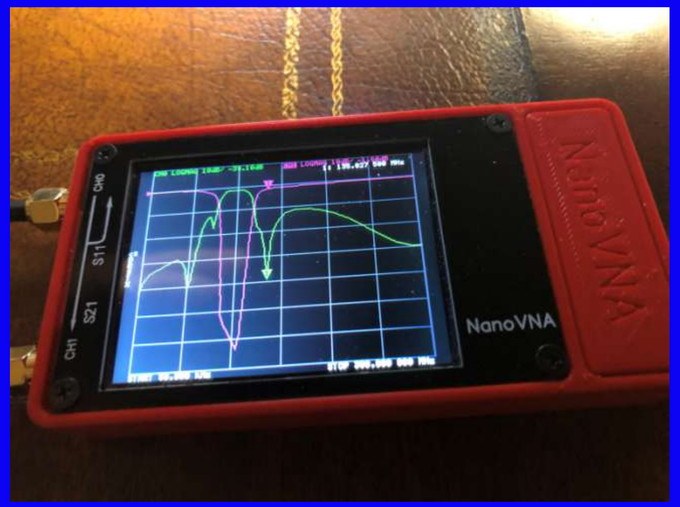
– Crystals, resonances, impedances

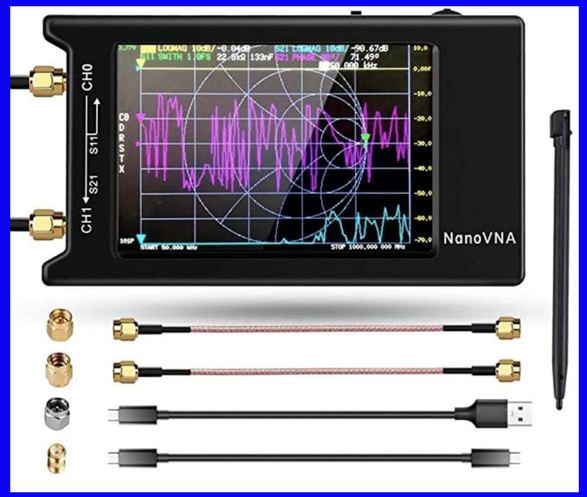
– Amplifier gain, delay

– Cable loss, length, velocity factor

Geek-Toy of the Year
NanoVNA

Handheld low cost Vector Network Analyzer “RF-multimeter”
capable of measuring electrical parameters of antennas,
filters & components to >1.5 GHz for $50-60 !





My NanoVNA

Purchased 1 time.
You purchased this item on September 15, 2019.
View this order

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

by AURSINC

4.5 out of 5 stars 33 ratings | 8 answered questions

Amazon's Choice for "nanovna"

Price: $72.99 ✓prime

Free Amazon product support included

- This is a DIY product that provides perfect vector network measurement capabilities, tiny and handheld, stand-alone with 2.8-inch LCD display, portable with battery powered or USB powered
- The improved frequency algorithm can use the odd harmonic extension of si5351 to support the measurement frequency up to 900MHz. The 50535-300MHz frequency range of the si5351 direct output provides better than 70dB dynamic, The extended 300M-600MHz band provides better than 60dB of dynamics, and the 600M-900M band is better than 50dB of dynamics
- The default firmware main function is used for antenna performance measurement. The TX/RX method can measure the complete S11 and S21 parameters. If you need to obtain S12 and S22, you need to manually replace the transceiver port wiring
- The metal shield is designed to reduce the external interference and improve the measurement accuracy
- Package include NanoVNA host (with battery) x1, USB Type-C data cable x1, 30mm SMA male to male RG174 RF cable x2, SMA simple calibration kit x1, SMA female to female connector x1

NanoVNA
Backgrounder

Original NanoVNA 300MHz kit design “edy555” in 2016
- Japanese ham published 2016 via **open-source HW & FW at GitHub**
- Based on kit by Tom Baier DG8SAQ Mar/Apr 2007 QEX

Clone manufacturing took off in China 2019

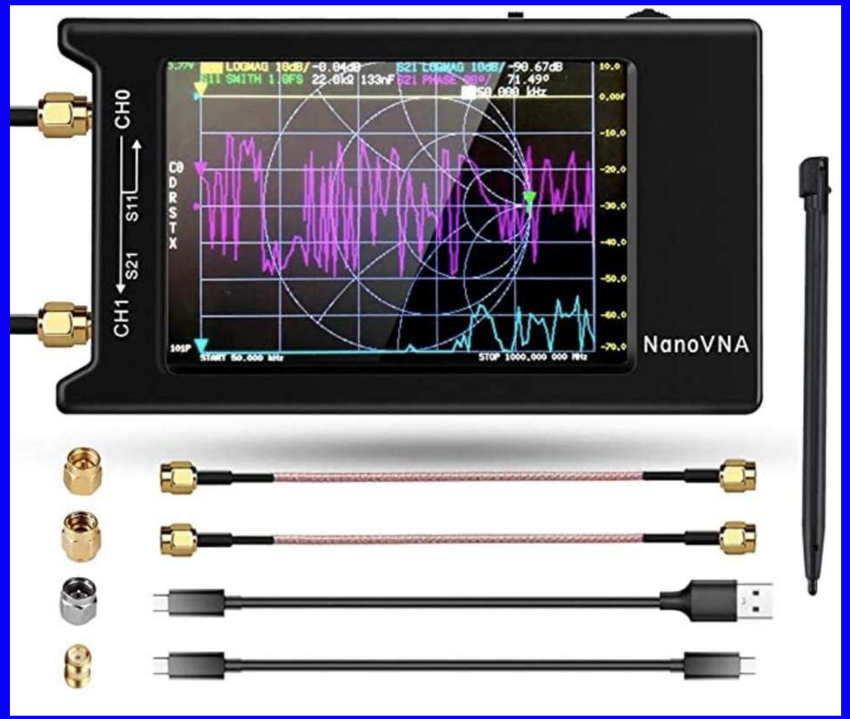
Productized & marketed by “hugen79” a Chinese ham in 2019
- NanoVNA version gen111.taobao.com
- Extended to 1.5 GHz

Product evolution continuing
- Larger screens 4 inch
- Extension to >3GHz
- SD card - record screen images & .s1p and .s2p
- Time Domain Reflectometers
- Tiny Spectrum Analyzers

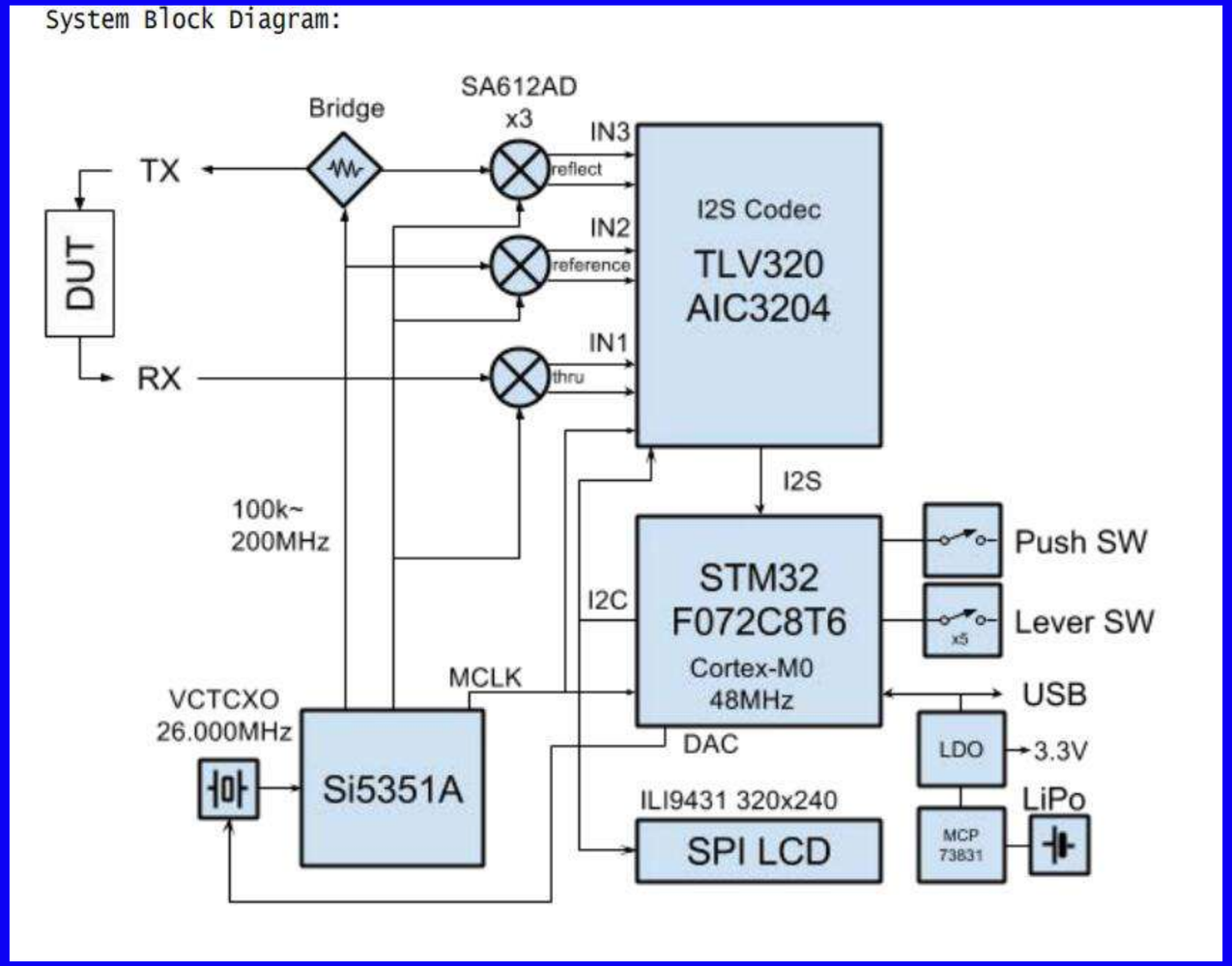
As of today

Best option is the H4 model

NanoVNA-V2plus4 and others coming with higher performance



NanoVNA



Si5351A Clock Generator

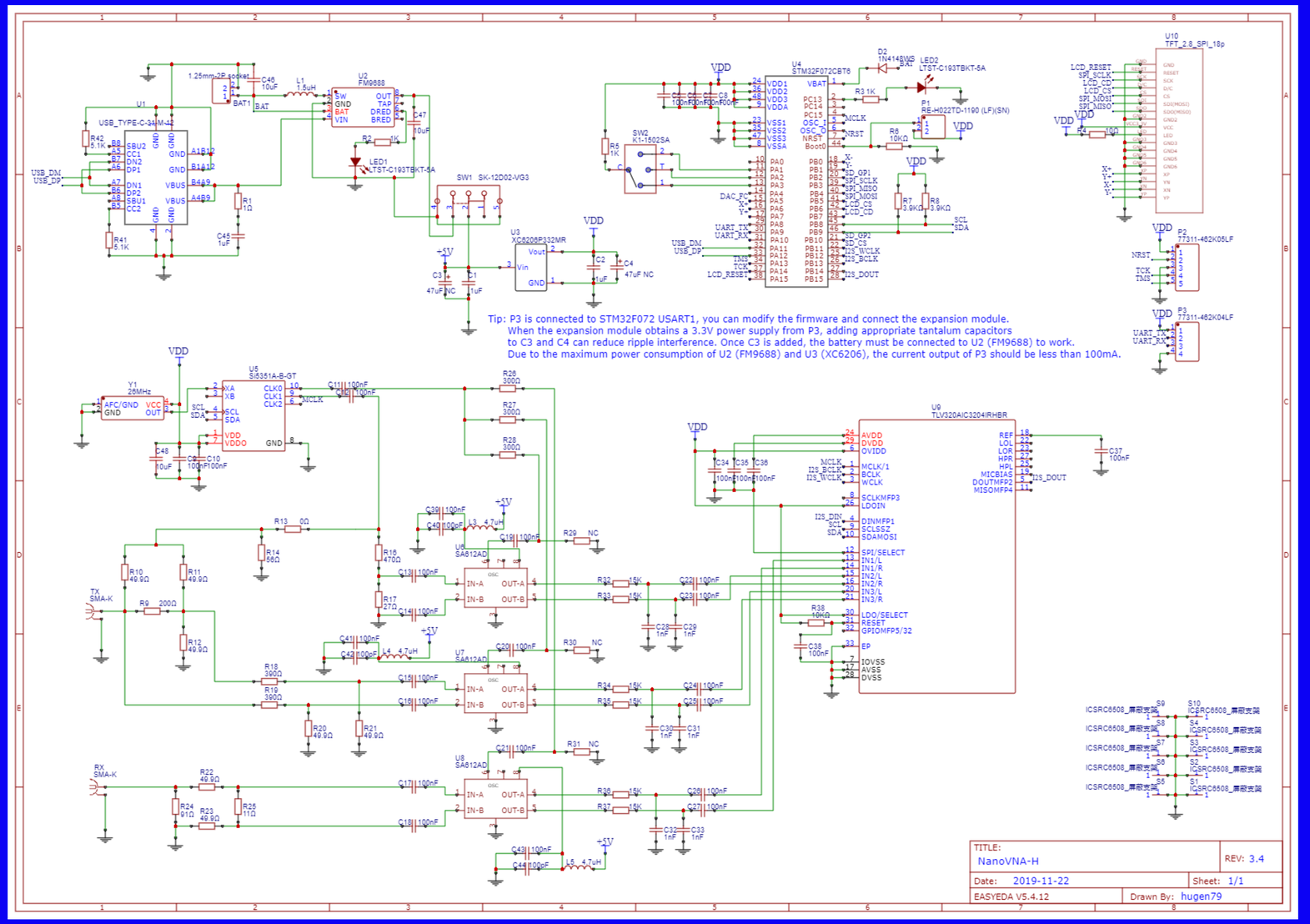
SA612AD Mixer-Oscillator

TLV320 AIC3204
I2S/PCM interface
audio codec

STM32 Microcontroller

LCD

NanoVNA Schematic

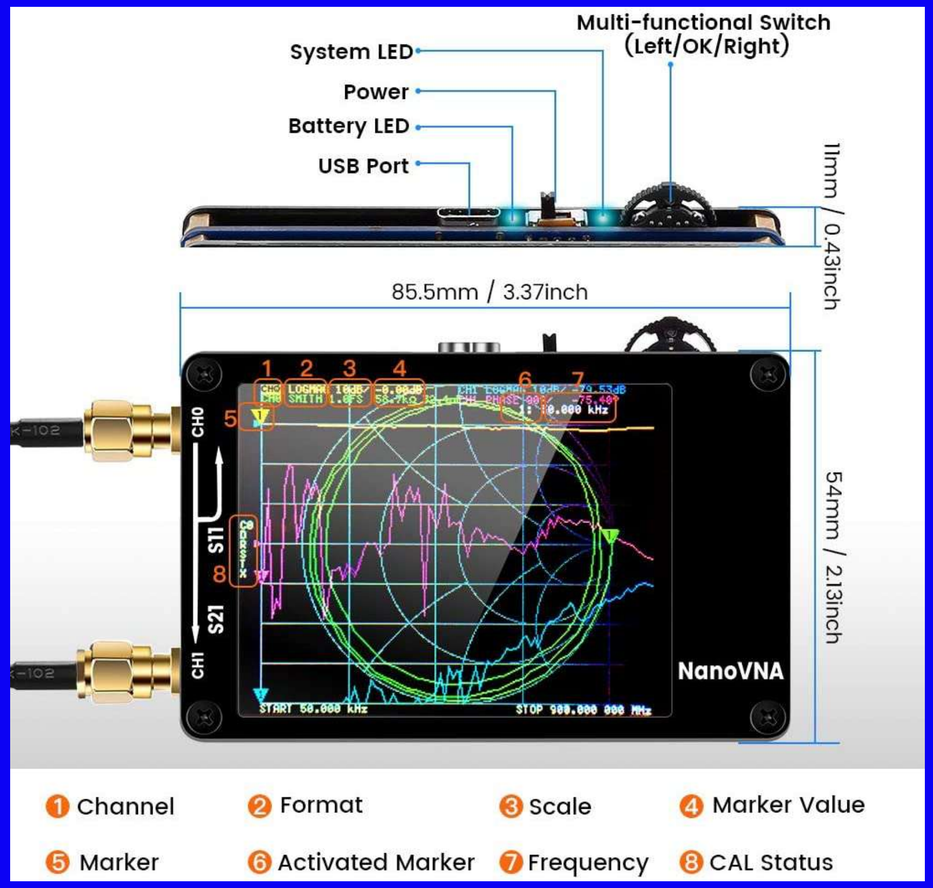


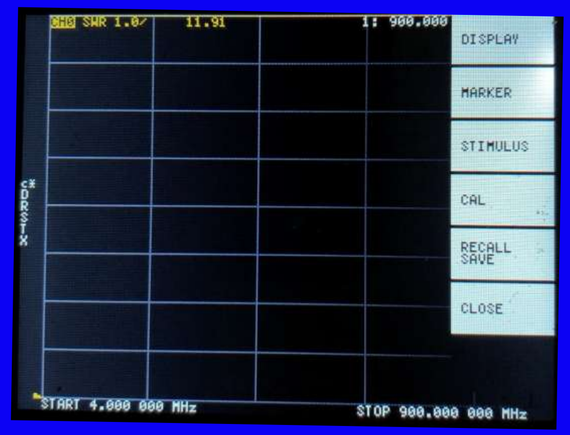
NanoVNA H4 specifications

Frequency Range	10kHz to 1.5GHz
RF output	0 dbm
Dynamic Range	70dB (50kHz - 300MHz), 60dB (300MHz - 900MHz), 40dB (0.9GHz - 1.5GHz)
Display	4 inch TFT (320x480)
USB Interface	USB Type C (power + data)
Power	USB 5V 200mA, internal LiPo battery 1950 mAh
Scanning Points	101 (fixed)
Display	4 traces, 4 markers + 5 memories for calibration
Frequency deviation	<0.5 ppm

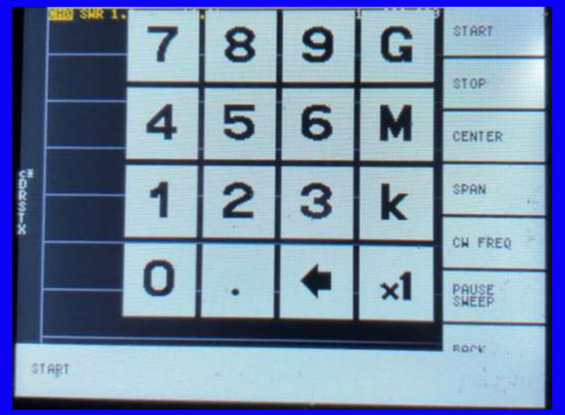
Vector Network Analyzer, 2-Port S-Parameters

NanoVNA user interface





Traces, Formats, Scale, Channels
Add, Function, Search
Start, Stop, Center, Span
Calibration



NanoVNA Menu Structure Map

HOME MENU

- DISPLAY
- MARKER
- STIMULUS
- CAL
- RECALL SAVE
- CLOSE

RECALL
- SAVE
- BACK

RECALL 0
- RECALL 1
- RECALL 2
- RECALL 3
- RECALL 4
- BACK

SAVE 0
- SAVE 1
- SAVE 2
- SAVE 3
- SAVE 4
- BACK

TRACE
- FORMAT
- SCALE
- CHANNEL
- BACK

CH0 REFLECT
- CH1 THROUGH
- BACK

SCALE/DIV
- REFERENCE POSITION
- ELECTRICAL DELAY
- BACK

LOGMAG
- PHASE
- DELAY
- SMITH
- SWR
- MORE
- BACK

POLAR
- LINEAR
- BACK

NUMERIC KEYPAD

TRACE 0
- TRACE 1
- TRACE 2
- TRACE 3
- BACK

OFF
- SINGLE
- BACK

SELECT MARKER
- START
- STOP
- CENTER
- SPAN
- BACK

MARKER 1
- MARKER 2
- MARKER 3
- MARKER 4
- ALL OFF
- BACK

START
- STOP
- CENTER
- SPAN
- CW FREQ
- PAUSE SWEEP
- BACK

NUMERIC KEYPAD

CALIBRATE
- RESET
- CORRECT
- BACK

OPEN
- SHORT
- LOAD
- ISOLATION
- THRU
- DONE
- BACK

SAVE 0
- SAVE 1
- SAVE 2
- SAVE 3
- SAVE 4
- BACK

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

By: AE5CZ
Date: 26 July 2019
Release: 1.1

NanoVNA Measurement Configuration*

Before each measurement we need to configure NanoVNA for the type of measurement:

- Traces to display (up to four)
- Format
- Channel (CH0 REFLECT or CH1 THROUGH)
- Scale for each trace separately
- Reference position
- Stimulus frequency range (sweep frequency)
- Calibrate the NanoVNA

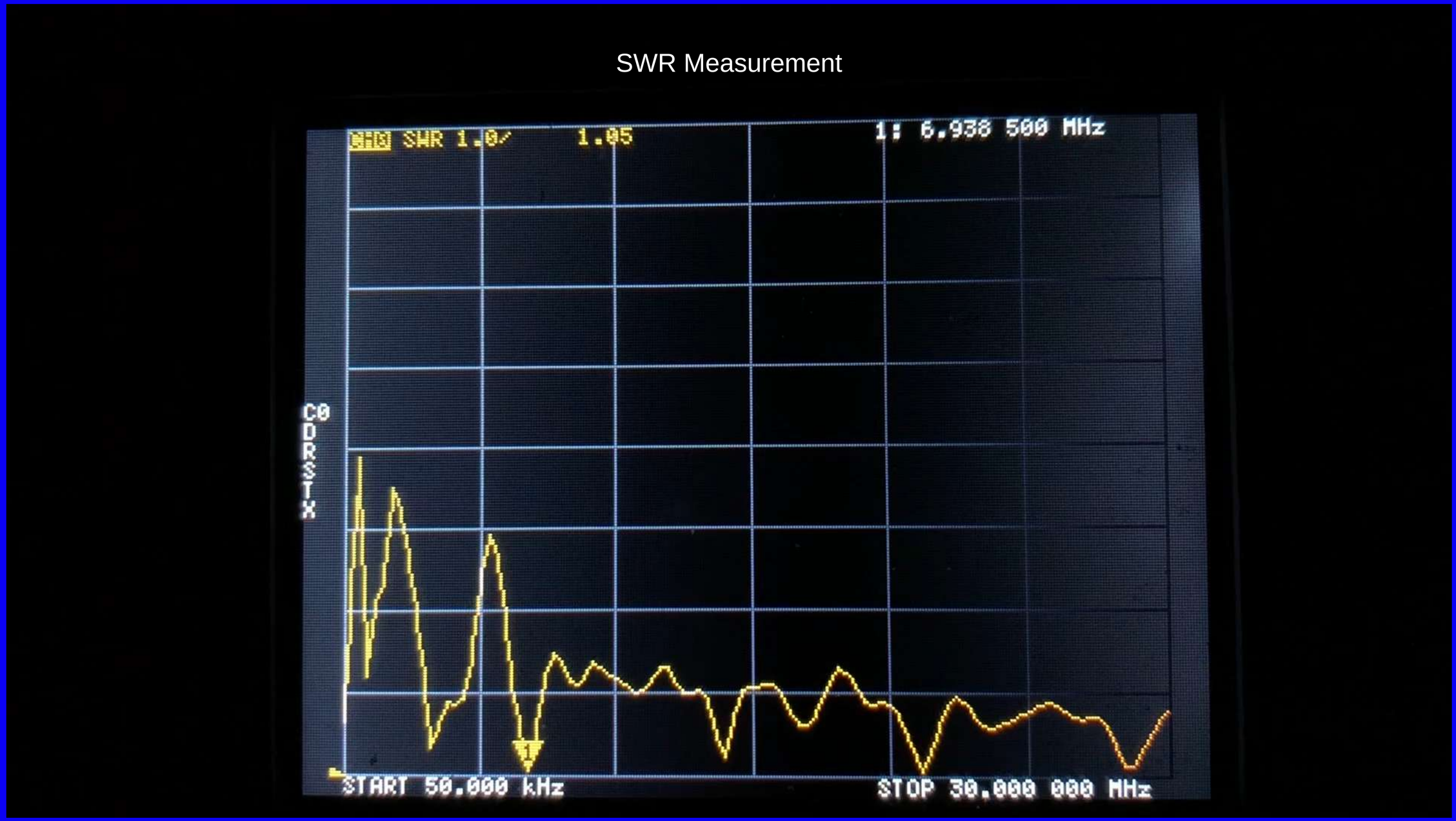
Calibration (done last) also saves the display settings, so you can easily **recall the whole setup**.

* Absolute Beginner’s Guide to NanoVNA , Martin Svaco, 9A2JK

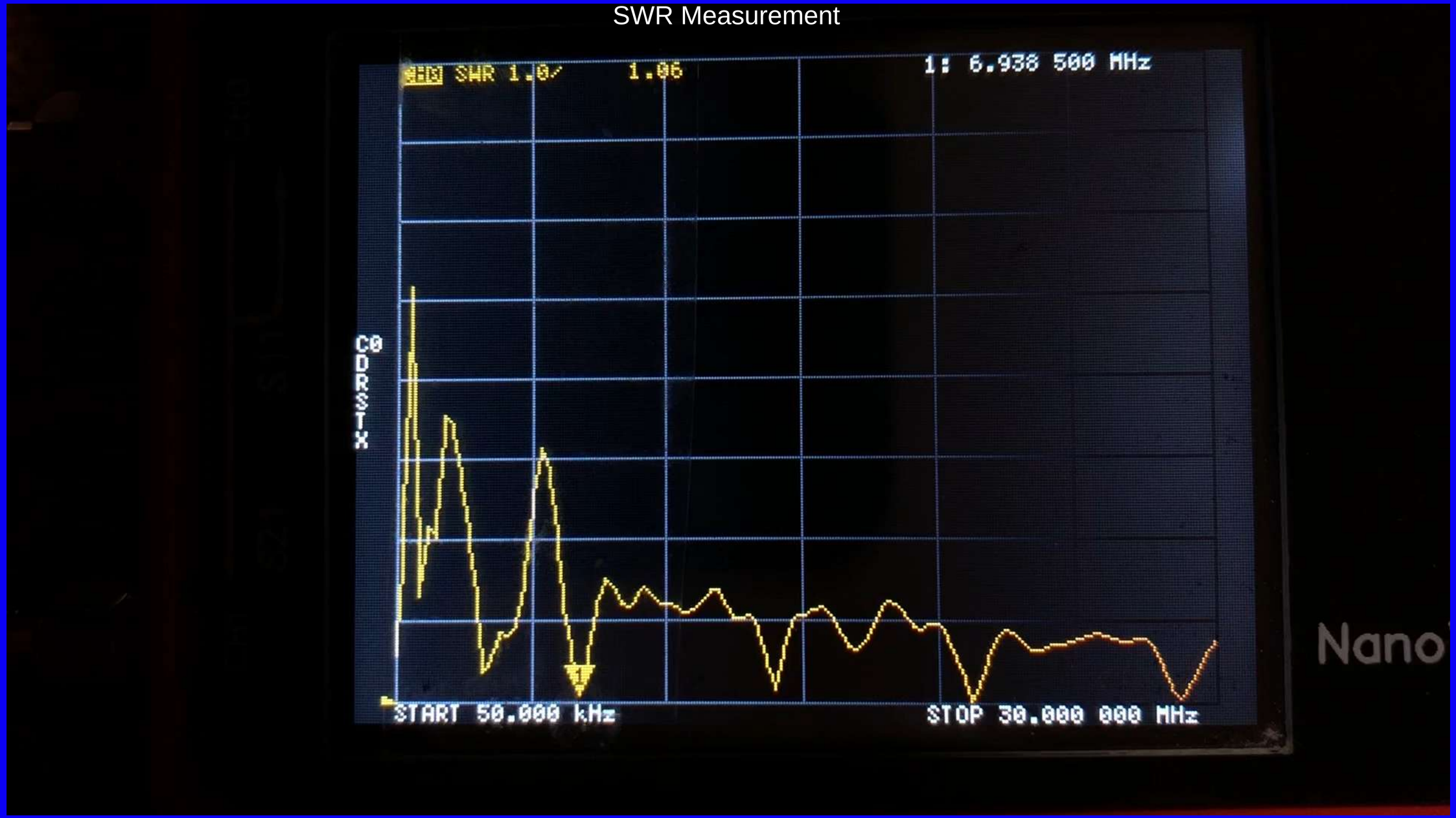
NanoVNA Calibration

C = Calibrated - current frequency range
c = Calibration loaded but doesn't match frequency range
0,1,2,3,4,* = Calibration values storage location

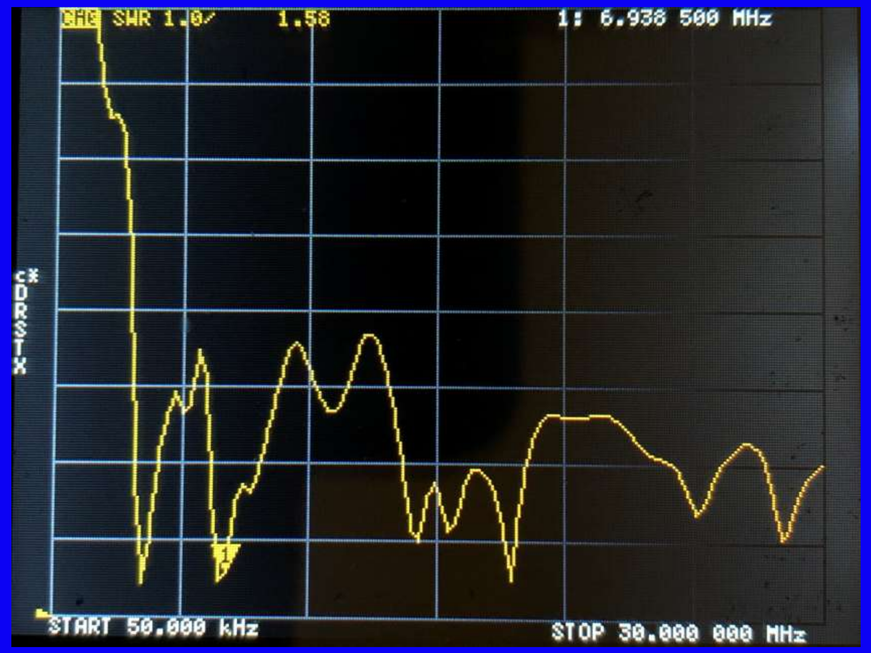
SWR Measurement



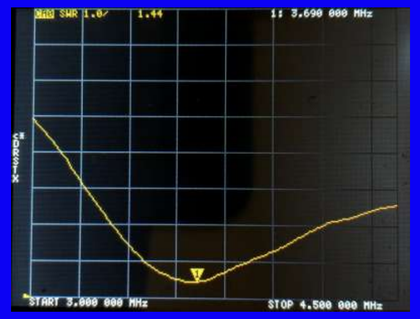
SWR Measurement



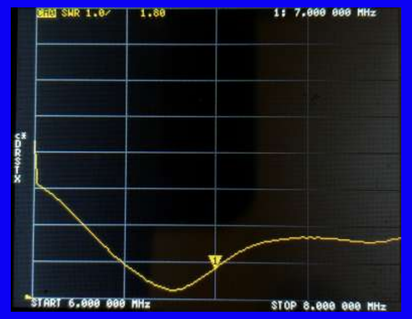
SWR
OCF Dipole Antenna



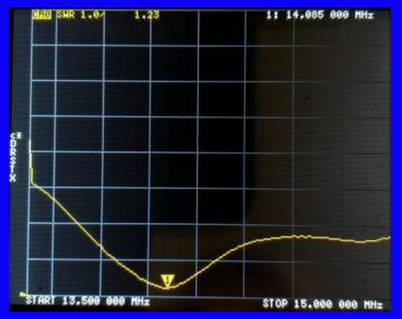
80-10 Meters



80 M



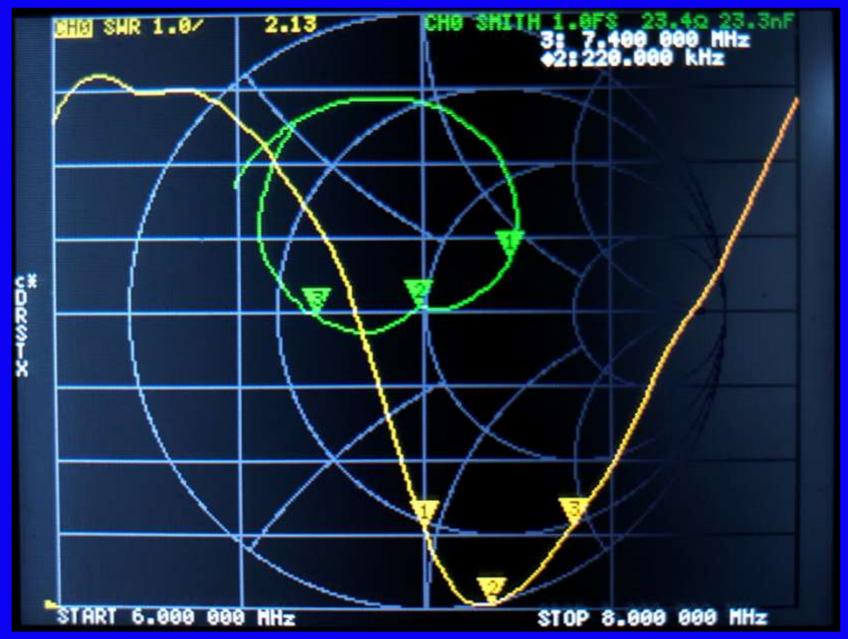
40 M



20 M

SWR
40 Meter Dipole Antenna

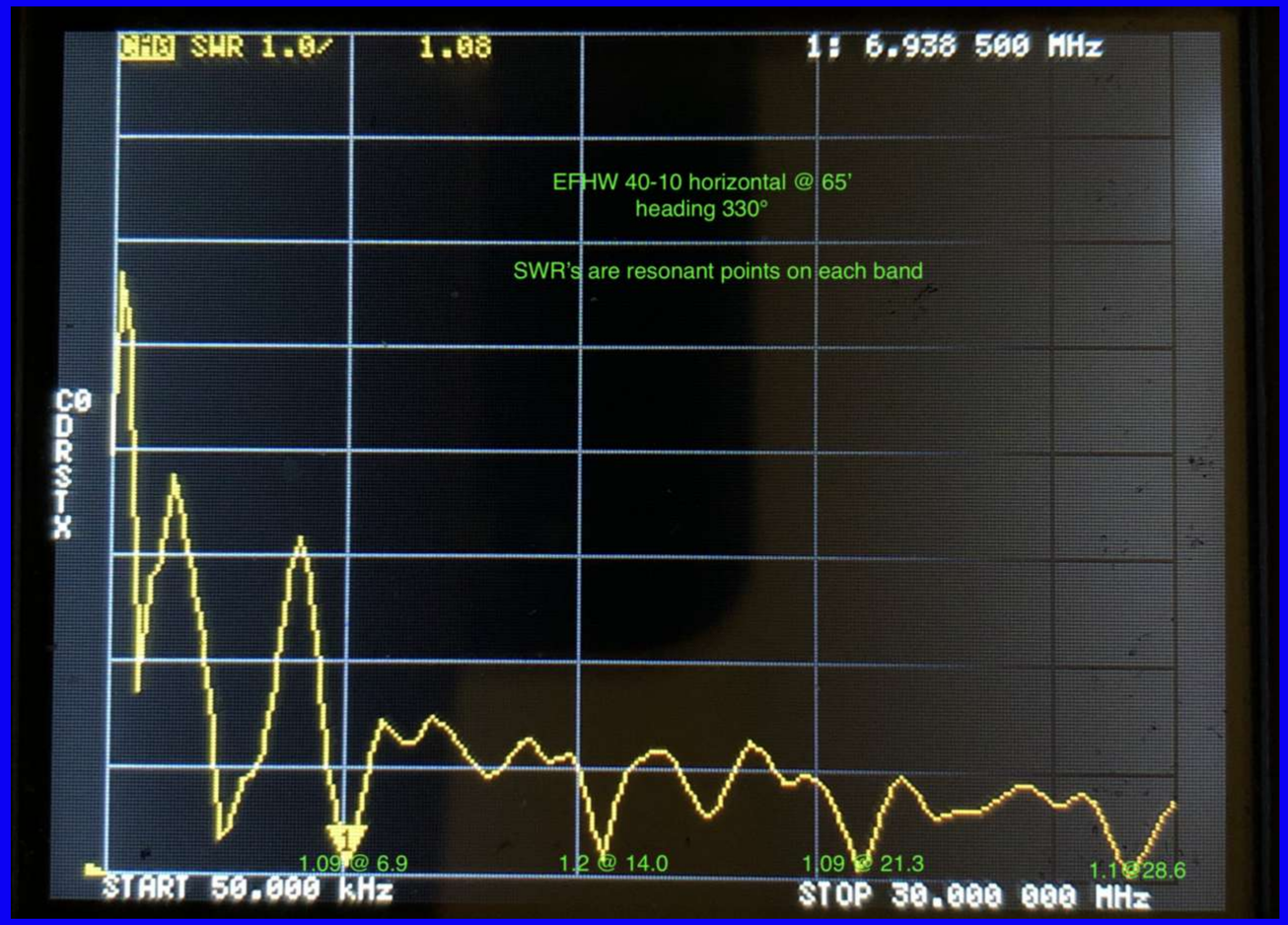
50KHz to 30 Mhz



6 to 8 MHz

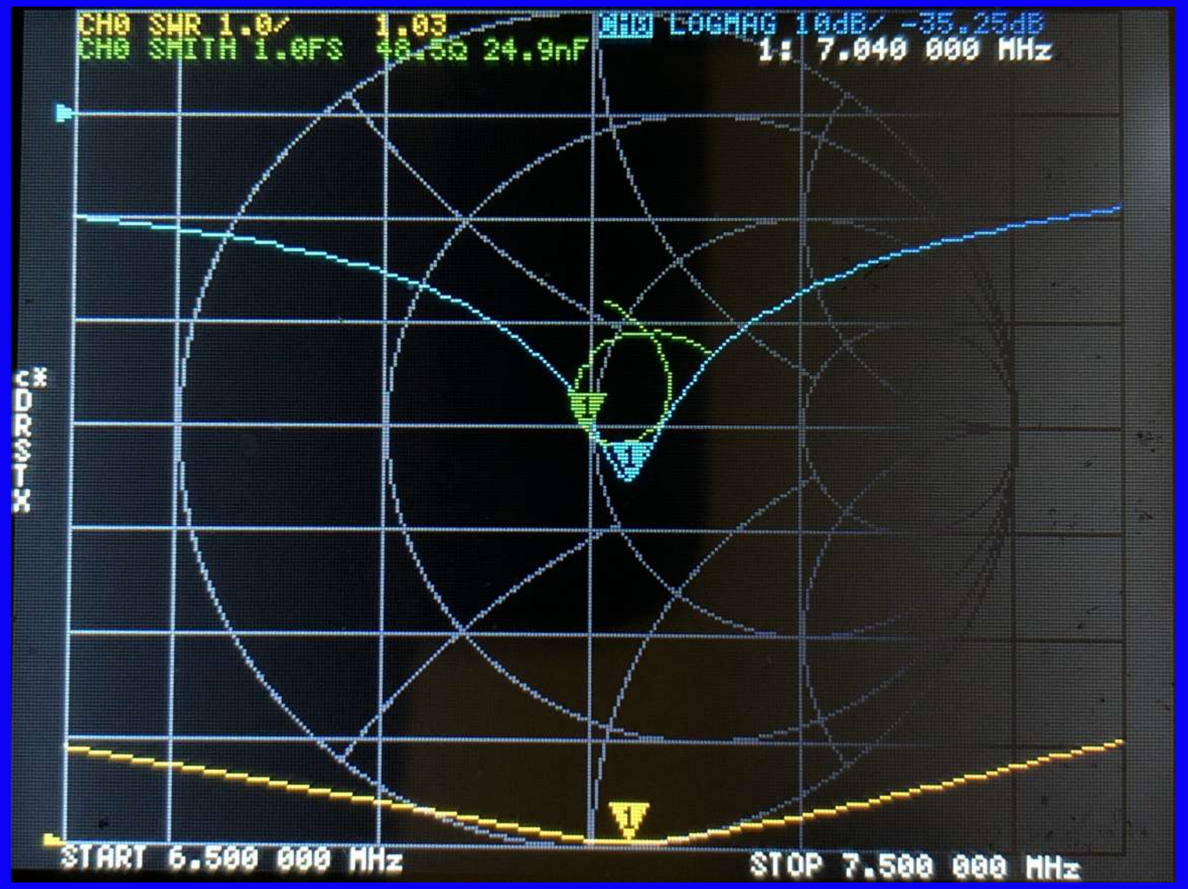
SWR Comparison

NanoVNA



IC-7300

EFHW @ 7 MHz
SWR, Return Loss & Smith Chart



Filter & Amplifier Characteristics

88-108 MHz Bandstop filter

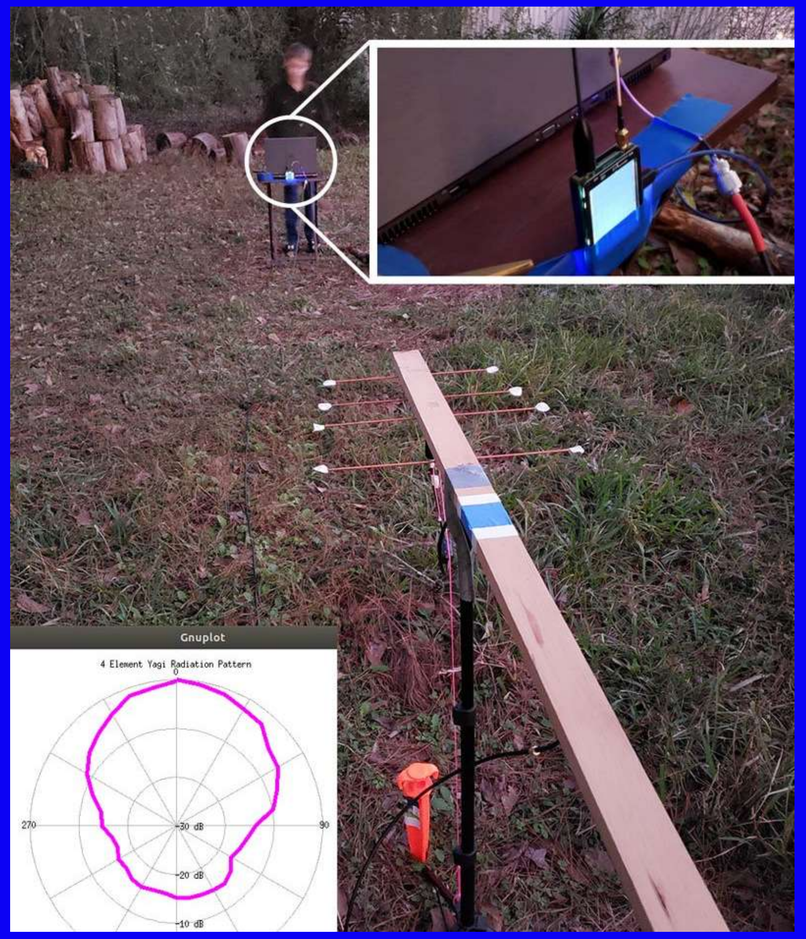
Antenna Radiation Pattern

Set up antenna with NanoVNA outside the near field

Yagi on TX ChO port via a long coax cable
Omnidirectional whip antenna on RX Ch1 port

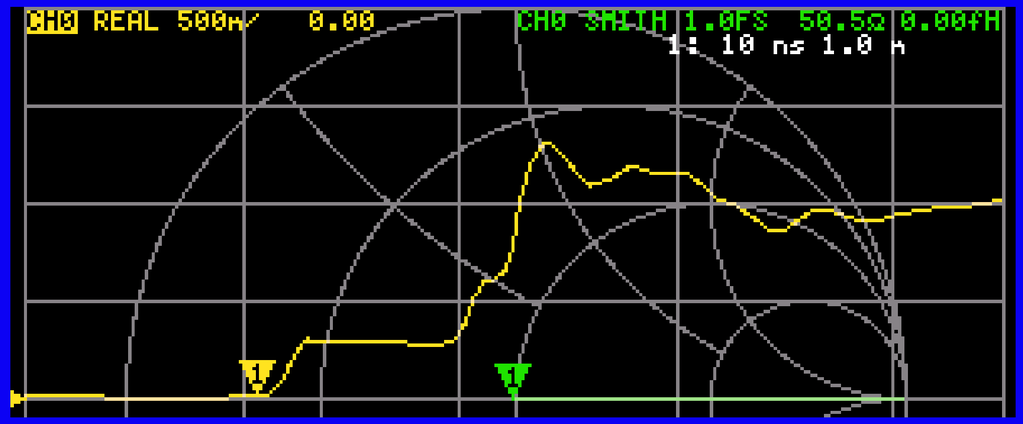
Measure collect S21 reading over multiple rotations of Yagi

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 Saver

NanoVNA Saver

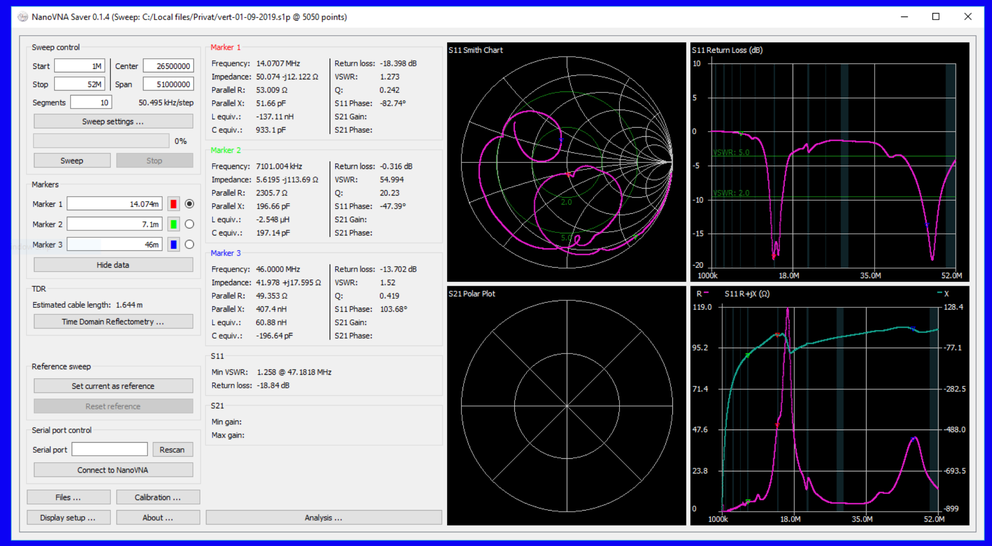
A multi-platform tool to save Touchstone files from the NanoVNA, sweep frequency spans in segments to gain more than 101 data points, and generally display and analyze the resulting data.

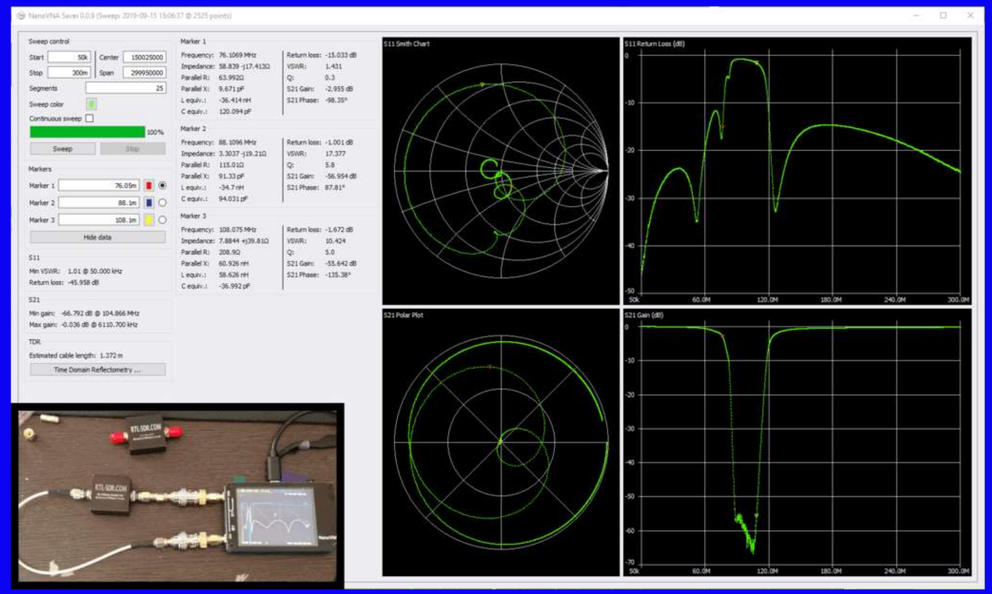
Introduction

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 & VSWR-charts, S11 & S21
Displaying markers, and the impedance, VSWR, Q, equivalent capacitance/inductance etc. 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

NanoVNA groups.io Forum

Documentation & Update Files:
Knowledge-based Wiki:
Group Home:

NanoVNA User Guide

Absolute Beginner's Guide to The NanoVNA

W2AEW YouTube NanoVNA videos

NanoVNA Saver by Rune B. Broberg / 5Q5R

Smith Chart intro video

groups.io

nanovna-users@groups.io

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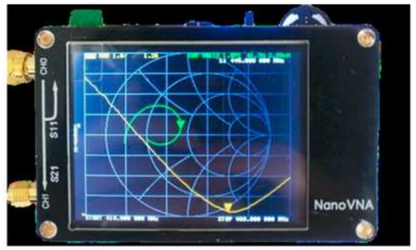
Forum Members

Please take note of all the GREAT INFORMATION in the WIKI, Photos and FILES areas of the NanoVNA Forum



nanovna users nanovna-users@groups.io

Users of nanovna small VNA
Files: https://groups.io/g/nanovna-users/files
Wiki: https://groups.io/g/nanovna-users/wiki

Group Information

8,147 Members
1,918 Topics, Last Post: 12:16pm
Started on 06/02/19
Feed

Group Email Addresses

Post: nanovna-users@groups.io
Subscribe: nanovna-users+subscribe@groups.io
Unsubscribe: nanovna-users+unsubscribe@groups.io
Group Owner: nanovna-users+owner@groups.io
Help: nanovna-users+help@groups.io

Group Settings

All members can post to the group.
Posts to this group do not require approval from the moderators.
Posts from new users require approval from the moderators.
Messages are set to reply to group.
Subscriptions to this group do not require approval from the moderators.
Archive is visible to anyone.
Wiki is visible to members only.
Members cannot edit their messages.
Members can set their subscriptions to no email.

Top Hashtags [See All]

#calibration 46
#nanovna-saver 37
#firmware 30
#nanovna-h4 23
#measurement 20
#applications 16
#improvement 15
#nanovna-v2 15
#buying 14
#test-jig 11

Groups.io | Your Groups | Find or Create a Group | Help | Lee email

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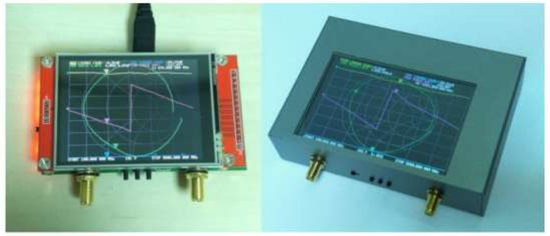


NanoVNAV2@groups.io NanoVNAV2@groups.io

NanoVNAV2@groups.io

NanoVNA V2 (S-A-A-2) user group official

This is the official support forum/user group for the NanoVNA V2, which is a low cost 3GHz T/R VNA (vector network analyzer). It is not based on ttrftech's NanoVNA design but a new from scratch design using 2 ADF4350 to cover up to 3GHz and Si5351 to cover down to 50kHz. Compared to the original ttrftech design, V2 uses only the fundamental signal for measurements and achieves higher dynamic range.

There is only one official NanoVNA V2 groups.io forum, which is NanoVNAV2@groups.io. All other groups are unofficial and you will only get support on this forum. Check the official website for user groups and social media pages:

https://nanorfe.com/nanovna-v2.htm

Hardware revisions

You can check your hardware revision by selecting CONFIG > VERSION in the menu.
Please see https://nanorfe.com/nanovna-versions.html
There are many clones of the NanoVNA V2. While they are all based on the earliest V2.2 design, some differ in parts used and may not be compatible with the official firmware. To ensure you get a supported hardware version, see official stores below.

Name	Release Date	Remarks
V2 Plus4 (V2.4)	2020/10	4 inch display. 4x faster sweep (400 points/s). Up to 80dB dynamic range to 3GHz.
V2 Plus (V2.3)	2020/10	2x faster sweep (200 points/s). Noise improvements. PCB text still indicates "V2_2".
V2.2	2019	The earliest version of the V2 hardware. No longer sold.

Summary

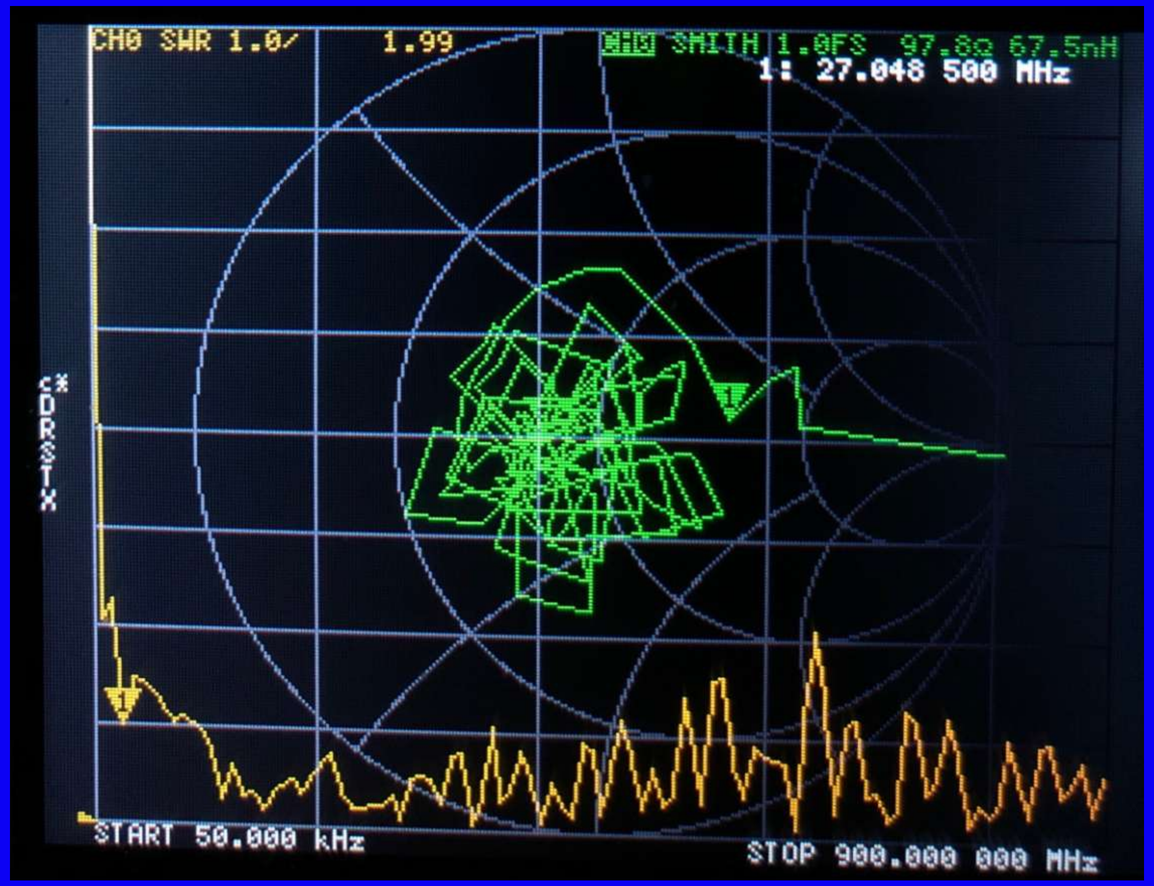
NanoVNA - Software defined RF tool extraordinaire

Functionality expanding - open architecture

User groups and YouTube videos

US source - R&L Electronics - $60

Test Question
Name of this antenna type?



Q & A