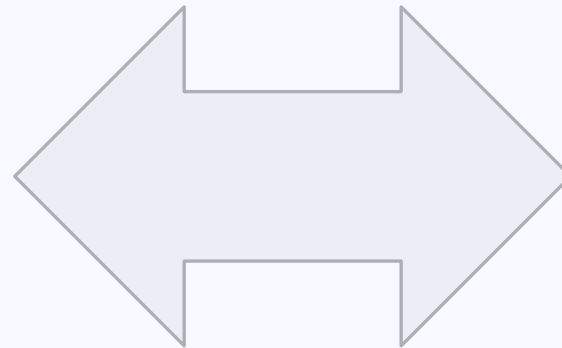# NANOVNA AS AN ANTENNA ANALYZER

Feb 25 2022

William Dodge, N4ZSG

NANOVNA – BASIC OPERATIONS

What is a vector network analyzer

How to operate the NANOVNA

How to use VNA-SAVER
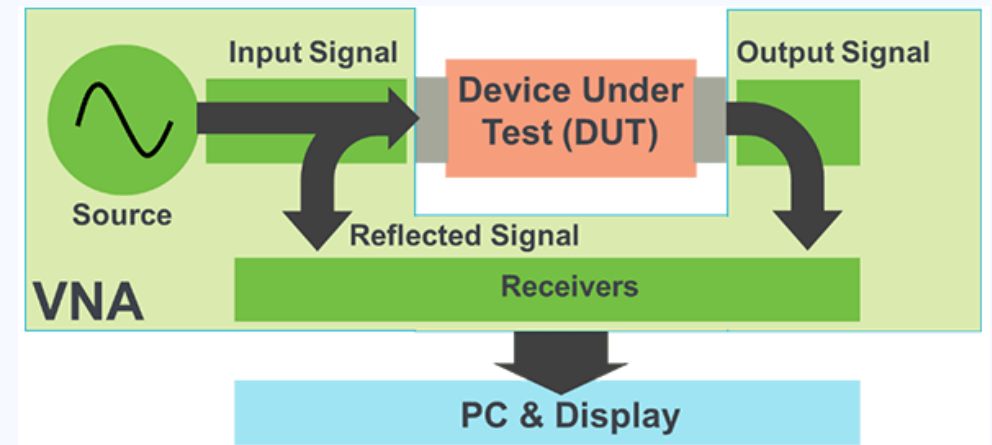
Basic demonstration on the N4ZSG yagi

WHAT IS A VNA?

Vector **N**etwork **A**nalyzer

Measures amplitude and phase in electronic networks

Inject a signal into the network and measure output and reflected signals

Measures s-parameters (S11 S12 etc)

$10k -- $200k

NANOVNA

Inexpensive VNA kit designed in Japan by "edy555"

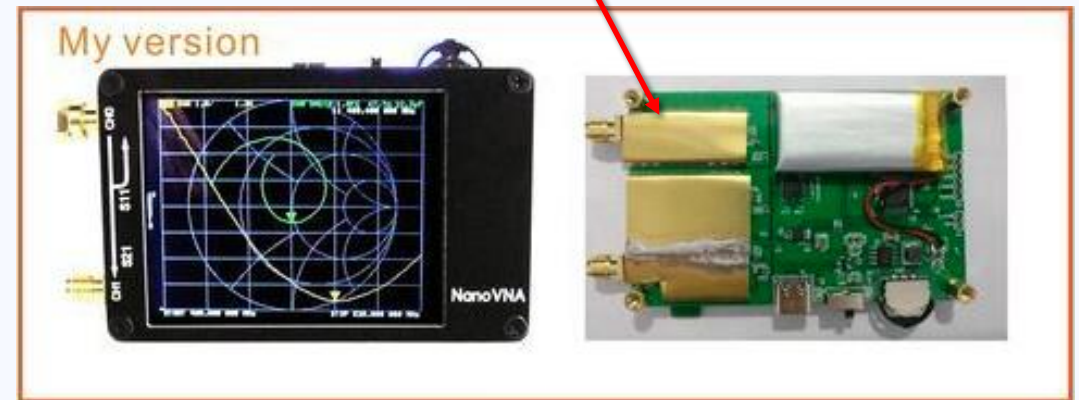Widely reproduced by China with varying quality
◦ Buyer beware, buy from R&L

Several hardware versions exist
◦ Original versions
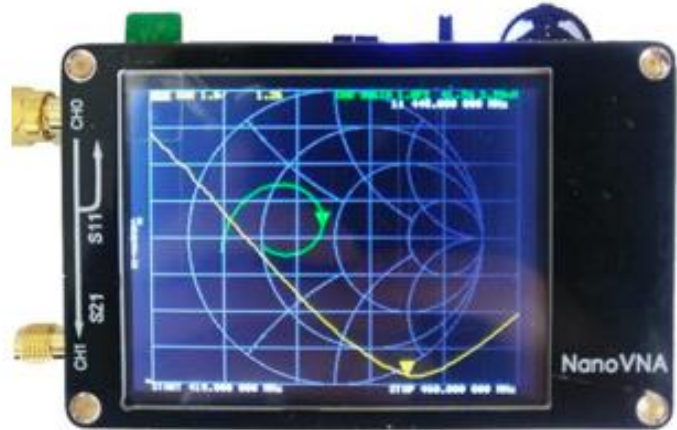◦ H4 large display version

Several firmware versions exist
◦ https://github.com/ttrftech/NanoVNA

CH0 = Port 1
TX & RX

CH1 = Port 2
RX only

S11	S21
SWR	Isertion Loss
Phase	Grain
Return Loss (RL)	Polar Plots
Impedance (Z)	Group Delay
Smith Chart	
Quality Factor	
R+jX	
Serial C	
Serial	

A S-parameter specifies the ratio of the electromagnetic wave exiting a port given that entering a port. For example:

In port 1 →

Device Under Test (DUT)
(2 port device)

← In port 2

Out port 1 ←

→ Out port 2
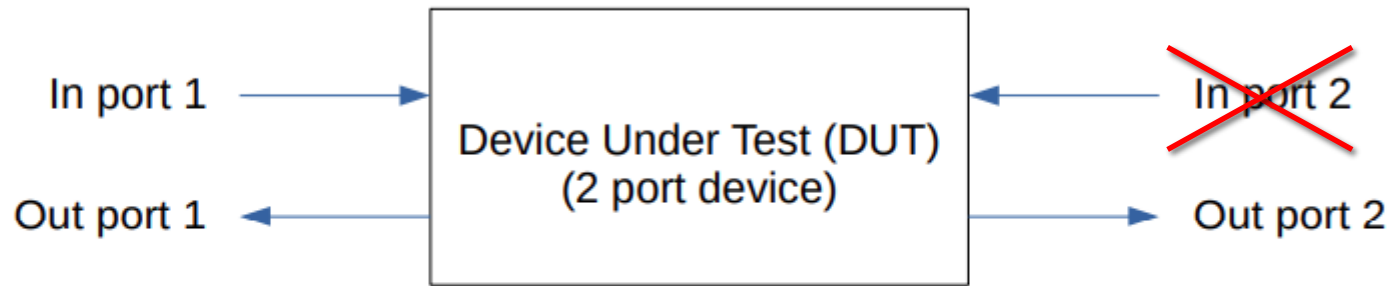
S11: ratio of wave exiting port 1 that is entering port 1. ← Analyze Antennas
S21: ratio of wave exiting port 2 that is entering port 1. ← Analyze Filters, UNUNS, etc
S12: ratio of wave exiting port 1 that is entering port 2.
S22: ratio of wave exiting port 2 that is entering port 2.

TRANSMISSION LINES EFFECTS

DUT Impedance $Z = \dfrac{V}{I}$

Any impedance mismatch on the transmission line will affect the measured DUT Z
- Compensate by calibration open/short/load at the DUT
- Calculate the effects and compensate
- Ignore it: Z at the port is the same as what the radio sees so tuning is still valid for a specific installation
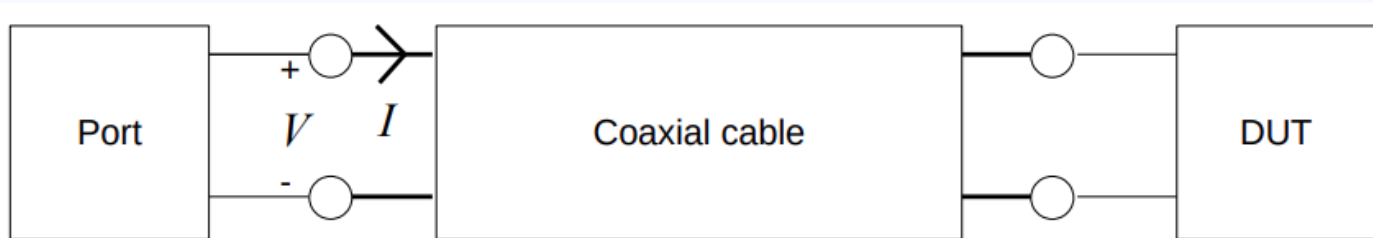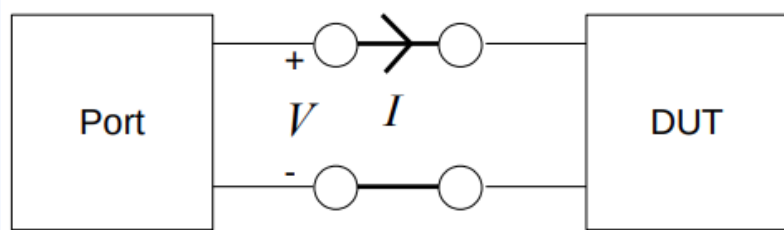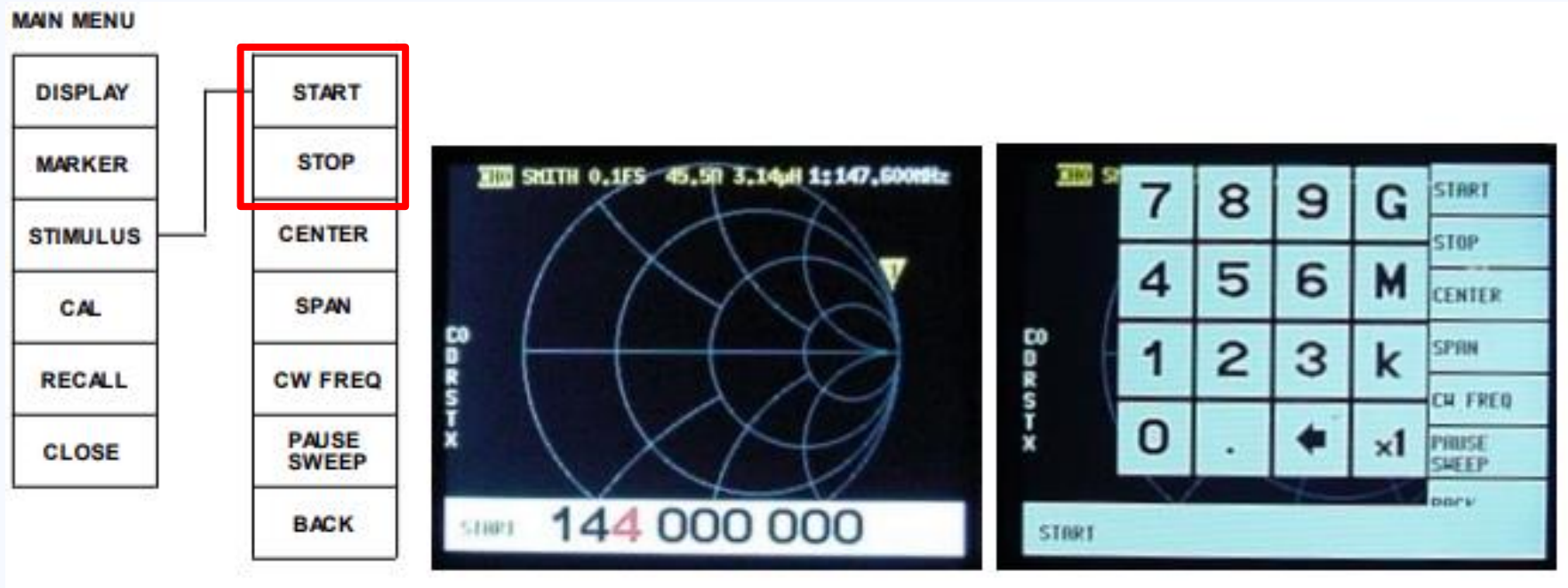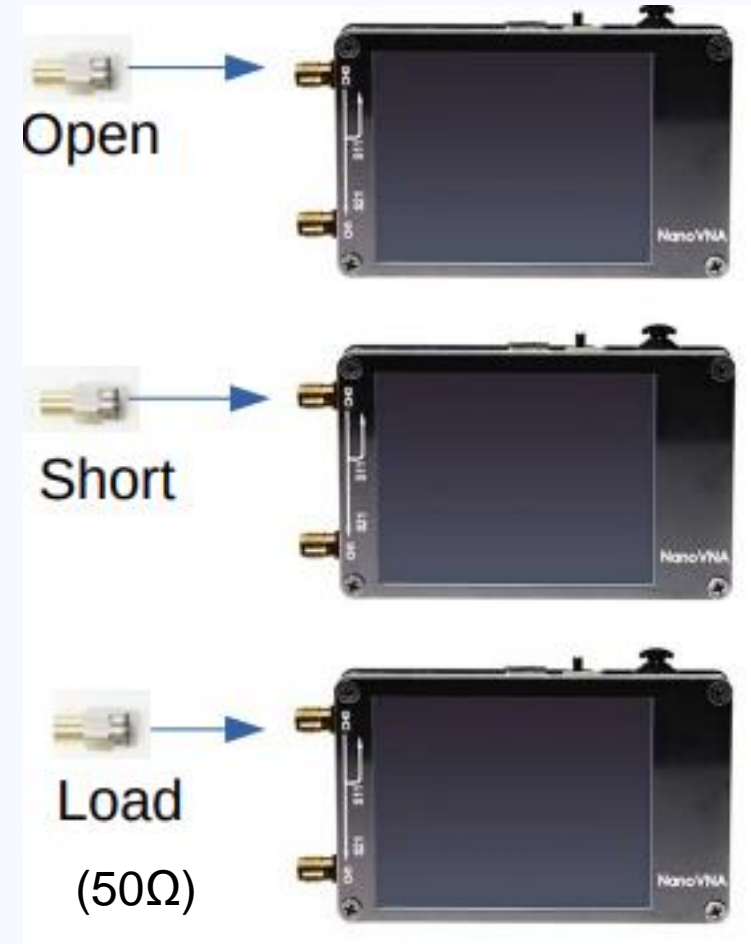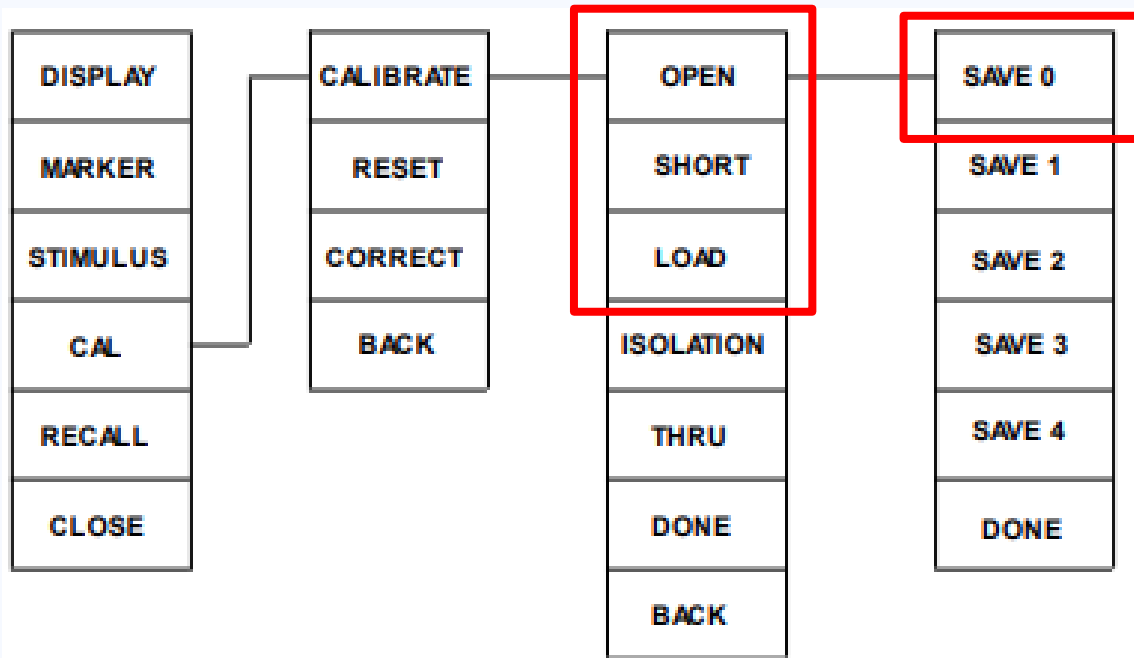
CALIBRATION

Calibrate every time you use it

Let it warm up first

Preferably select the correct frequency range for the DUT and use that during calibration

OPEN / SHORT / LOAD CALIBRATION

LIMITATIONS

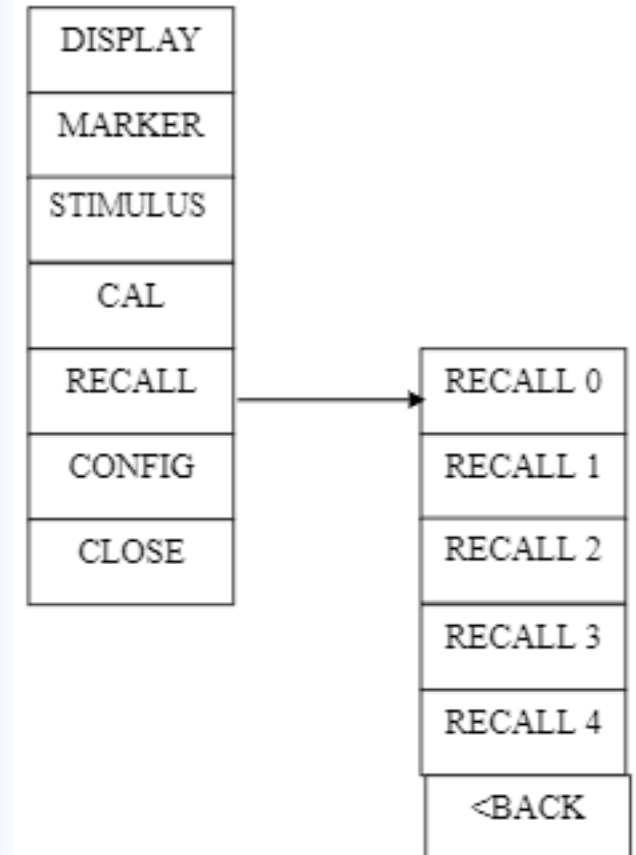SMA ports are weak, don't stack adapters
- ◦ Use SO239 or BNC patch cables

Device is limited to 101 data points, only check one band at a time
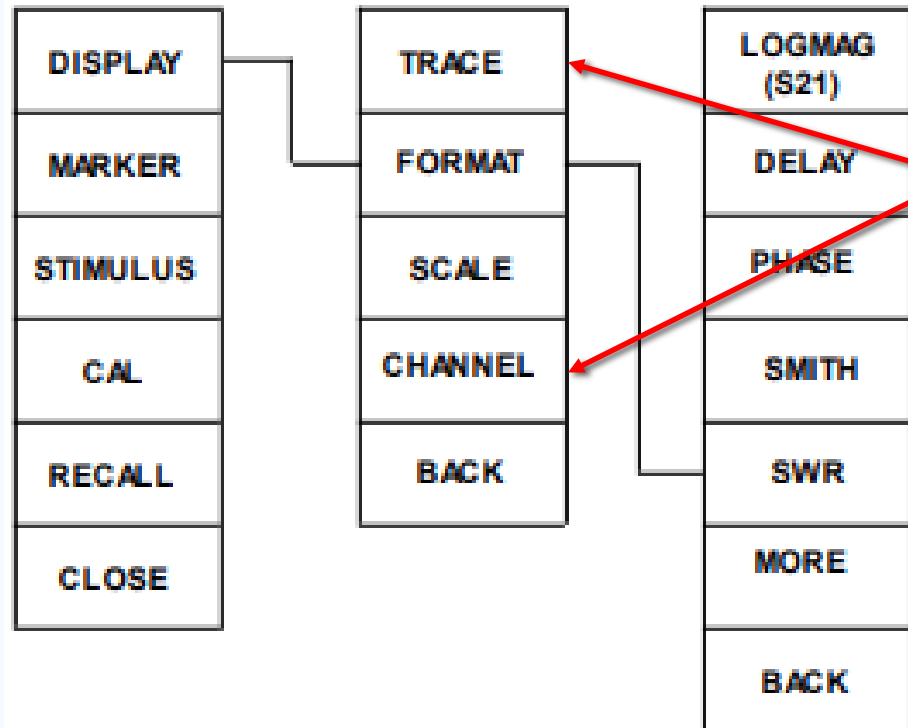- ◦ 80-6m =≅ 465 kHz steps
- ◦ 2m-70cm =≅ 3 MHz steps

Save calibration for several common bands
- ◦ SAVE 1 =144-148 MHz ≅ 40 kHz steps
- ◦ SAVE 2 = 420-450 MHZ ≅ 500 kHz steps

BASIC ANTENNA CHECK
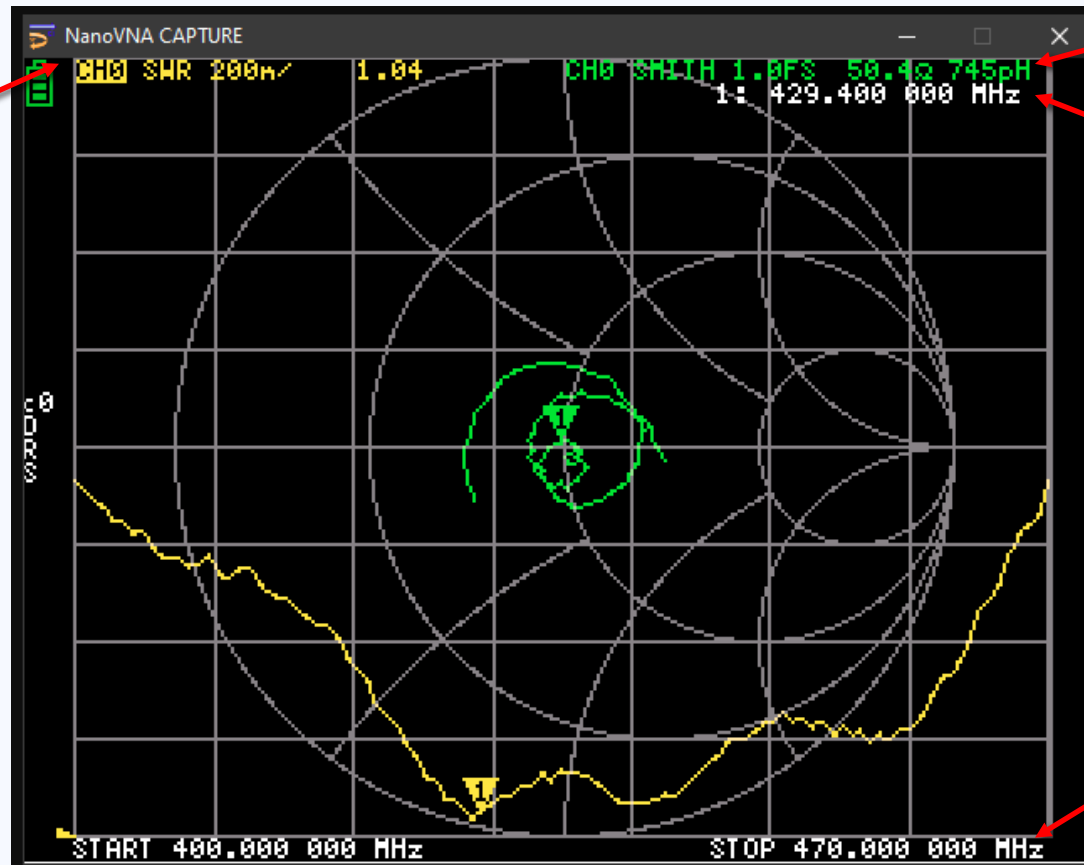

- Select a frequency range

- Calibrate OPEN / SHORT / LOAD calibration on port 1

- Select a channel (CH0 for port 1)

- Setup the traces
  - Long press – enable/disable
  - Short press -- select

- Set the format for the active trace
  - SWR
  - Smith

- Connect port 1 (CH0) to the antenna where the radio would be connected

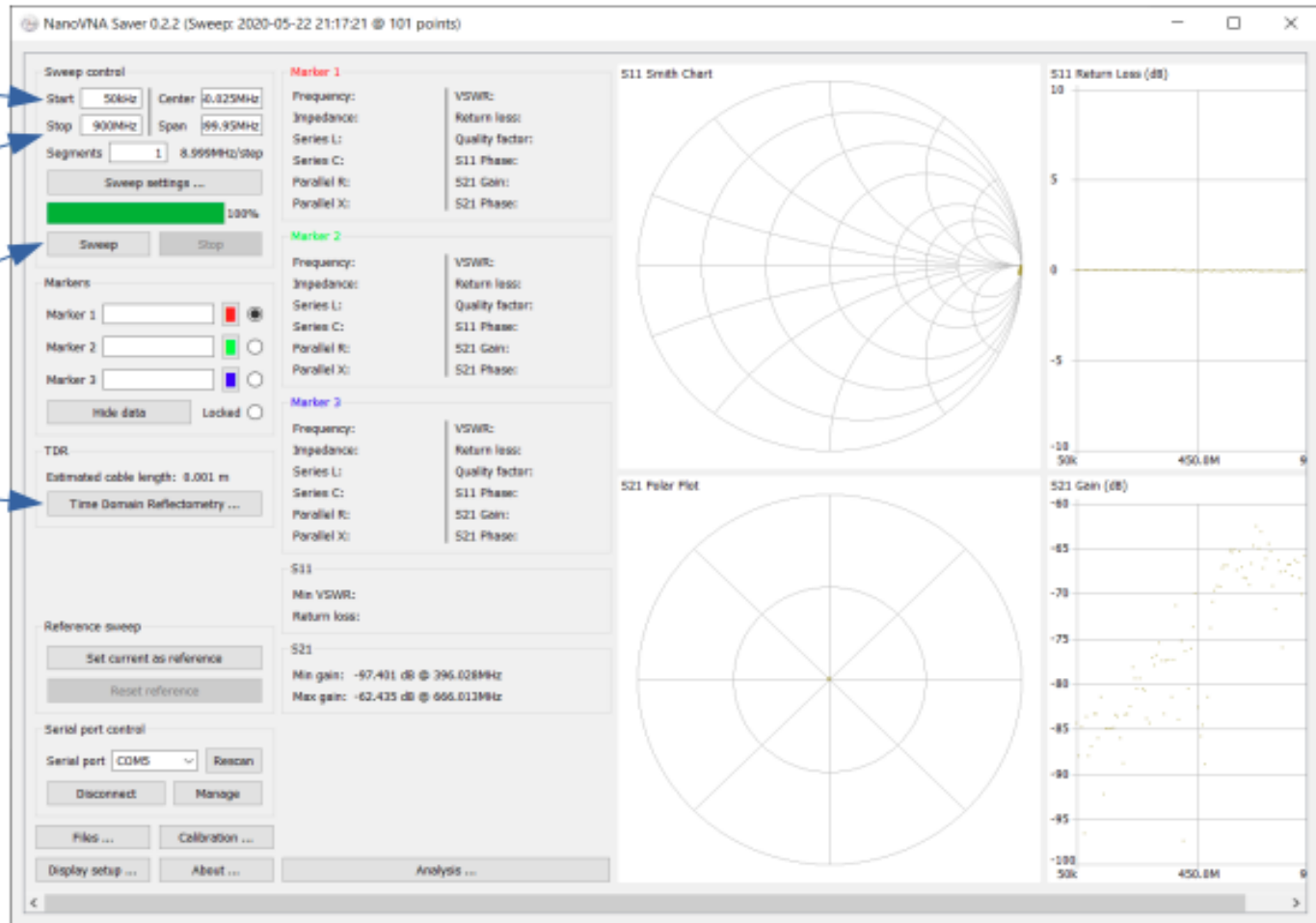# 70 CM ANTENNA EXAMPLE

NANOVNA SAVER

Start Frequency

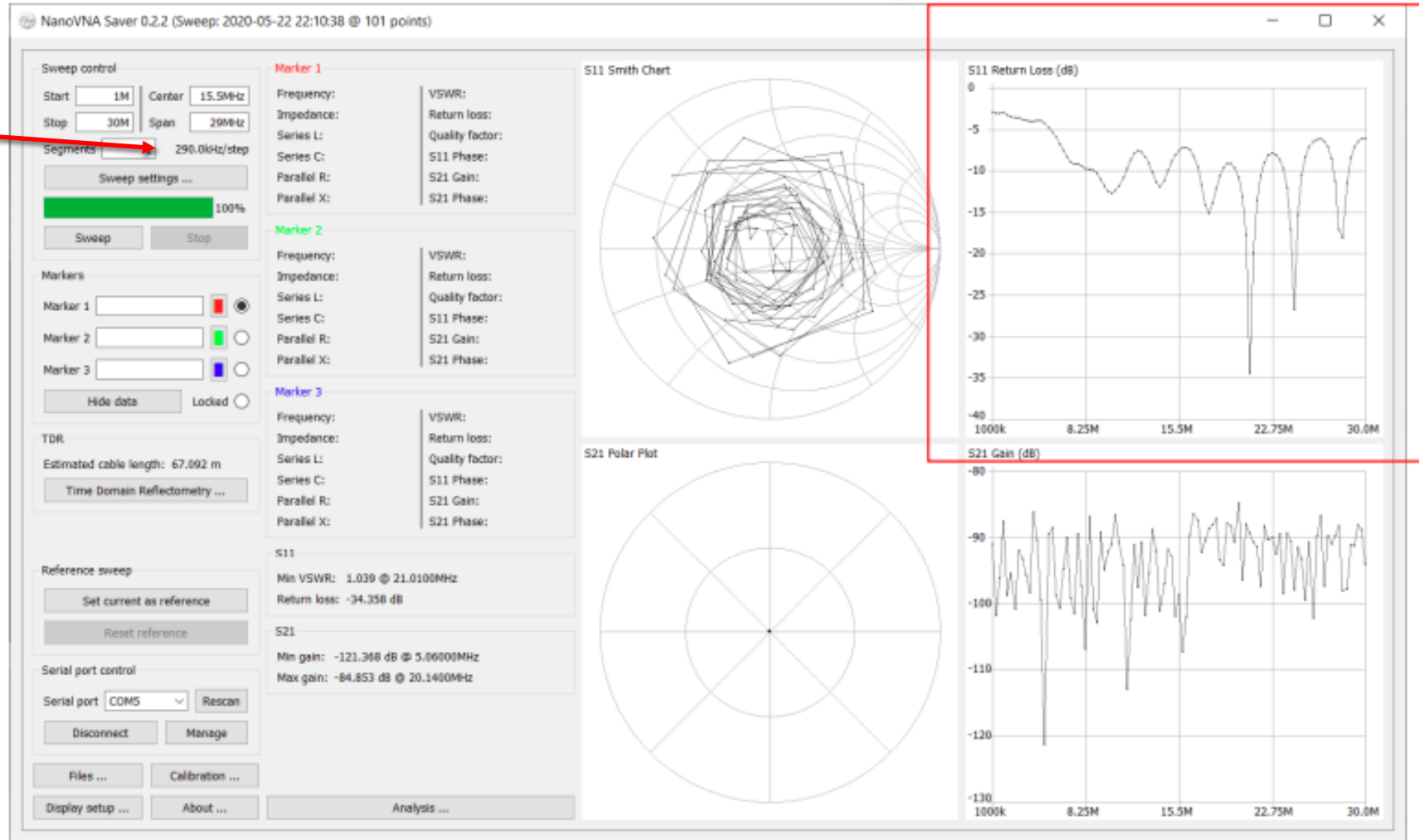**Stop Frequency**

Initiate Sweep

Time Domain Reflectometry

In general, you should calibrate using the NanoVNA internal calibration, but then you use NanoVNA saver to acquire your data.

Sweep of HF antenna: Long wire on 9:1 unun, approximately 160 feet of LMR400 cable

290 kHz steps (each step is 101 data points)

TIME DOMAIN REFRACTOMETRY

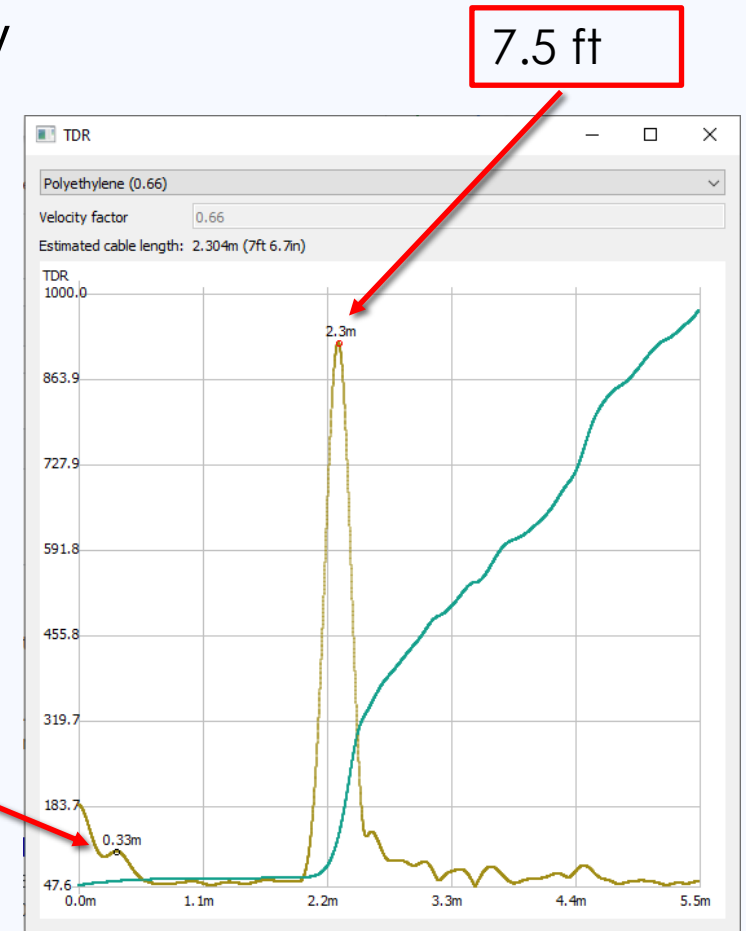Measure the length of a cable or distance to a discontinuity

Stimulus:

- Start 50kHz

- Stop (MHz) = $\dfrac{5850}{Max\ length\ (m)} \times velocity\ factor\ (decimal)$

Reflections at impedence changes

- End of the cable

- Connectors

Example: 1ft patch cable, 6ft coax to a yagi

7.5 ft

1.08 ft

REFERENCES

http://www.kb5tx.org/Presentations/RARS-Club-NanoVNA-presentation.pdf

https://docplayer.net/204699027-Nano-vna-introduction-to-the-nano-vector-network-analyzer-greg-algieri-wa1jxr-g-algieri-wa1jxr.html

https://www.bwcelectronics.com/articles/NanoVNA%20User%20Guide.pdf

https://oristopo.github.io/nVhelp/html/hardware.htm

https://github.com/NanoVNA-Saver/nanovna-saver/releases/
- ◦ May require the latest version of Python3 to be installed

DEMONSTRATIONS