NanoVNA – A quick overview

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What can a Ham do with an antenna analyzer?

- Determine SWR of an antenna for a specific frequency
- Display graph of SWR for a multiband antenna
- Find resonance frequency (ies) of antennas
- Determine value of inductance or capacitance needed for resonance
- Check impedance of cables and circuits
- Generate Smith Charts
- Use TDR (Time Domain Reflectometer) capability to check cables and circuits
- Much more for design engineers……..

Comments on the NanoVNA:

- One of the most cost effective solution for a multifunction antenna or vector network analyzer. Pricing from $50 or $60 up to about $130. Open source coding allows many suppliers to develop alternate versions eg. different frequency ranges. The hardware remains constant. (Compare to SDR capability)
- Capable of being controlled by your PC thru USB
- Display multiple functions simultaneously eg. SWR, LOGMAG*, SmithChart
- Biggest drawback: Not a great unit for roof or tower use due to touchscreen rather than knobs and switches. Harder to read some of the screen data in bright sunlight than an analyzer with meters and switches.

**LOGMAG – on a network analyzer is either a two port plot of insertion loss in dB, or one port plot of return loss. It shows how much of your*

signal (in dB) doesn't return to the radio. (how much is going out or is lost) A higher number is better when measuring logmag.

Logmag in dB	VSWR
26.4	1.1
20.8	1.2
17.7	1.3
15.6	1.4
14.0	1.5
12.7	1.6
11.7	1.7
1.8	10.9
1.9	10.2
2.0	9.5

Scattering Parameters (S-Parameters) in RF Testing

S-parameters are used to define reflection and transmission in a multiport network with a frequency component. They are used to define how a device under test (DUT) behaves with a signal in both the forward and reverse direction.

The NanoVNA has two port network capabilities. The primary port for SWR measurement is port 1 and is also labeled the TX port. The other port is labeled Port 2 and is also labeled the RX port and with port 1 is used measuring gain/loss, impedance, admittance, phase and delay as well as TDR (Time Delay Reflectometry).

Since the NanoVNA is a network analyzer it is also labelled with traditional S-parameters, specifically S11 and S21. ***S parameters follow the convention of the first number being the exiting or output port and the second being the incident or input port.*** Therefore when port 1 is connected to an antenna feedline for an SWR measurement, it will be

considered an S11 configuration since the output is on port 1 and the reflected signal comes back into port 1.

Basic SWR and antenna resonance will be done with the S11 configuration. The S12, S21 and S22 configurations will be used for many of the other capabilities of the NanoVNA. A basic chart of conventions is printed on the rear of the NanoVNA.

How To Calibrate The NanoVNA

1. Set Frequency parameters and add any connectors needed for this config
2. Open CAL menu, then press Reset
3. Press Calibrate to open menu
4. Connect SMA OPEN to Port 1. Wait 3 seconds and then press OPEN
5. Connect SMA Short to Port 1. Wait 3 seconds and then press SHORT
6. Connect SMA Load to port 1. Wait 3 seconds and then press LOAD
7. Leave load on Port 1 and after 3 seconds press ISOLN
8. Connect RF cable from Port 1 to Port 2. After 3 seconds press THRU
9. After 3 seconds press DONE. Press SAVEx to save these settings to save to location SAVE0, SAVE1, SAVE2, SAVE3, or SAVE4. The parameters for this setup ie. Frequency etc. will be saved for future RECALL.

Measuring SWR of an Antenna with the NanoVNA

(Same process for single or multi-band – only change is frequency range)

1. Setup the NanoVNA (Using the Quick Start Guide)

    a) Turn on unit
    b) Select Stimulus, Start, Then enter Start frequency on keypad
    c) Select Stimulus, Stop, Then enter Stop frequency on keypad
    d) Calibrate or recall calibration (*When powered on unit will load **SAVE0***)
    e) If you want to save this range: Select Cal, Save, Save n (N=0-4)
    f) Select Display, Format, then SWR
    g) Select Display, Channel, then S11 Reflect
    h) Select Display, Trace, Trace 0
    i) Select Marker, Select Marker, Marker 1

2. Connect DUT to Port 1 (Antenna to be tested)

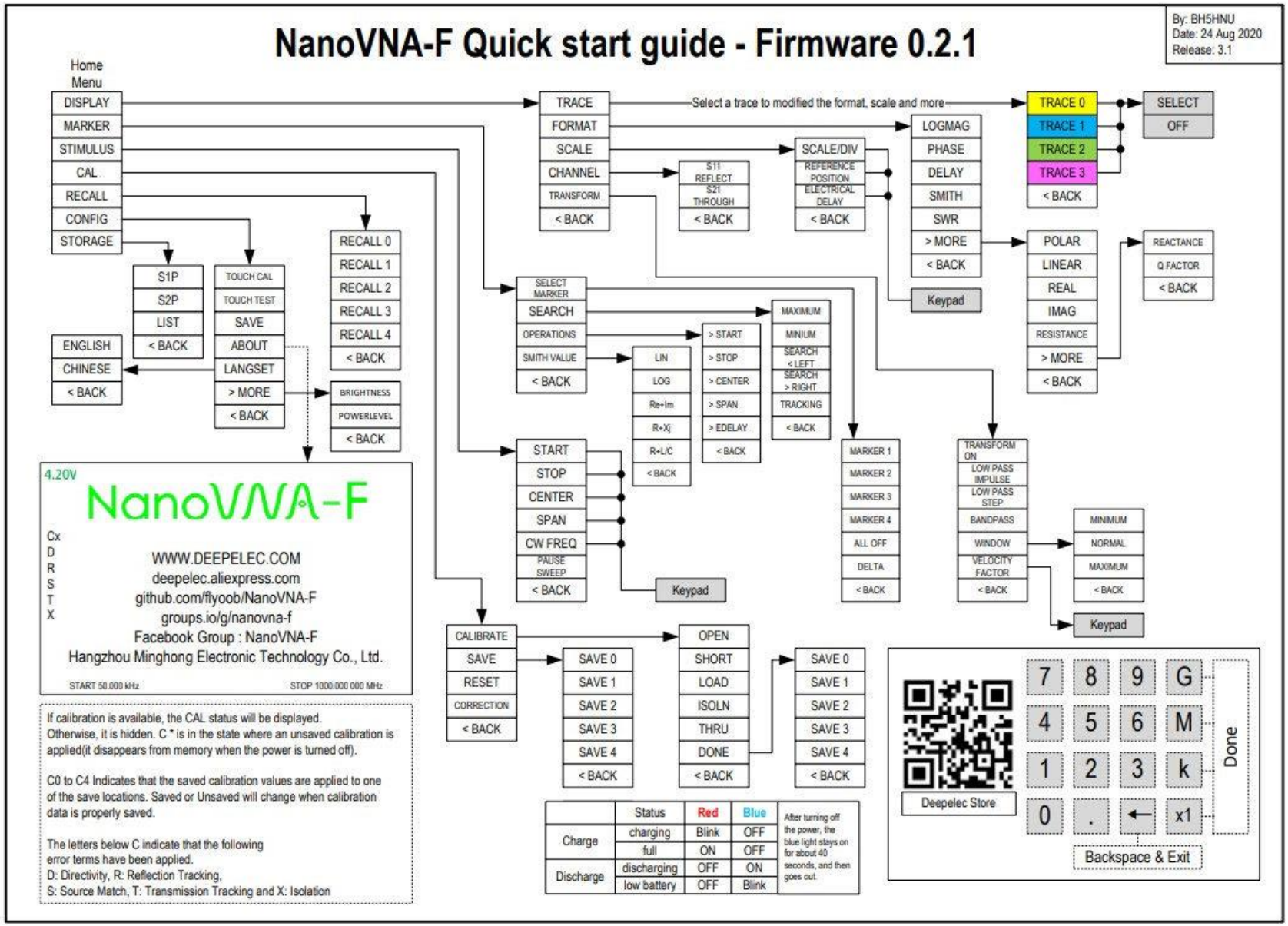
3. SWR will be displayed – Use thumbwheel to position marker to desired frequency

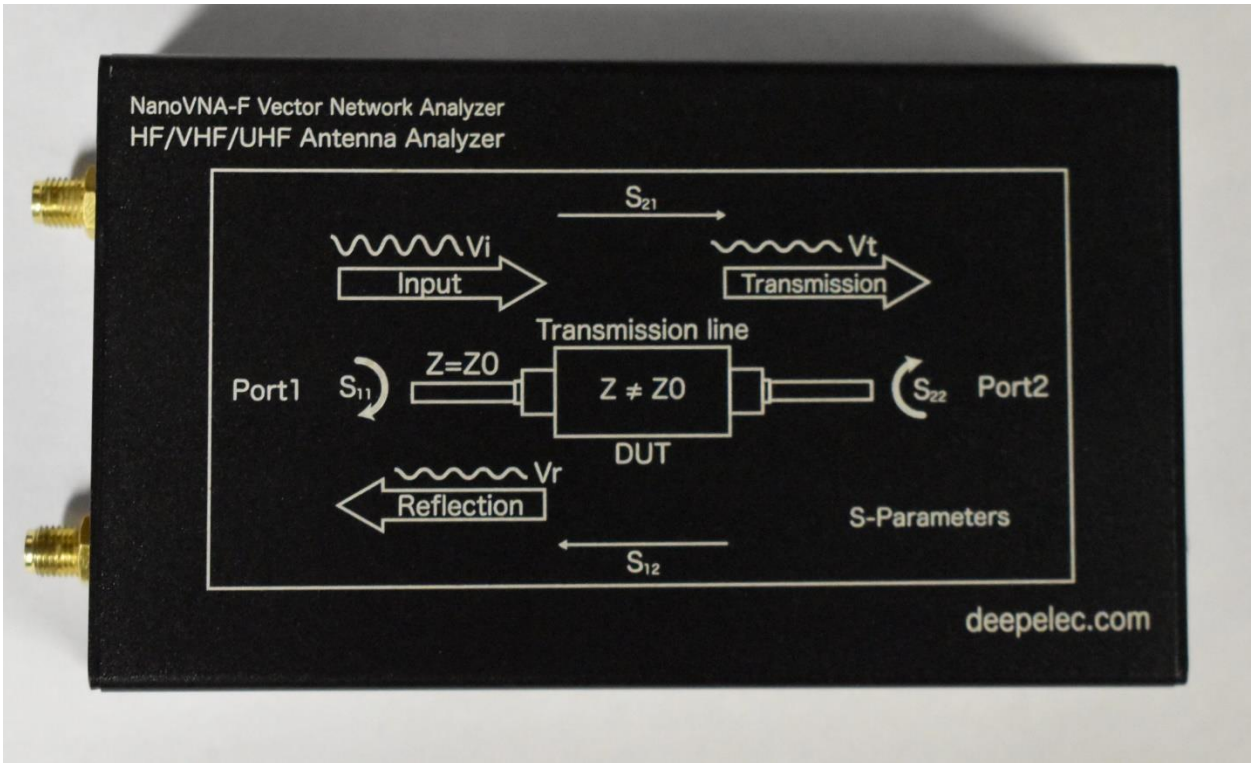
Characteristic

Description	Specification	Supplemental Information
Frequency range	50 kHz to 1 GHz	measurable frequency up to 1.5 GHz, accurate measurement up to 1.35 GHz
Frequency reference		
Temperature Stability (-30 ~ +85 ℃)	± 0.5 ppm ~ ± 2.0 ppm	
Aging (at 25 ℃)	± 1 ppm / year Max.	
Data points	101	Number of calibration points Number of scanning points
Sweep cycle	About 1.9 s	Turn on the built-in filter
Display Trace	4	
Marker	4	
Parameter storage	5	
Measurements	S11, S21 magnitude and phase	
	S22, S12 magnitude and phase	need reverse DUT connection
Formats	Log magnitude, linear magnitude, VSWR, phase, Smith chart, polar, group delay, real, imaginary, resistance, reactance	
System dynamic range		after calibration and normalization
50 kHz ~ 300 MHz 300 MHz ~ 600 MHz 600 MHz ~ 1000 MHz	60 dB 50 dB 40 dB	S11
50 kHz ~ 300 MHz 300 MHz ~ 600 MHz 600 MHz ~ 1000 MHz	70 dB 70 dB 60 dB	S21
PORT1 output power		
50kHz to 300MHz	-13 dBm	maximum -9 dBm
PORT2 damage level		
50kHz to 300MHz	+20 dBm	
Display	4.3 inch IPS LCD	800*480 dots
Communication & Charging interface	USB Type-C	Communication mode: CDC (serial)
Power consumption	Discharging: 5V 200mA; Charging: 5V Max 2A	LCD Backlight 75%, adjustable;
Output capacity	5V/1A	USB Type-A
Battery	4000mAh	Discharge cut-off voltage 3.0V
Size	14CM * 7.5CM * 2CM	length, width and height

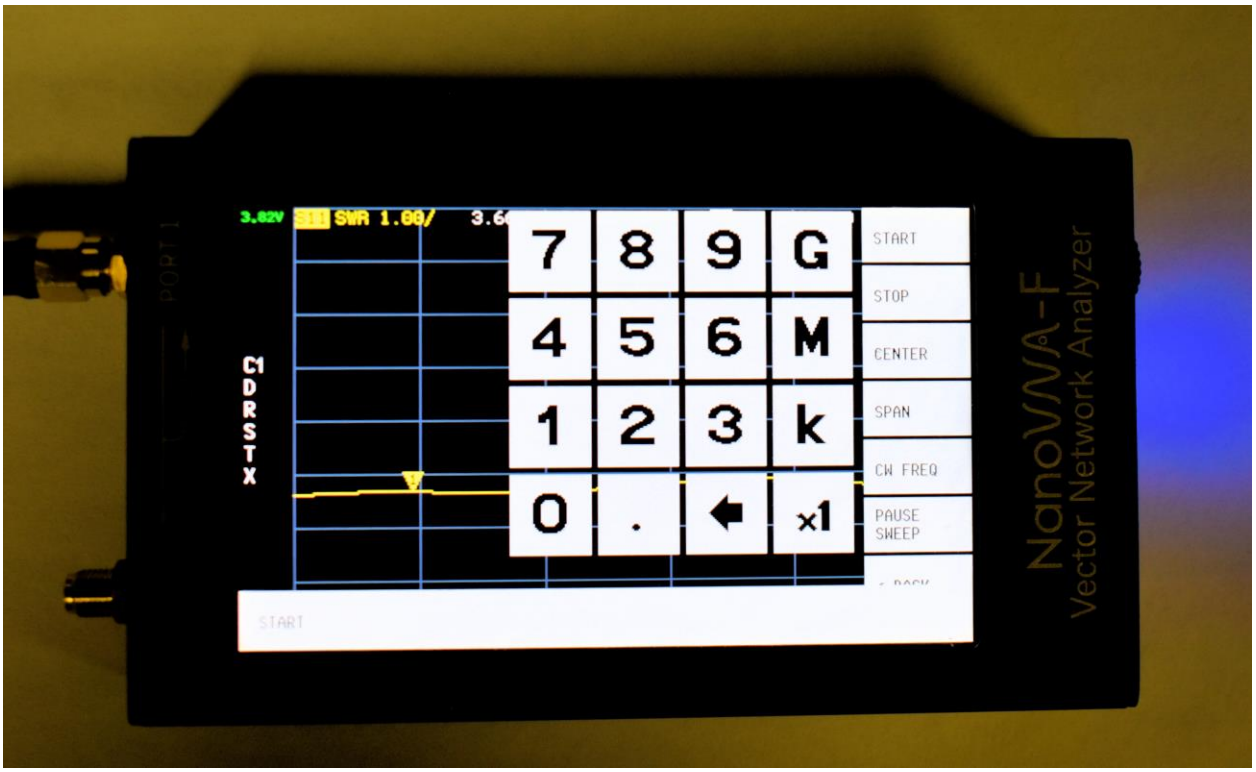
NanoVNA-F Quick start guide - Firmware 0.2.1

By: BH5HNU
Date: 24 Aug 2020
Release: 3.1

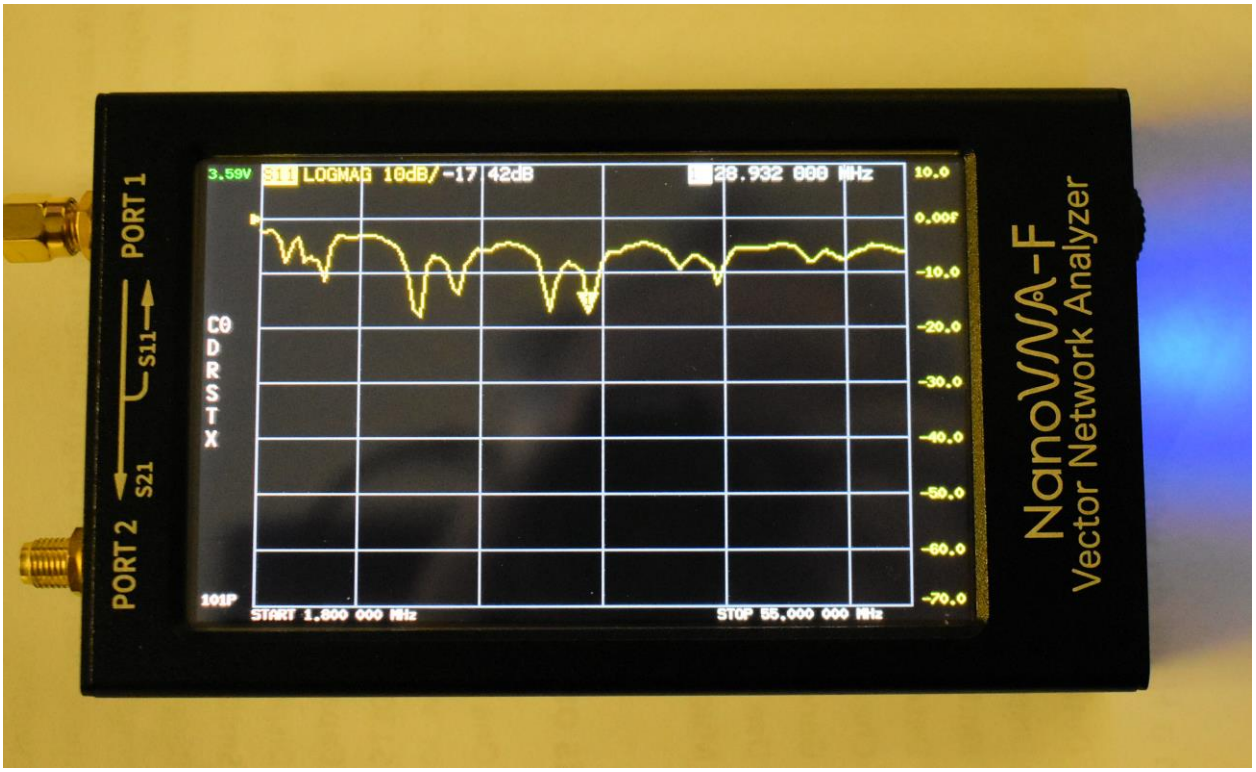




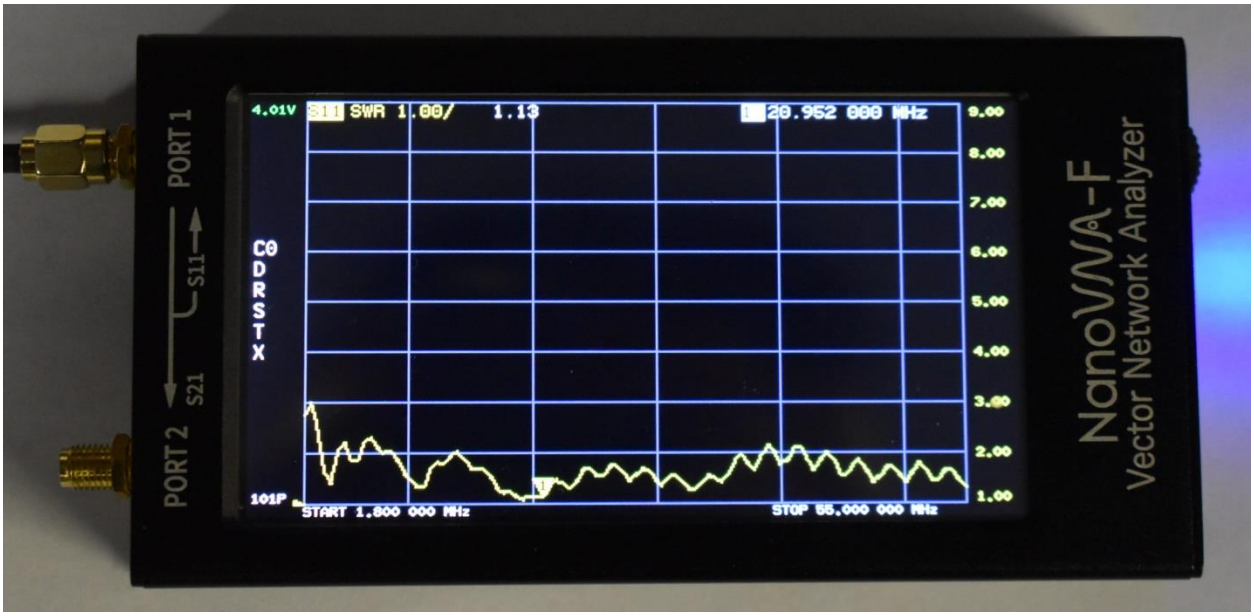
S-Parameters for the two port NanoVNA-F (On rear of device)



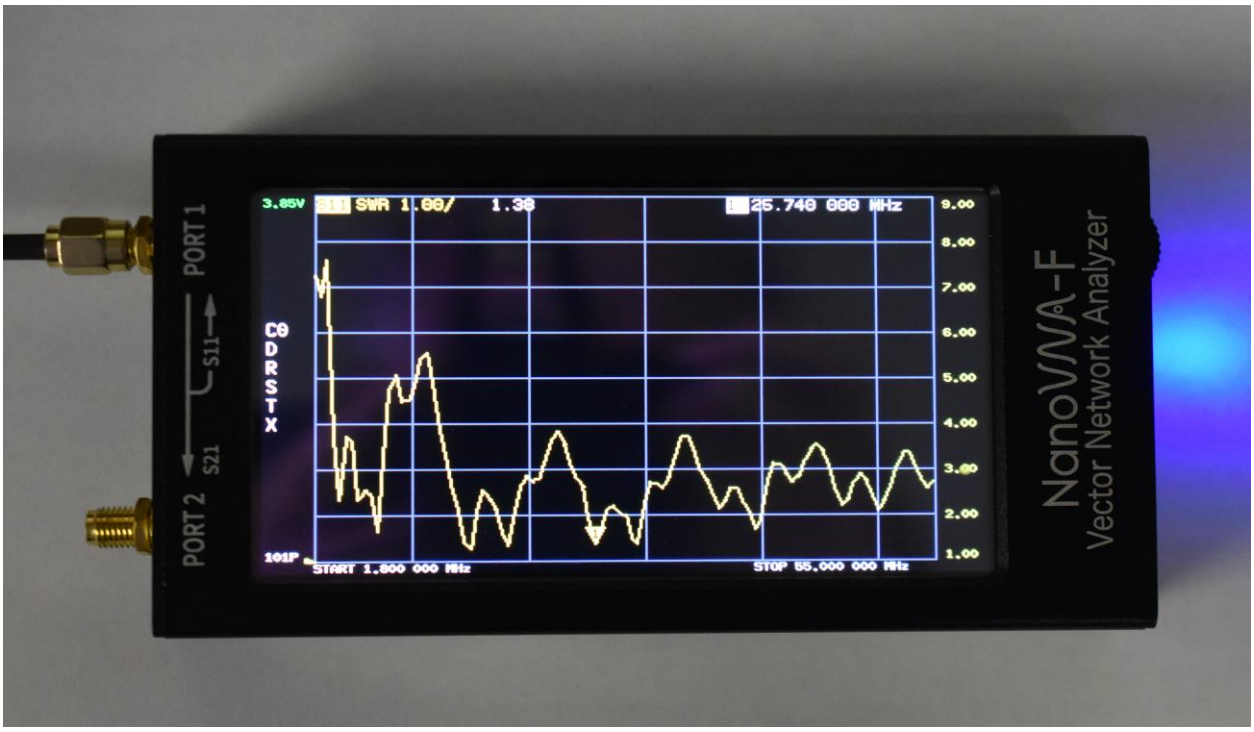
Keyboard – Use for entering frequencies: Start, Stop, Center, Span



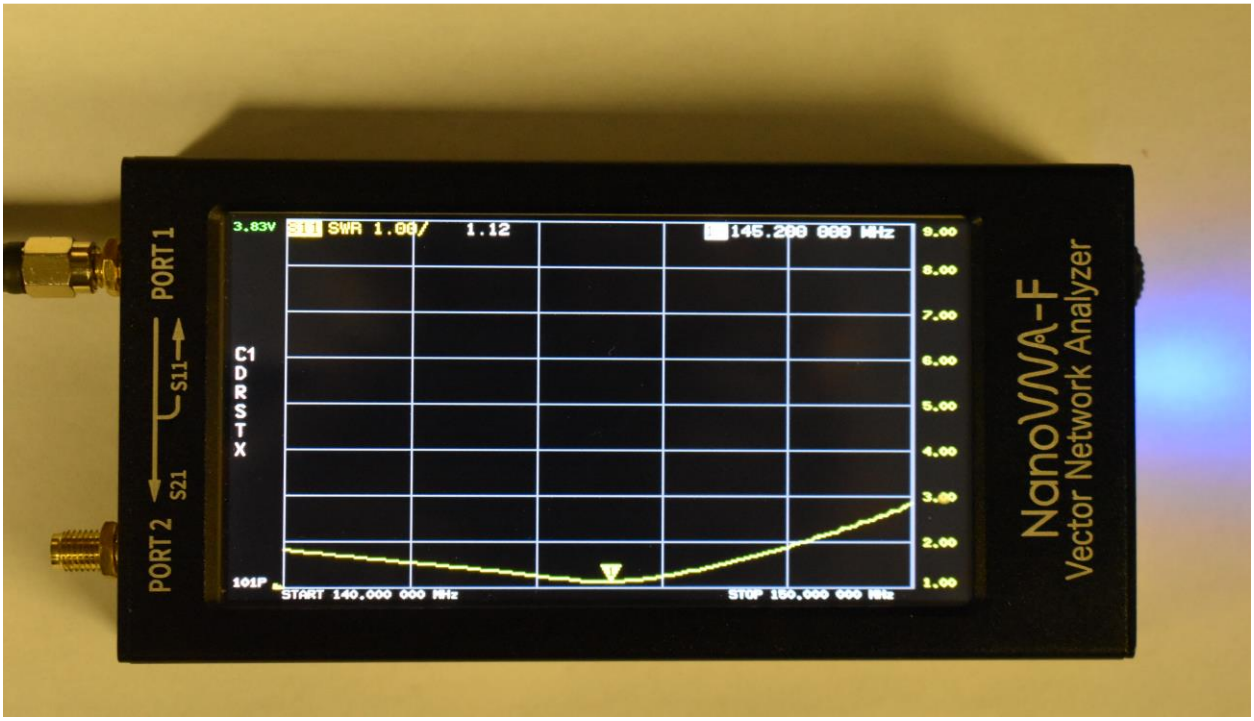
Multiband OCF Dipole Logmag plot at 10 meter band with 17.42 dB reading



SWR scan for multiband vertical 1.8 MHz - 55.0 MHz - marker on 15m band



SWR plot for 80 meter OCF Dipole – marker at 15 meter band



SWR Plot for Tape Measure Antenna showing resonance point

Tape Measure Antenna Smith Chart showing Impedance and Inductance