NanoVNA

- Objective
- NanoVNA Models
- Display, Smithchart and SWR
- Deep Dive into Measuring, Resonant Circuits
- Calibration explained
- Programs (Saver, View, App)
- Bonus: SimNEC 2.2 (SimSmith)

NanoVNA

Objective

- This presentation is intended as a hands-on, real-world, description of using a NanoVNA as an antenna testing tool.
- It is not a complete, nor deep detailed, description of what a NanoVNA is capable of doing, nor is it intended as a teaching session.
- This is just a demo of some important highlights of what I have learned and figured out while testing some circuits and scenarios.
- I am only showing using the Smith Chart and the SWR traces.

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NanoVNA description

NanoVNA is a handheld Vector Network Analyzer (VNA) with small outline, originally designed by edy555. It has become the most popular VNA and antenna analyzer project in the community since its release in 2019

Models and capabilities

- NanoVNA (The Original)
- NanoVNA-F (50k-1.5GHz. $160)
- NanoVNA-H (10k-1.5GHz. $75)
- LibreVNA (100k-6GHz. $1000)

(See http://nanovna.com and http://groups.io/g/nanovna-users/wiki)

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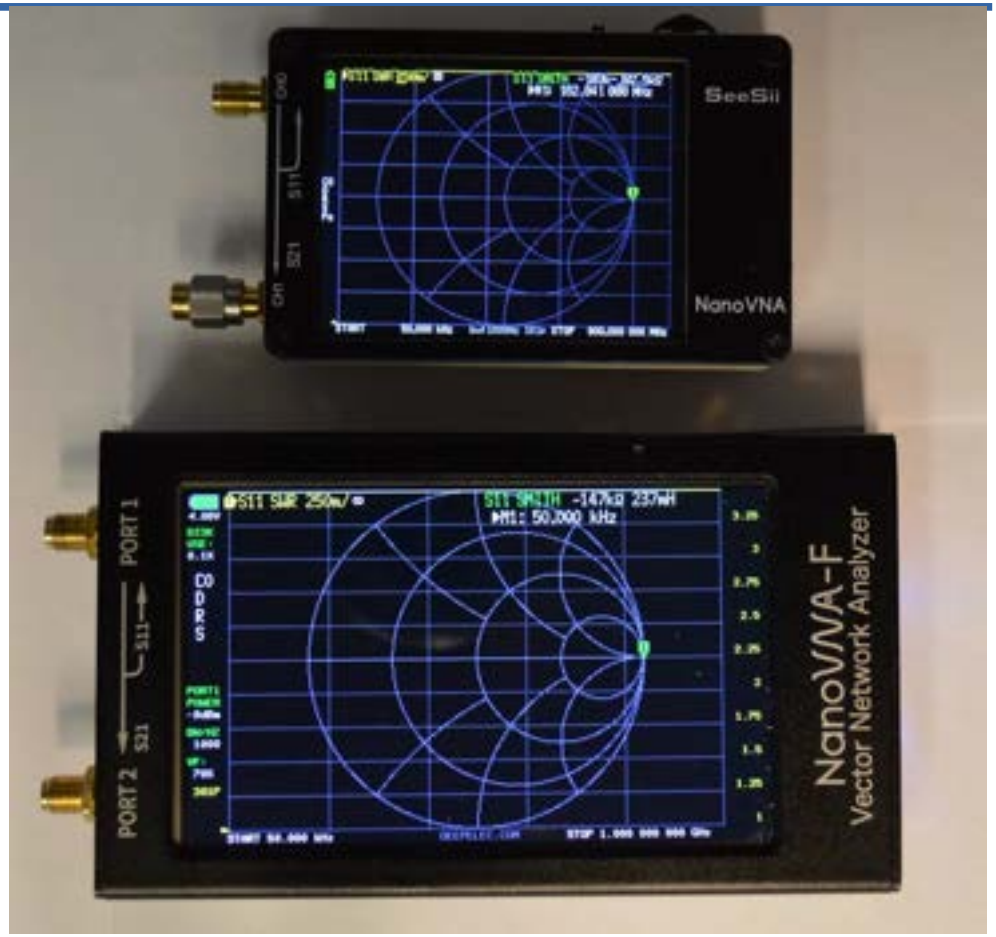
Demo Hardware:

- NanoVNA-H
- NanoVNA-F



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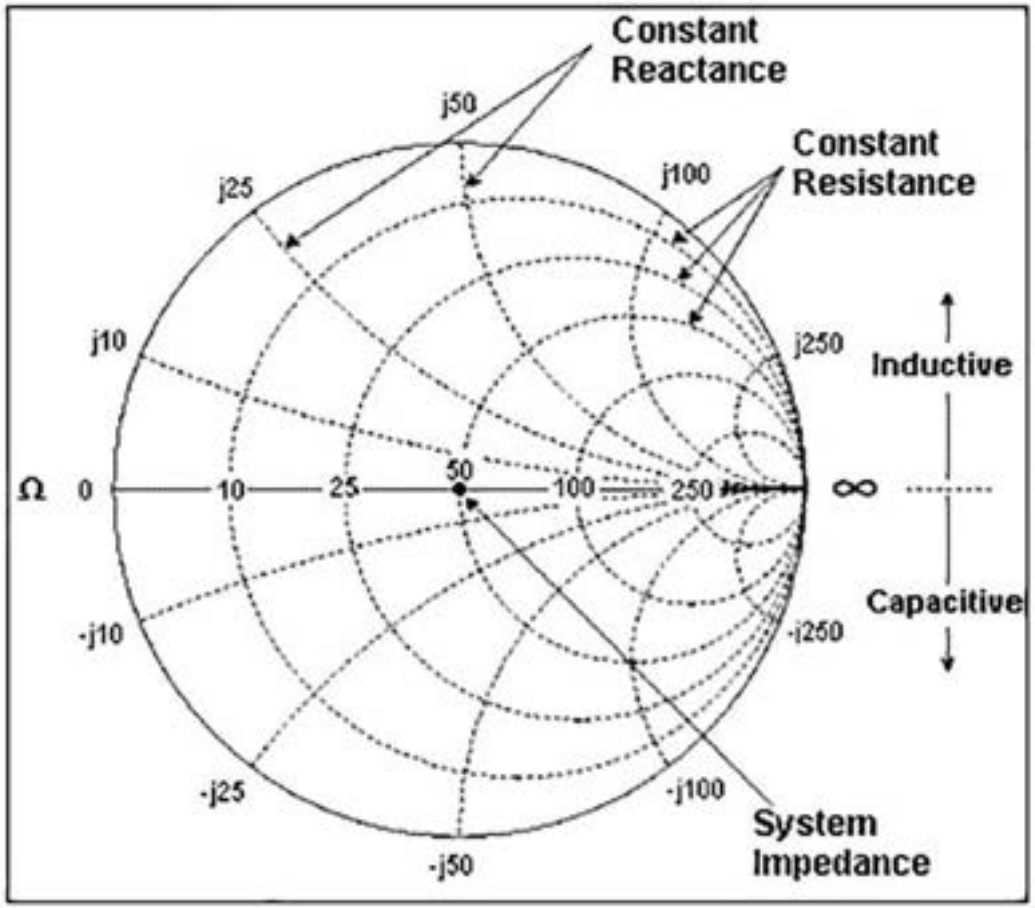
Smith Chart

- R (Resistive) is across center
- Inductive is + (up)
- Capacitive is - (down)
- Constant Circles are lines of constant R
- Arcs are lines of constant reactance (j)



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NanoVNA-F

Default when turned on

Open on Port 1

Nothing connected

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NanoVNA-F

Note that this is showing C0, which is the factory default calibration for the full frequency range

C0 - Calibrated
D - Directivity
R - Reflection Matching
S - Source Match

301P
Start 50 kHz
Stop 1.000 GHz

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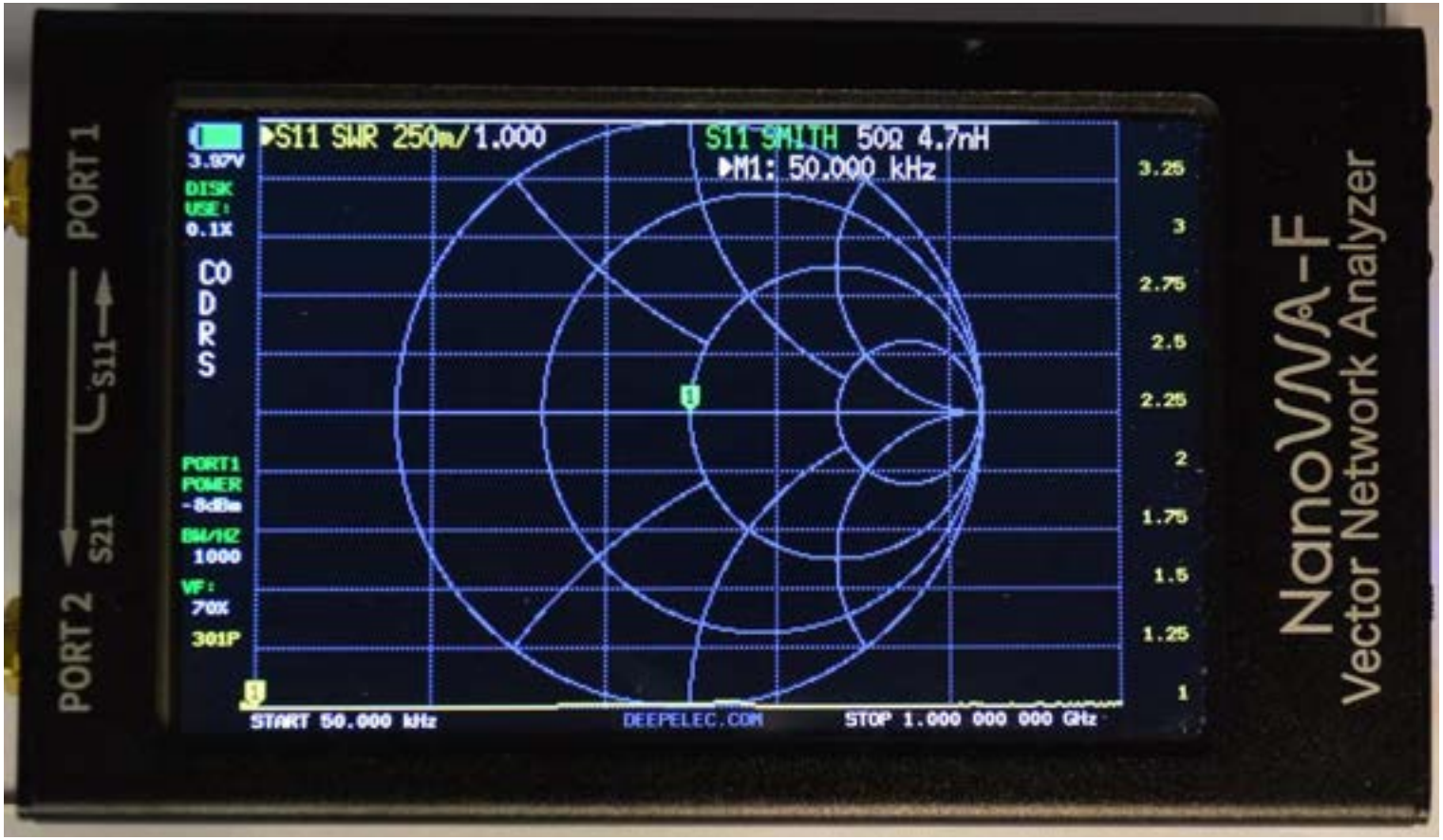

NanoVNA-F

Dummy Load on Port1
(50 ohms)

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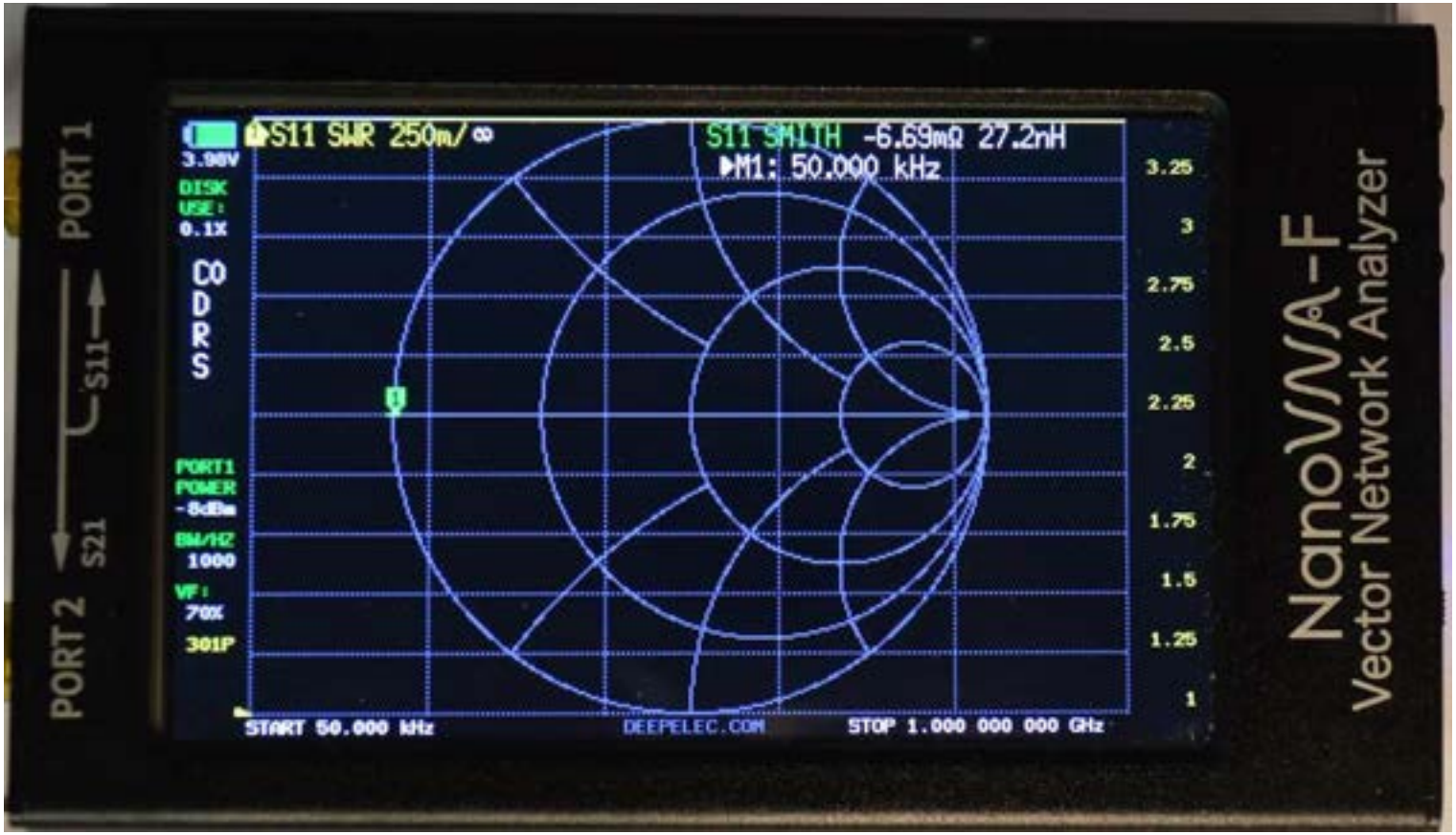

NanoVNA-F

Short on Port1

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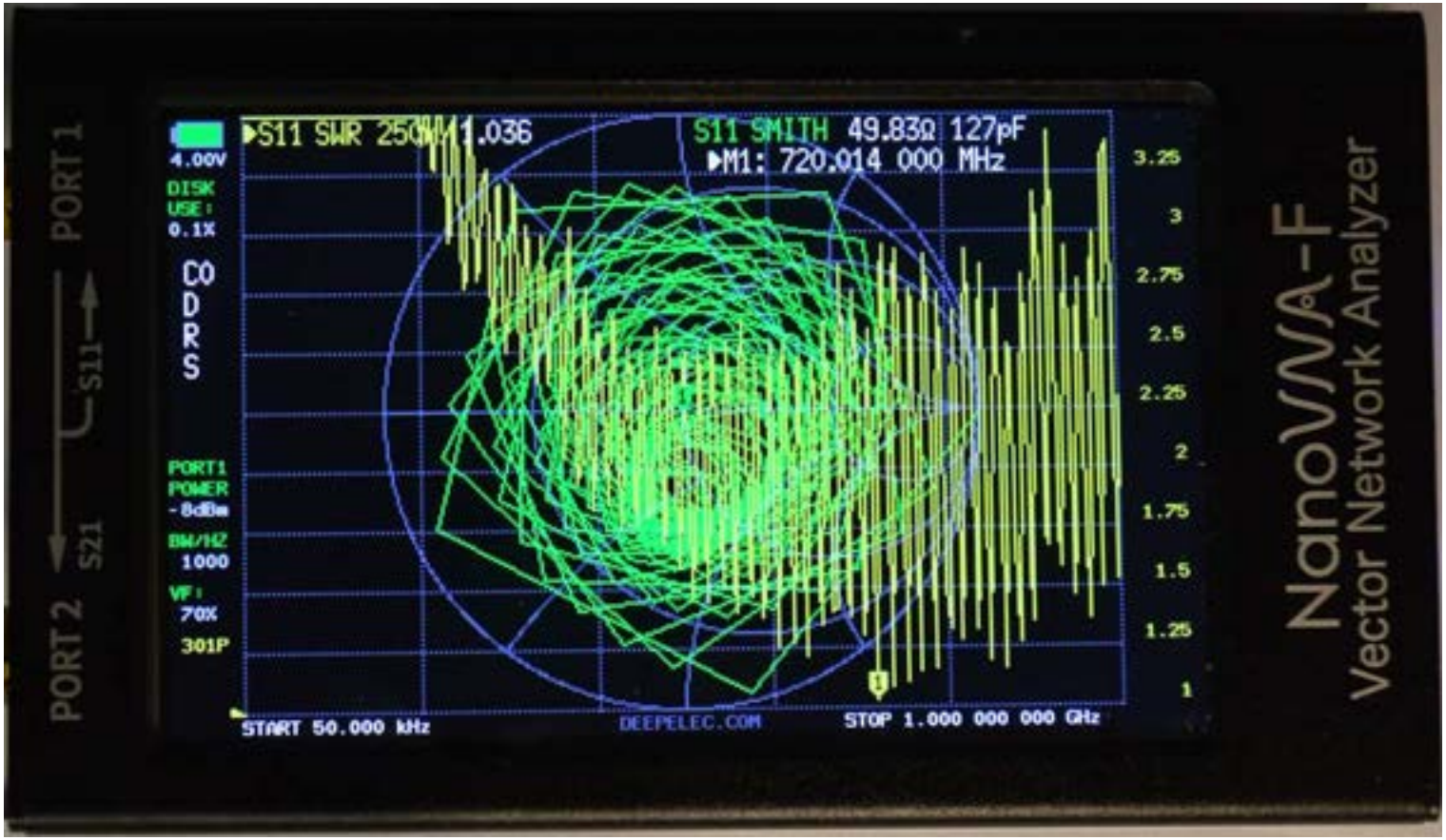

FEED LINE

Attaching a 7 Meter (Physical) feed line of RG58 A/U.

Don’t let me forget to mention that this represents about 10 Meters electrically.
Or the wavelength of about 30MHz.

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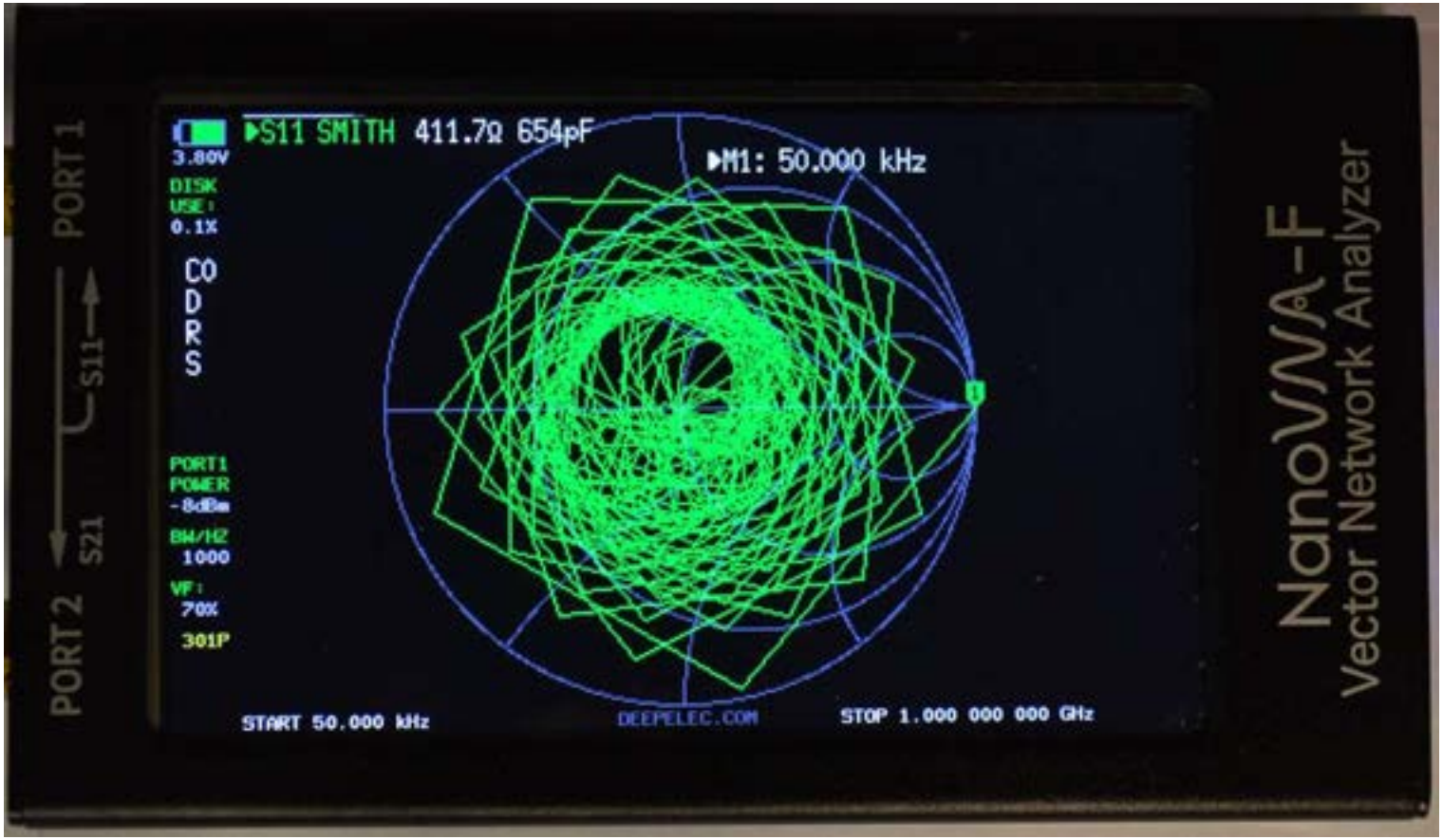

FEED LINE

Removed the SWR trace

The problem is that the Sweep Range is too high.

Notice the line from the marker at data point 1 to the next point.

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FEED LINE

Lets cut the Sweep STOP range in half, to about 500MHz.

Notice that the Calibration status changed from a white C0 to a green c0. This indicates that it is now in an Interpolate mode.

Also notice that data point 2 is not 1/2 the distance, and that data point 3 is where data point 2 was before.

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FEED LINE

Lets cut the Sweep STOP range in half, to about 250MHz.

Notice that the data points are now gettign close enough together to start to smooth out.

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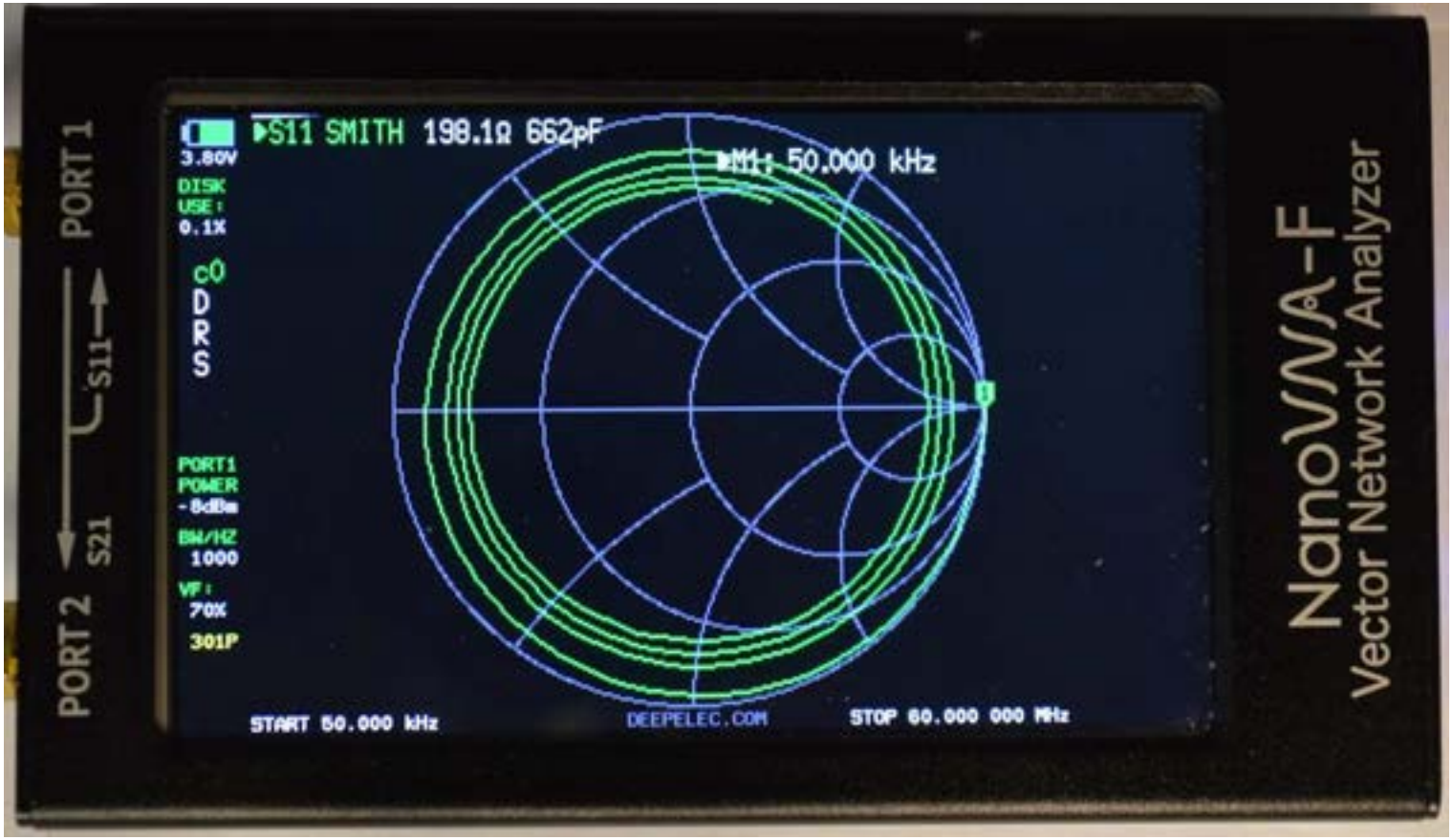

FEED LINE

Lets cut the Sweep STOP to 60MHz.

Now, Notice the sweep bar across the top of the screen. At 301 Points, it is taking about 1.8 seconds per sweep. If I change the sweep to only do 101 points, it speeds up the sweep to about .6 seconds each. So, depending on what you want to view, you can make this adjustment.

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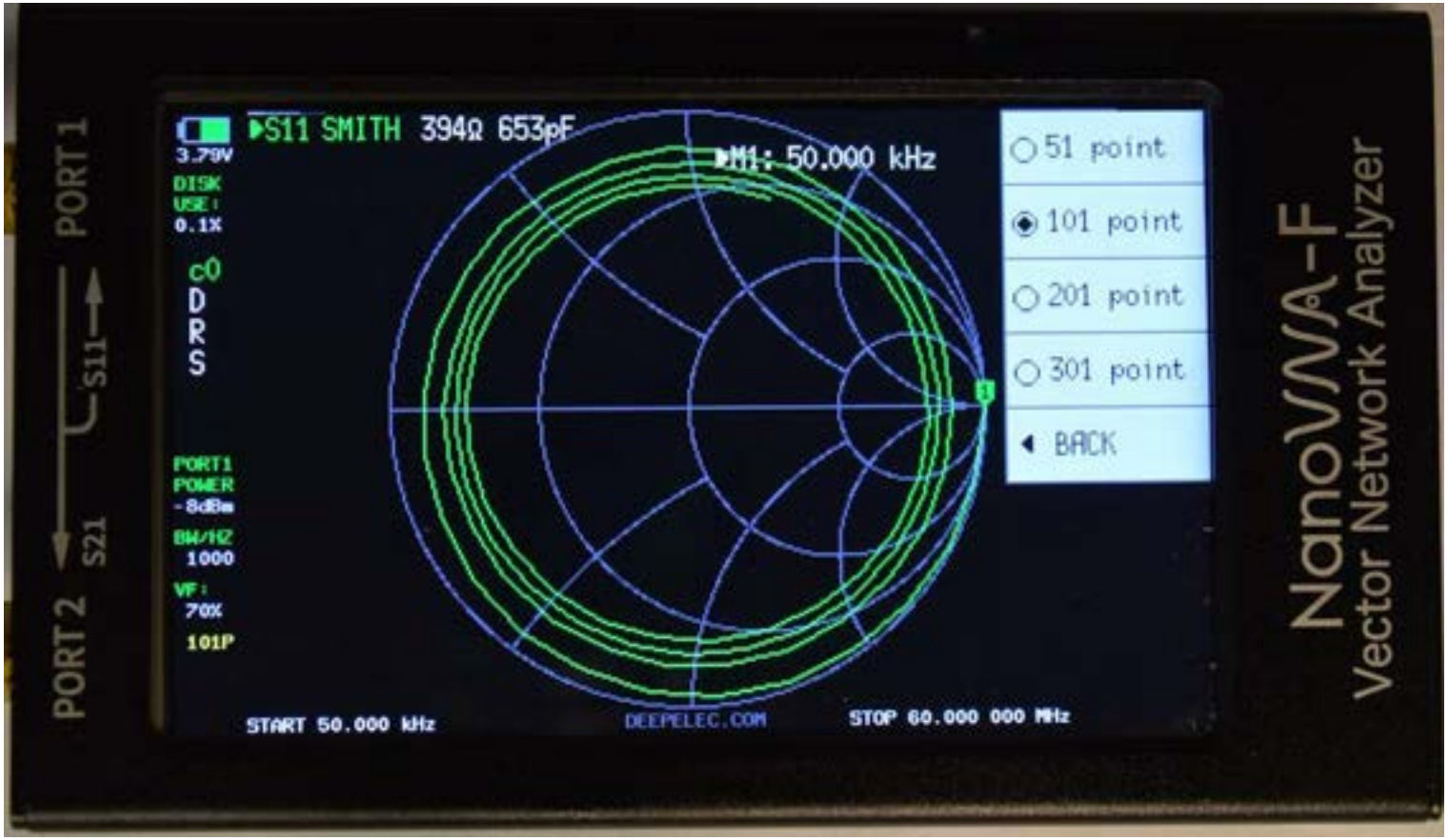
NanoVNA-F

We can change the number of points in a sweep

From the main menu:

Display -> Sweep Points

NanoVNA



NanoVNA-F

We can change the number of points in a sweep

From the main menu:

Display -> Sweep Points

Then select the number of Sweep Points.

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DEMO Sweep Duration

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So now that we understand how the data is presented, and how the sweep is managed, what else can we determine here?
I have already explained the Smith Chart, but what about all of the circles?
What can we determine from these data points?

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FEED LINE

Notice that the Marker has been moved to the first crossing of the R at Infinity side.
The frequency shows 15.637 MHz.

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I am going to explain the reflection of an RF signal and how it appears to the NanoVNA.

If the signal is reflected, the feed line will appear either inductive or capacitive depending on the phase of the returned signal.

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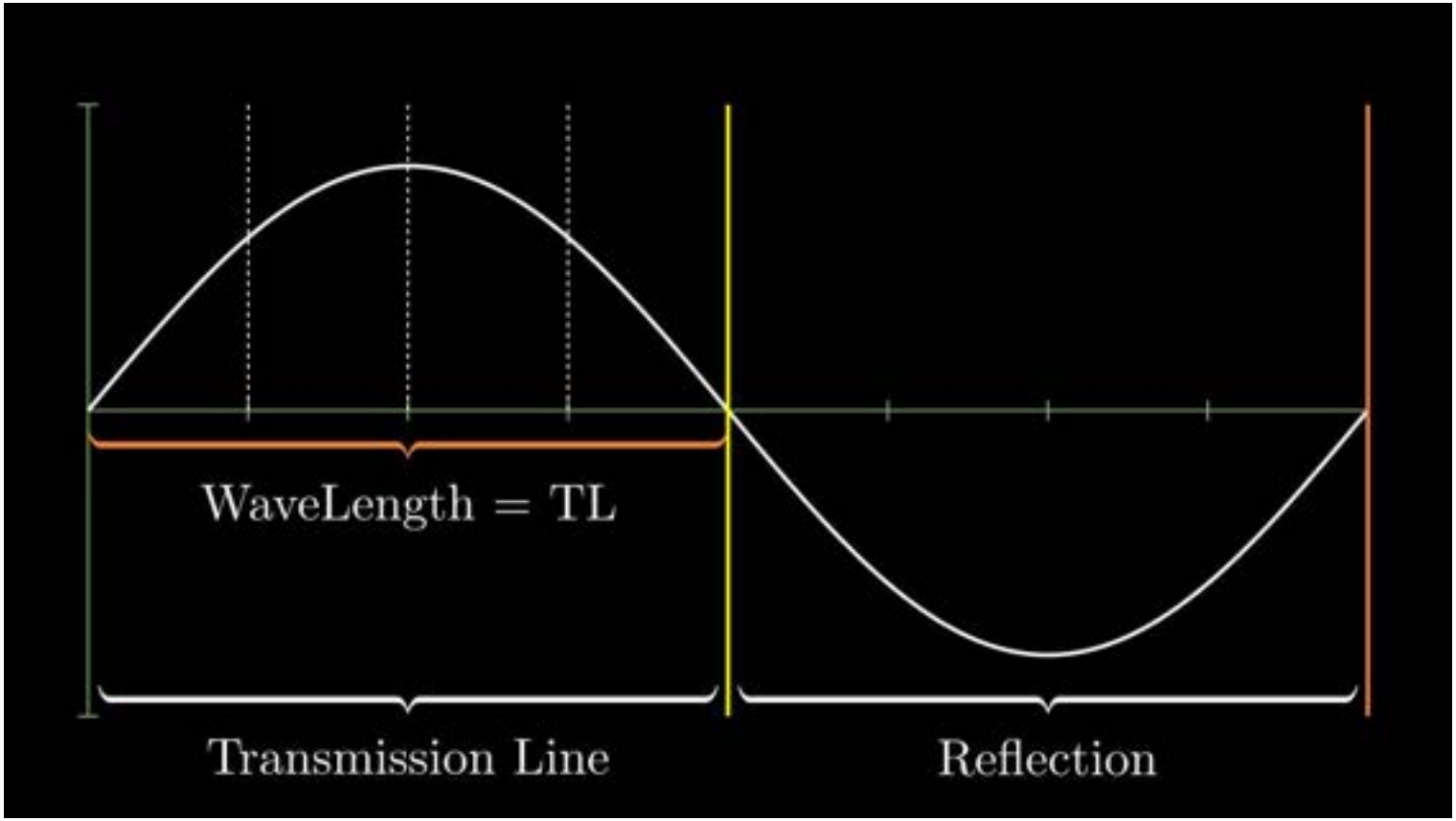

Reflected Wave

In the ideal instance that the Transmission line is 1/2 the wavelength of the transmitted signal, then the reflected signal comes back and the phase of the returned signal is identical to the source signal.

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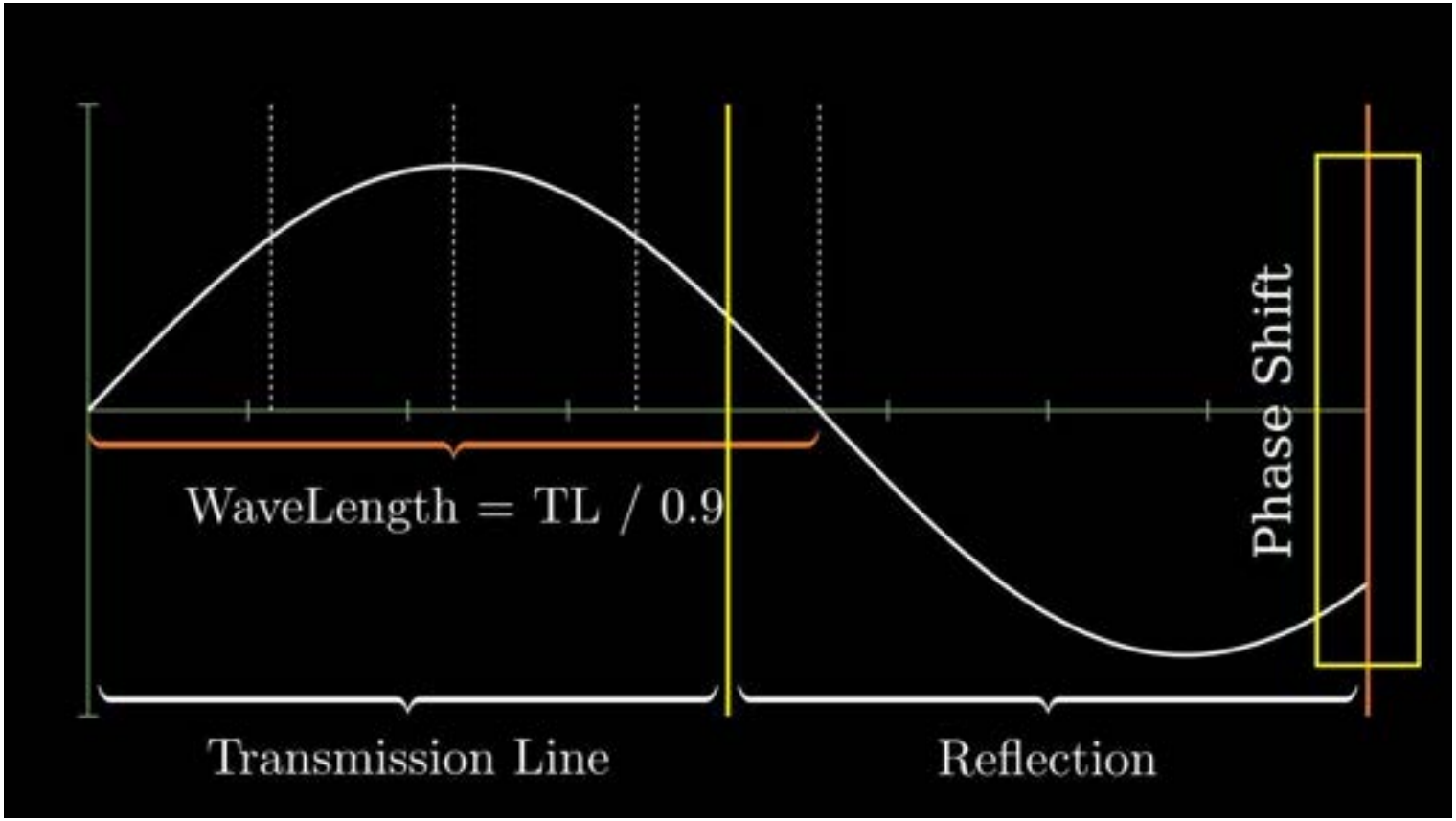

Reflected Wave

If the wavelength of the signal is longer than Transmission line, then the reflected signal comes back with a phase shift that looks capacitive.

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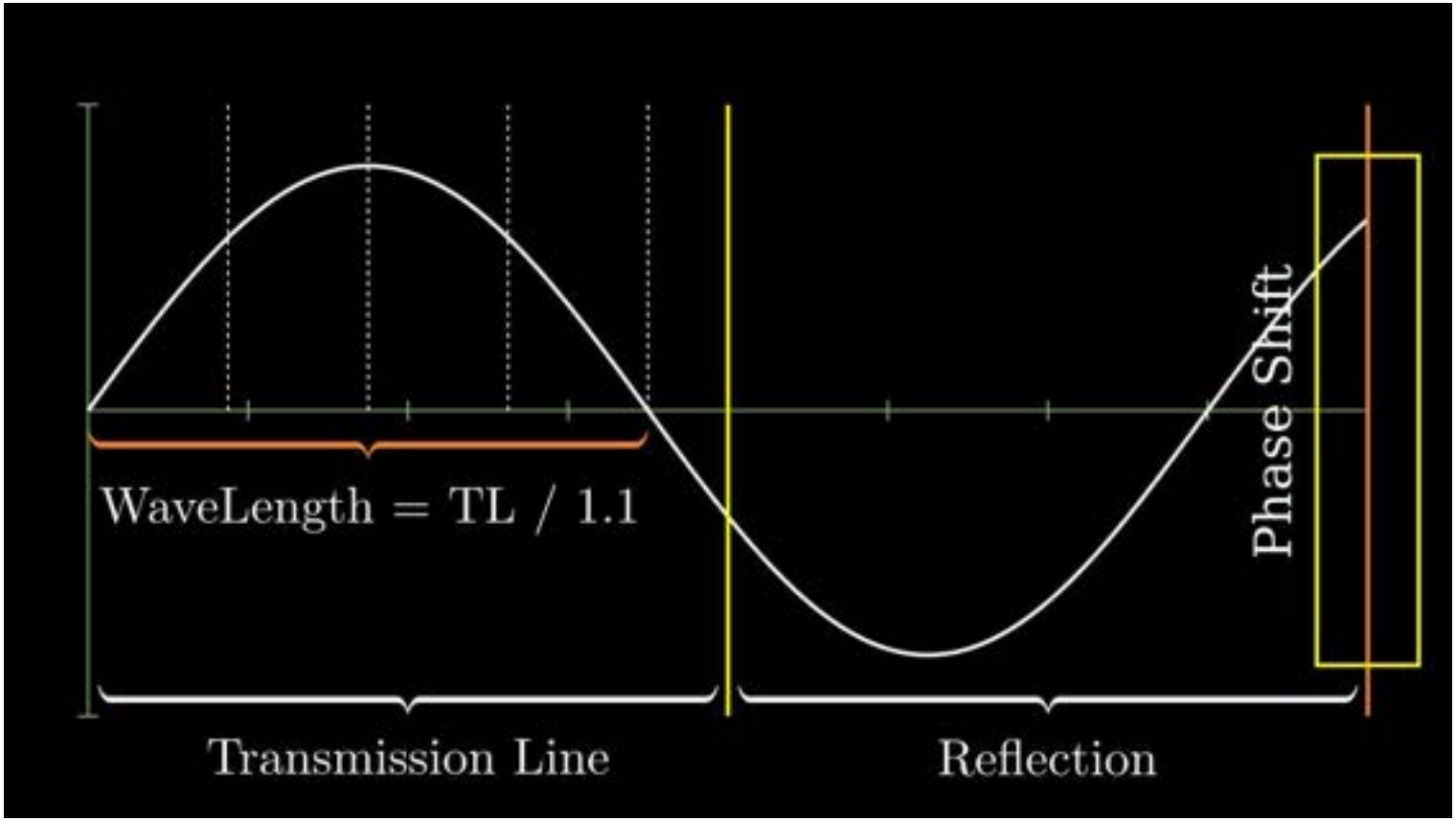

Reflected Wave

If the wavelength of the signal is shorter than Transmission line, then the reflected signal comes back with a phase shift that looks Inductive.

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So what does this mean for a sweep of frequencies with an antenna load?
I wanted to understand better so I built a simulated Antenna circuit to figure out the answer to just that question.

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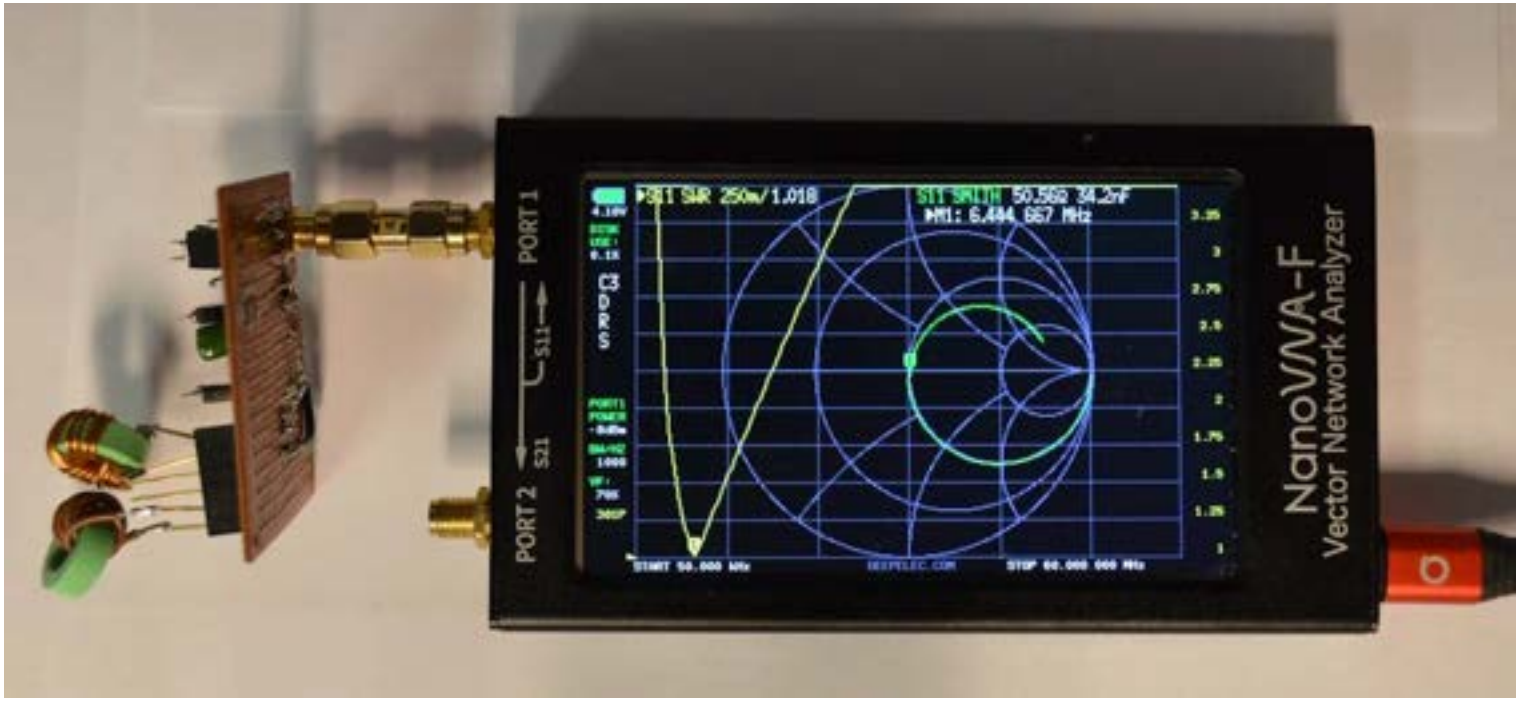

Sim Antenna

The circuit consists of a Resistor, Capacitor, and Inductor in series. I also can change jumpers to change the Resistor from 50 to 100 Ohms, and bypass the Capacitor and/or the Inductor.

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Sim Antenna

This is what the circuit looks like at the end of the feed line. Notice that the SWR dips to the smallest value when it is closest to the center point (50 ohms R).

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Calibration:

- Everything shown has been with the default calibration or Calibrated to the NanVNA
- So what does Calibration do?
- Can I look at the antenna without the effects of the Feed Line?
- Does Calibration change the display compared to Interpolated mode?
- Lets find out ....

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Calibration of Feed line.

- OPEN

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Calibration of Feed line.

- SHORT

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Calibration of Feed line.

- DUMMY Load

Note that this is what a dummy load looks like on any length feed line. Basically an infinite length feed line with no reflections.

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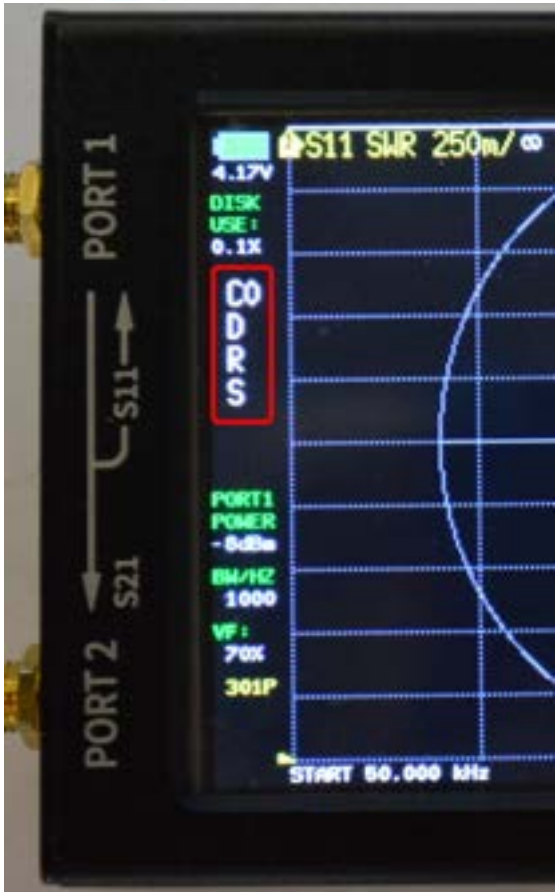

Calibration Indicators

C - Calibrated

During Calibration:

O - indicates that OPEN has been done,

S - indicates a SHORT has been done

D - Directivity

R - Reflection Tracking

S - Source Match

T - Transmission Tracking

X - Isolation

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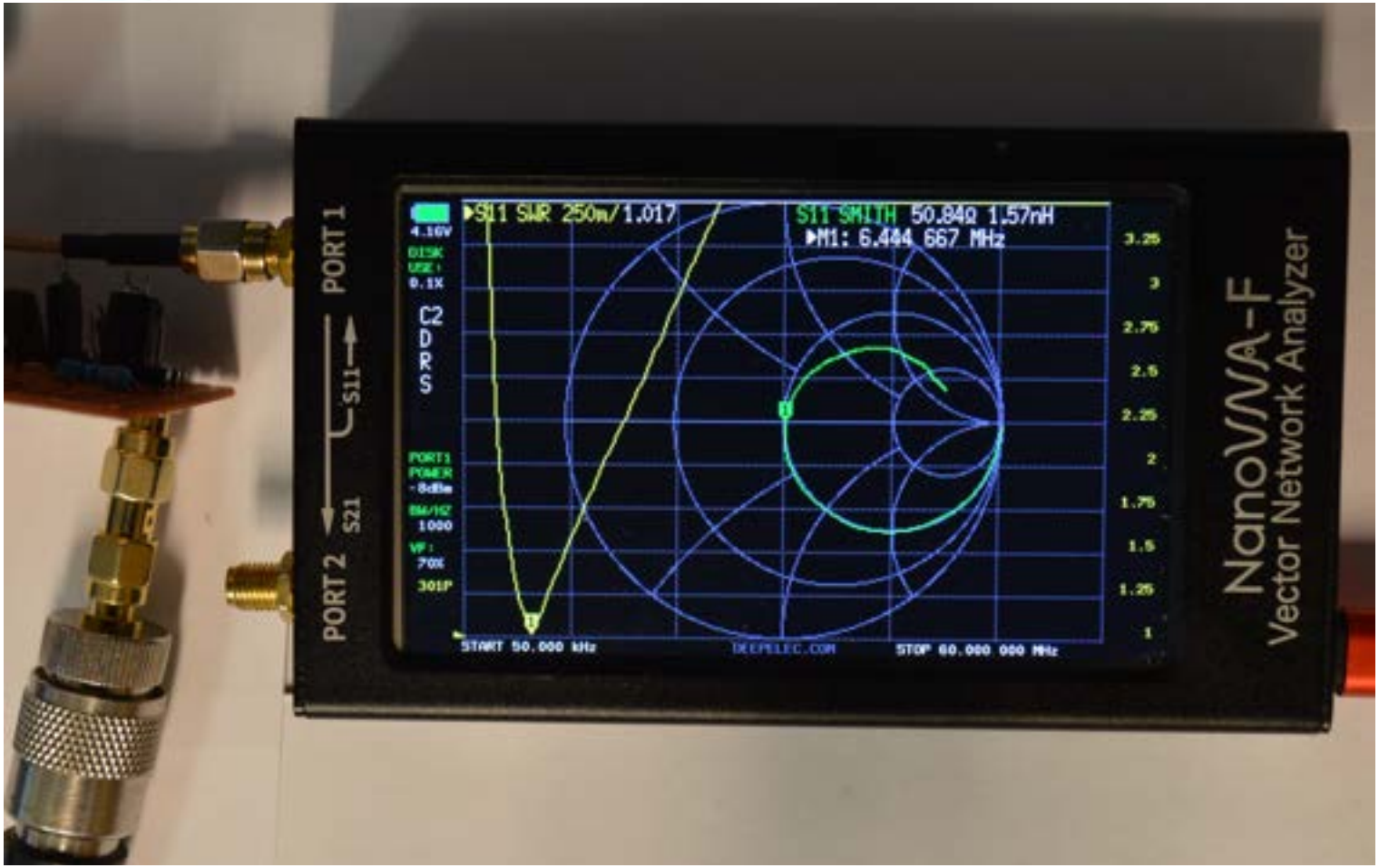
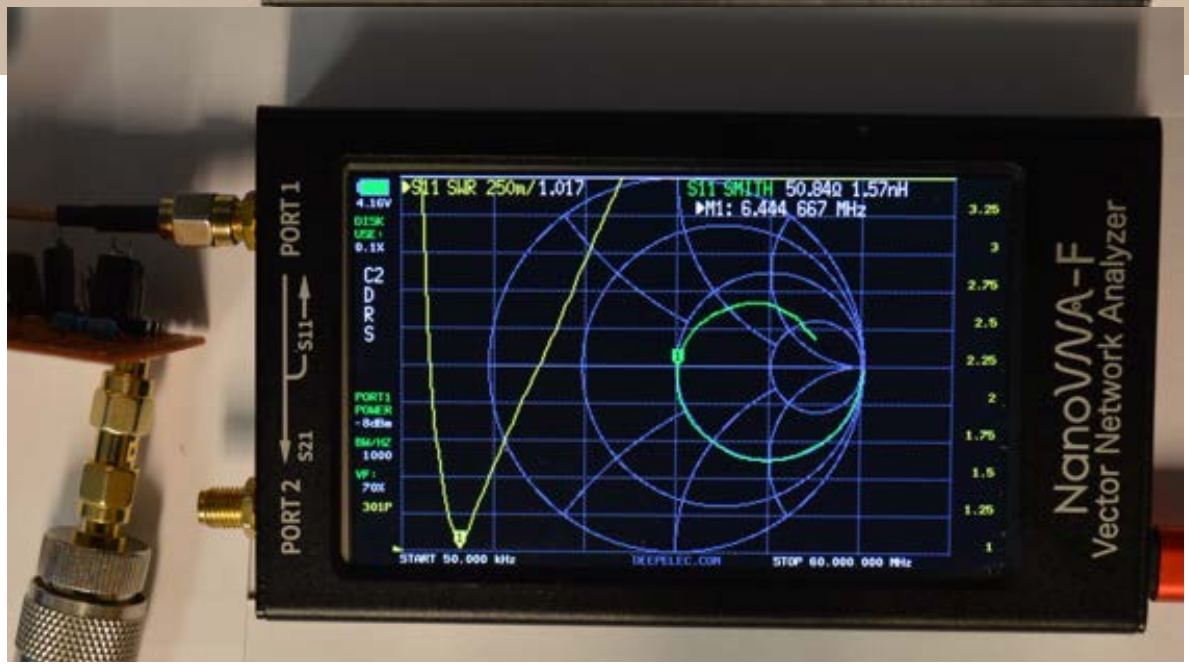


Calibration of Feed line.
Sim Antenna at the end of the feed line.

Calibration of Feed line.

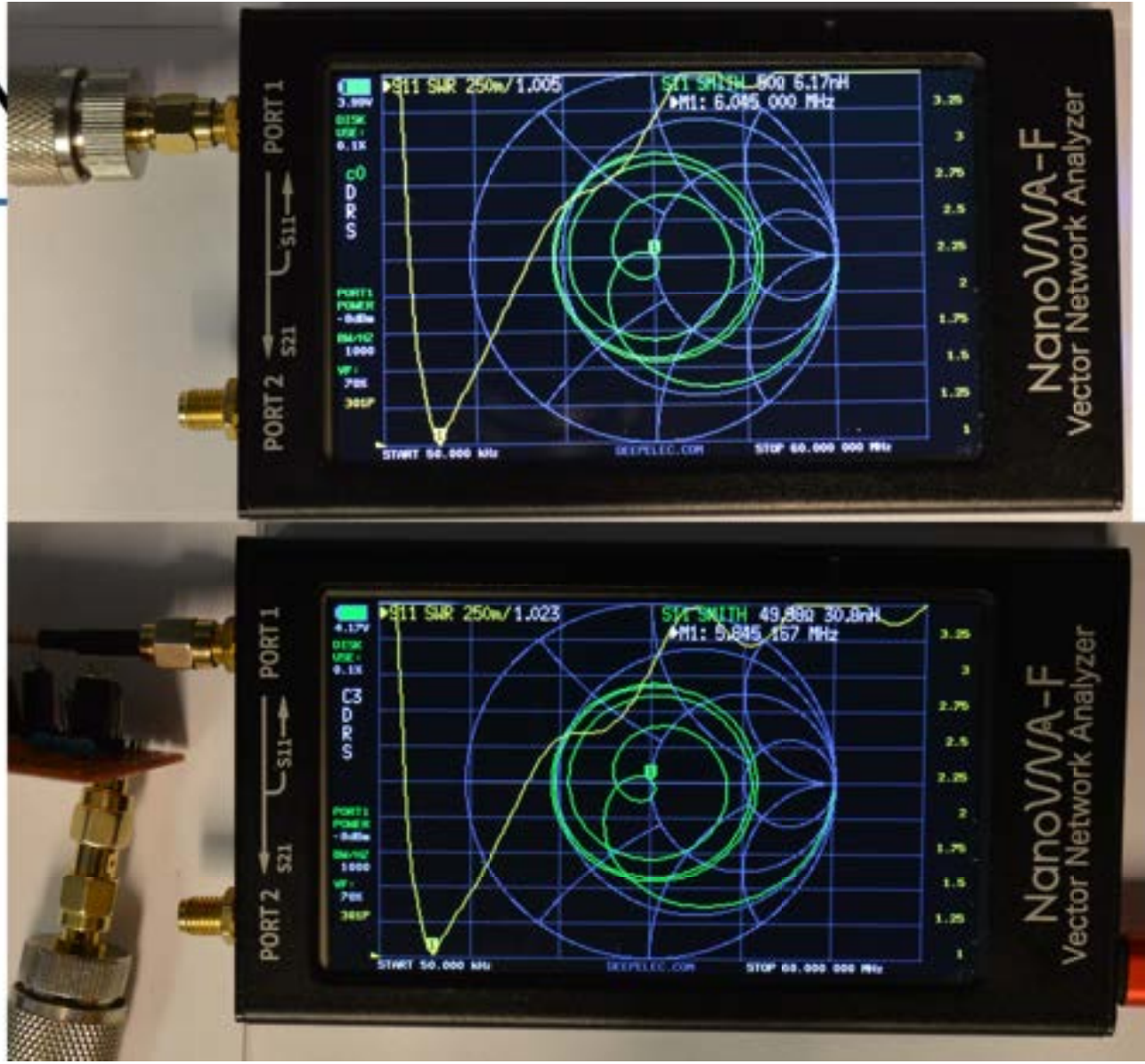
The top picture is with no feed line (C3).

The bottom picture is the same circuit with calibration to the end of the a feed line (C2).



Comparing: Interpolated vs Calibrated

These 2 pictures show a sweep of 50kHz to 60MHz
The Top picture is Interpolated with c0 and then the frequency changed.
The bottom picture is the same circuit but with C3, Calibrated to the frequencies.



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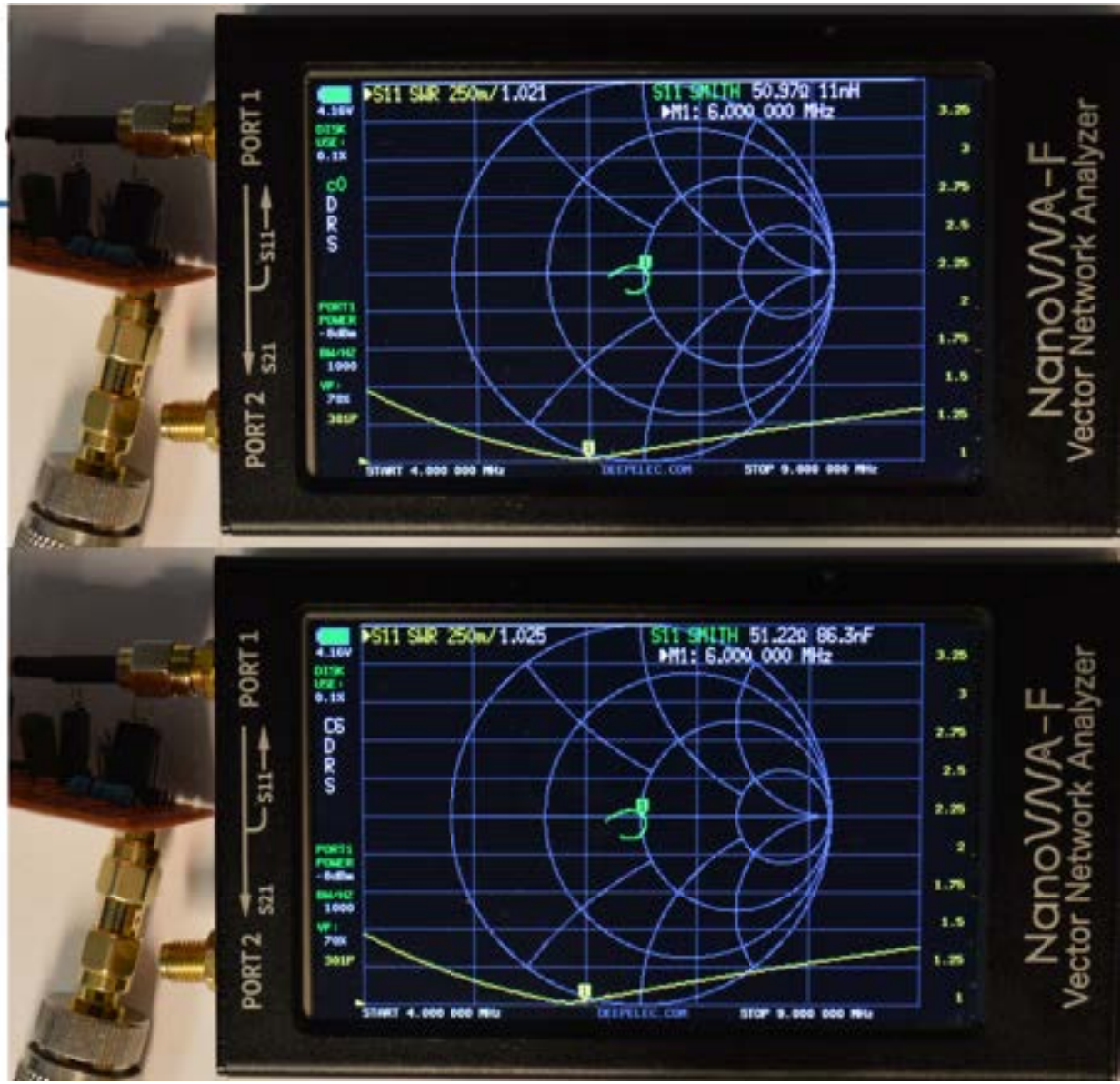
Comparing: Interpolated vs Calibrated

These 2 pictures show a sweep of 4MHz to 9MHz
The Top picture is Interpolated with c0 and then the frequency changed.
The bottom picture is the same circuit but with C6, Calibrated to the frequencies.



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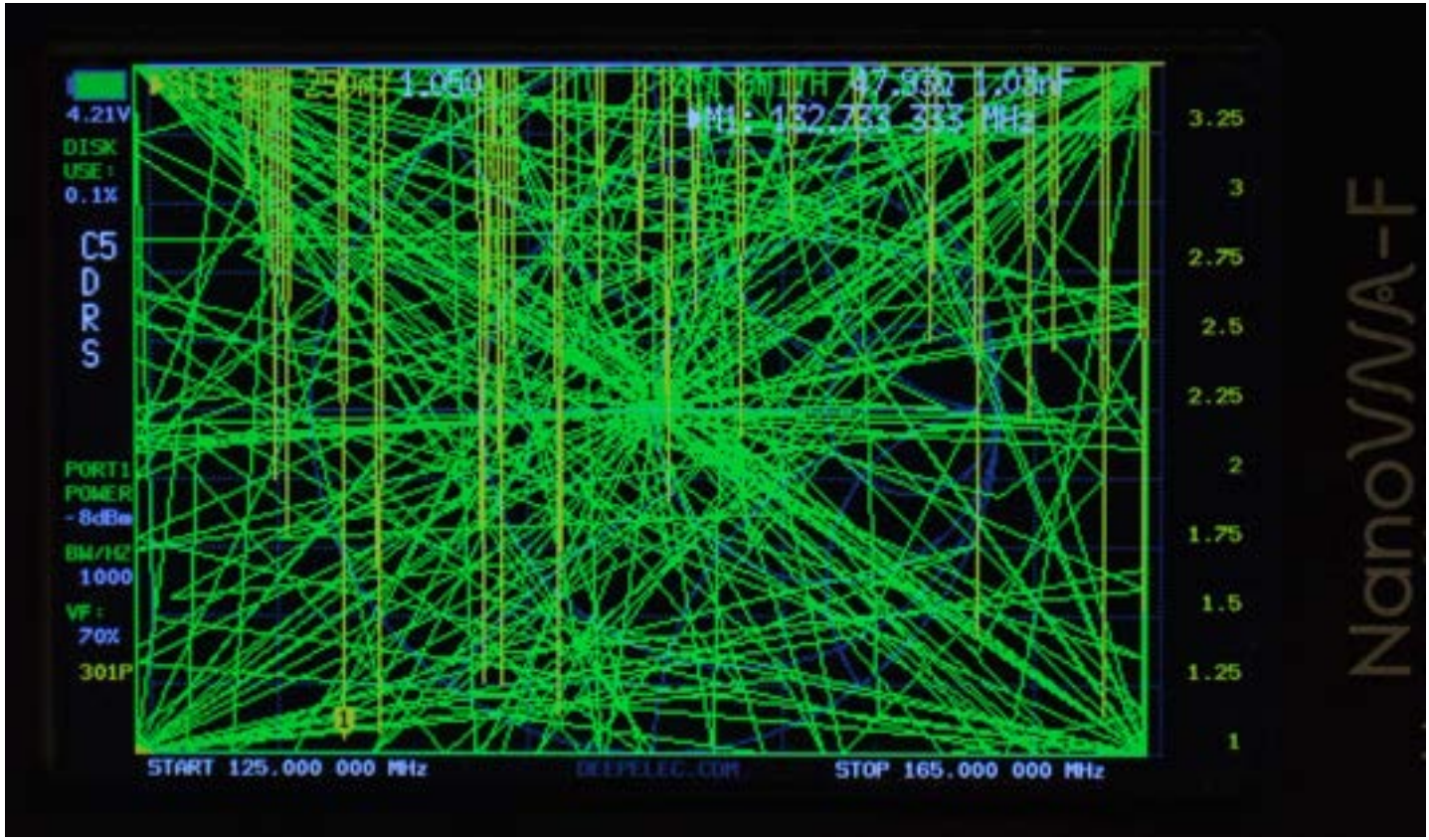
Bonus picture:

Static zap when I touched the j-pole during some documentation



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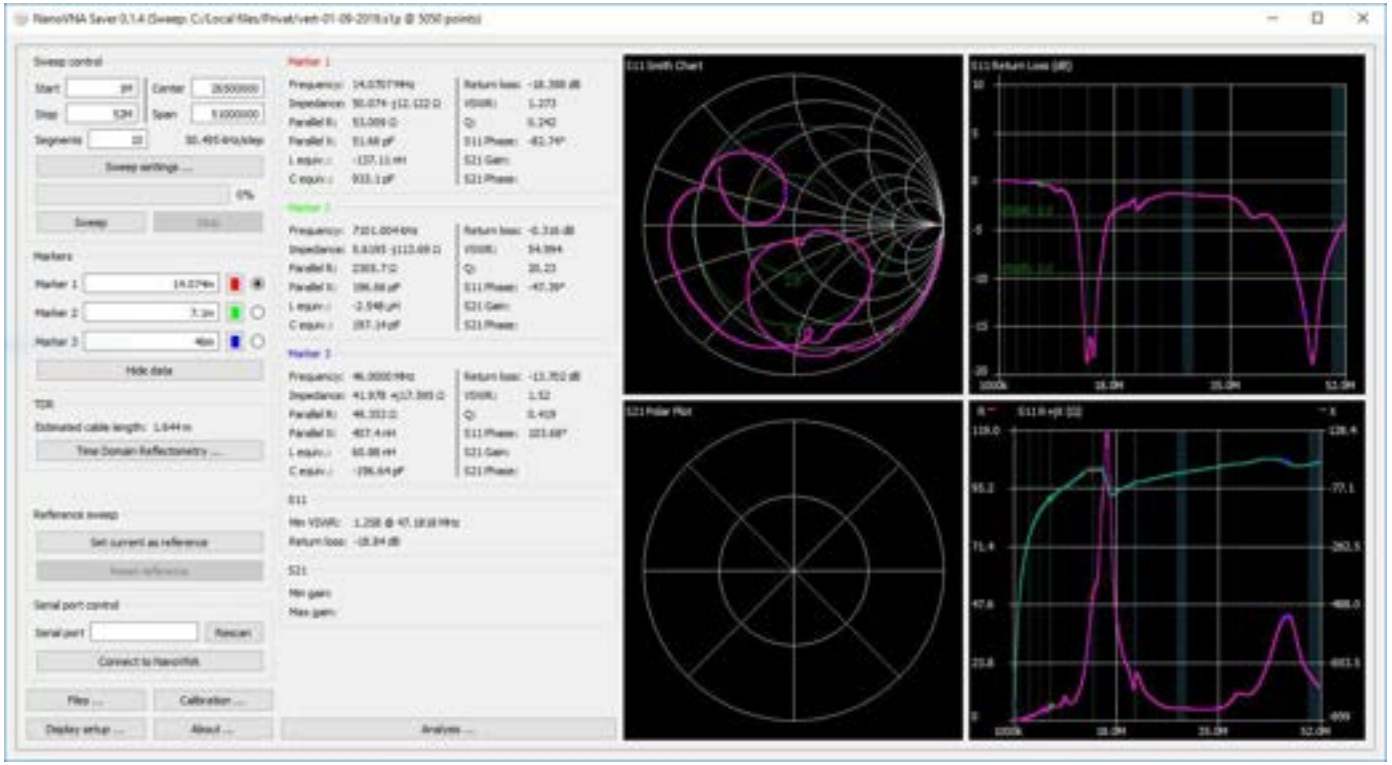
Bonus Content: Software

- NanoVNASaver
- NanoVNA-App
- Android NanoVNA app

NanoVNA

NanoVNASaver

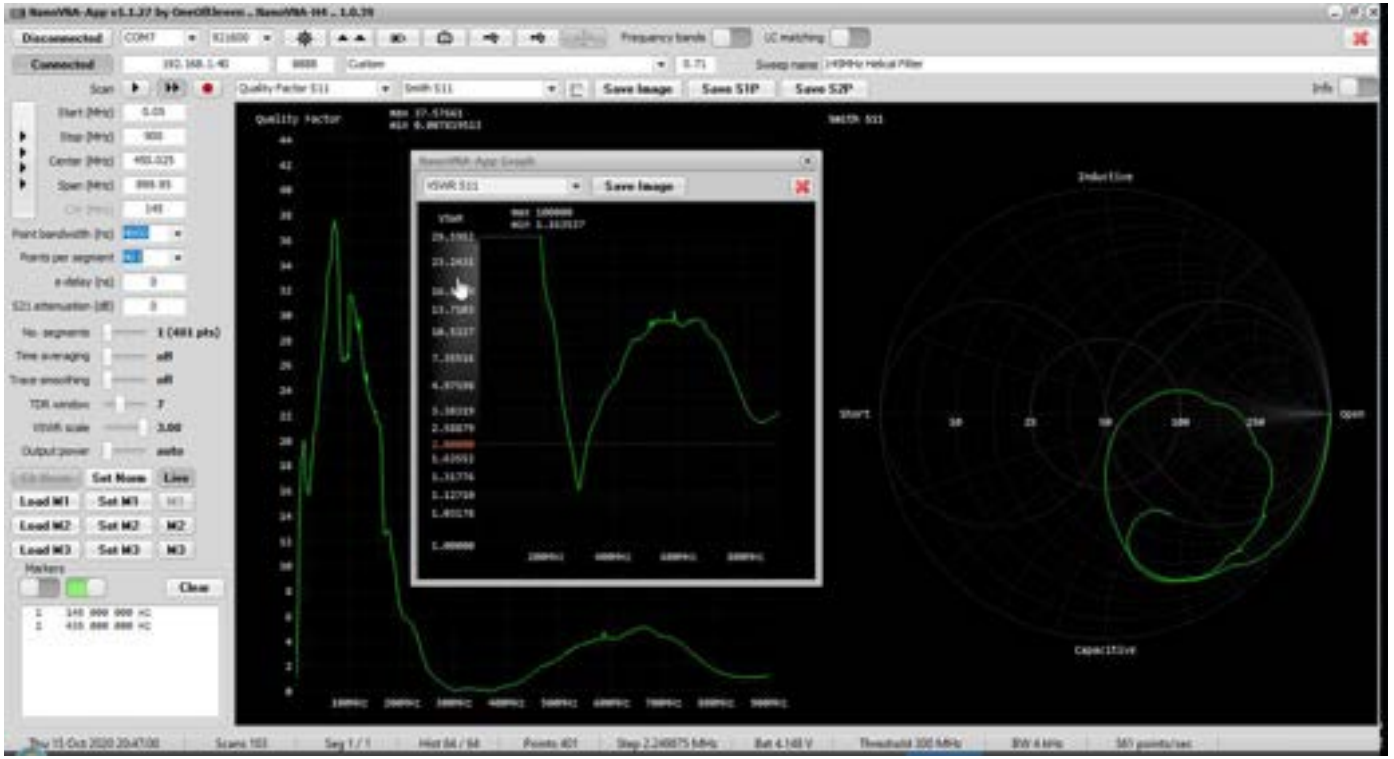
A tool to save Touchstone files from the NanoVNA, sweep frequency spans in segments to gain more than 101 data points, and generally display and analyze the resulting data



NanoVNA

NanoVNA-APP

A tool to manage the NanoVNA, sweep frequency spans in segments to gain more than 101 data points, and generally run it remotely.



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Android NanoVNA app

- **Android NanoVNA** app in Google Play Store for Android >= 6

NanoVNA SimNEC 2.2