From Confused to Confident: Mastering the NanoVNA for Real Amateur Radio Work

A Practical, Presentation-Ready Guide for New Hams

By Greg, N5XO

Introduction – So You Bought a NanoVNA… Now What?

The **NanoVNA** is one of the best things to ever happen to amateur radio.

It's cheap. It's powerful. It's… completely confusing the first time you turn it on.

You'll see lines, graphs, and charts that look like something from a NASA control room—and none of it means much until someone explains it in plain English.

That's exactly what we're going to do.

By the end of this, you'll know how to:

- Properly **calibrate** your NanoVNA (the most important step)
- Test **coax for loss and problems**
- Use **TDR to find faults**
- Measure and **tune antennas**
- Understand what the screen is actually telling you

And we'll do it without turning it into a college lecture.

PART 1 — CALIBRATION (YOUR FOUNDATION)

What Calibration Does (In Plain English)

Calibration tells the NanoVNA:

"Ignore your own imperfections and show me reality."

If you skip calibration, your readings will look legit…
They'll just be wrong.

Calibration Kit Basics

You should have:

- OPEN
- SHORT
- LOAD (50 ohms)
- THRU (or jumper cable)

If you don't… stop here and fix that first.

Step-by-Step Calibration

1. Set Your Frequency Range FIRST

Examples:

- 2 meters → 140–150 MHz
- 70 cm → 420–450 MHz
- 23 cm → 1240–1300 MHz

👉 Calibration only works for the range you set.

2. Reset Calibration

Menu:
CAL → RESET

3. Perform Calibration Steps

Follow this exact order:

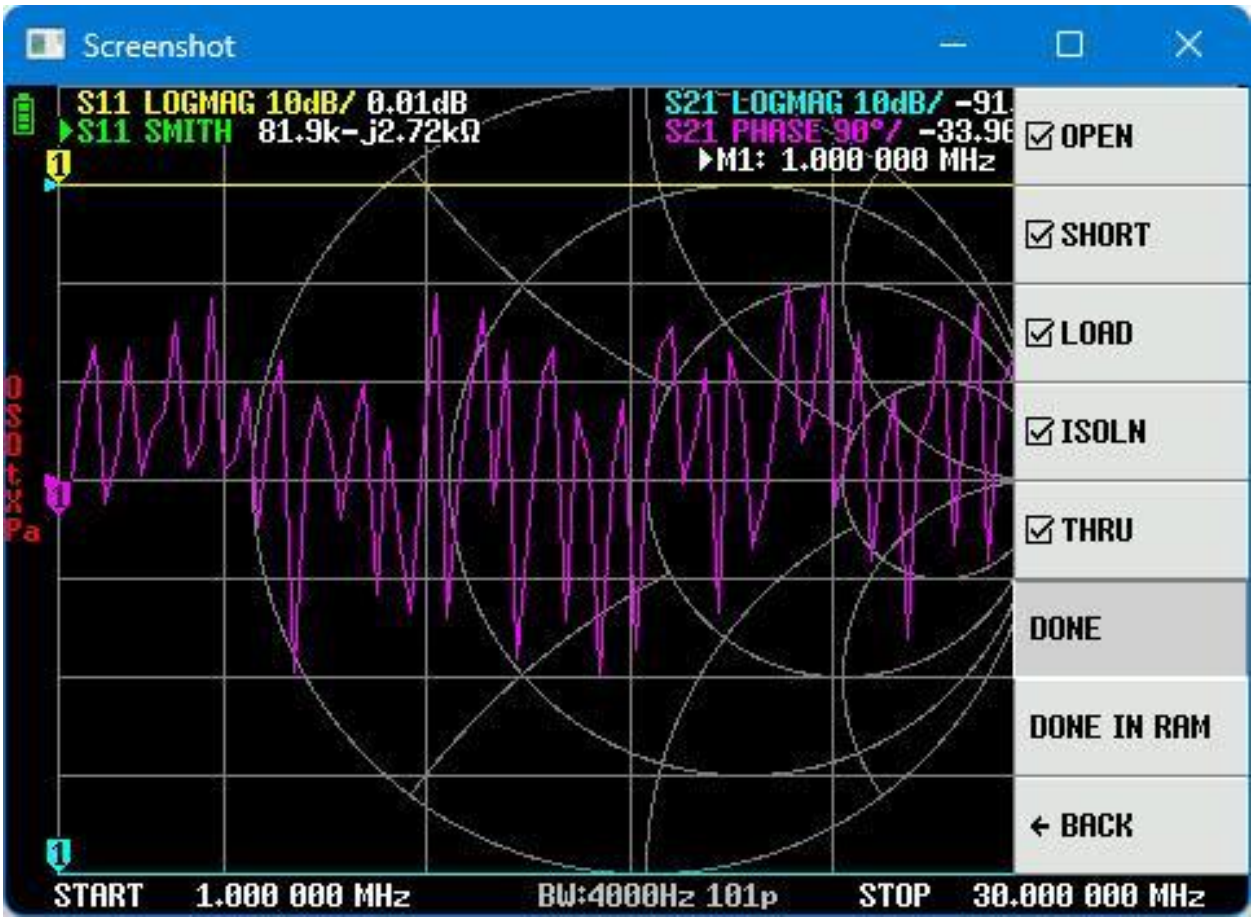
1. **OPEN** → connect open → press OPEN
2. **SHORT** → connect short → press SHORT
3. **LOAD** → connect load → press LOAD
4. **THRU** → connect Port 1 to Port 2 → press THRU

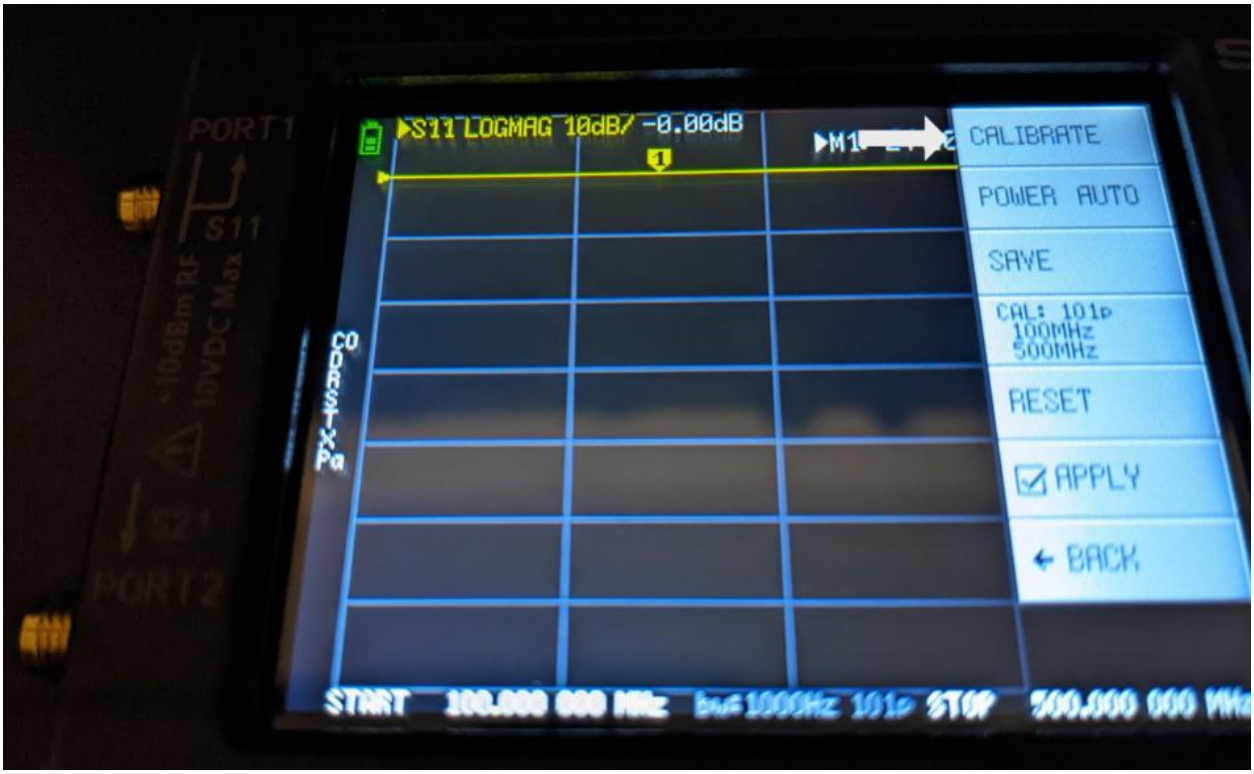
4. Save It

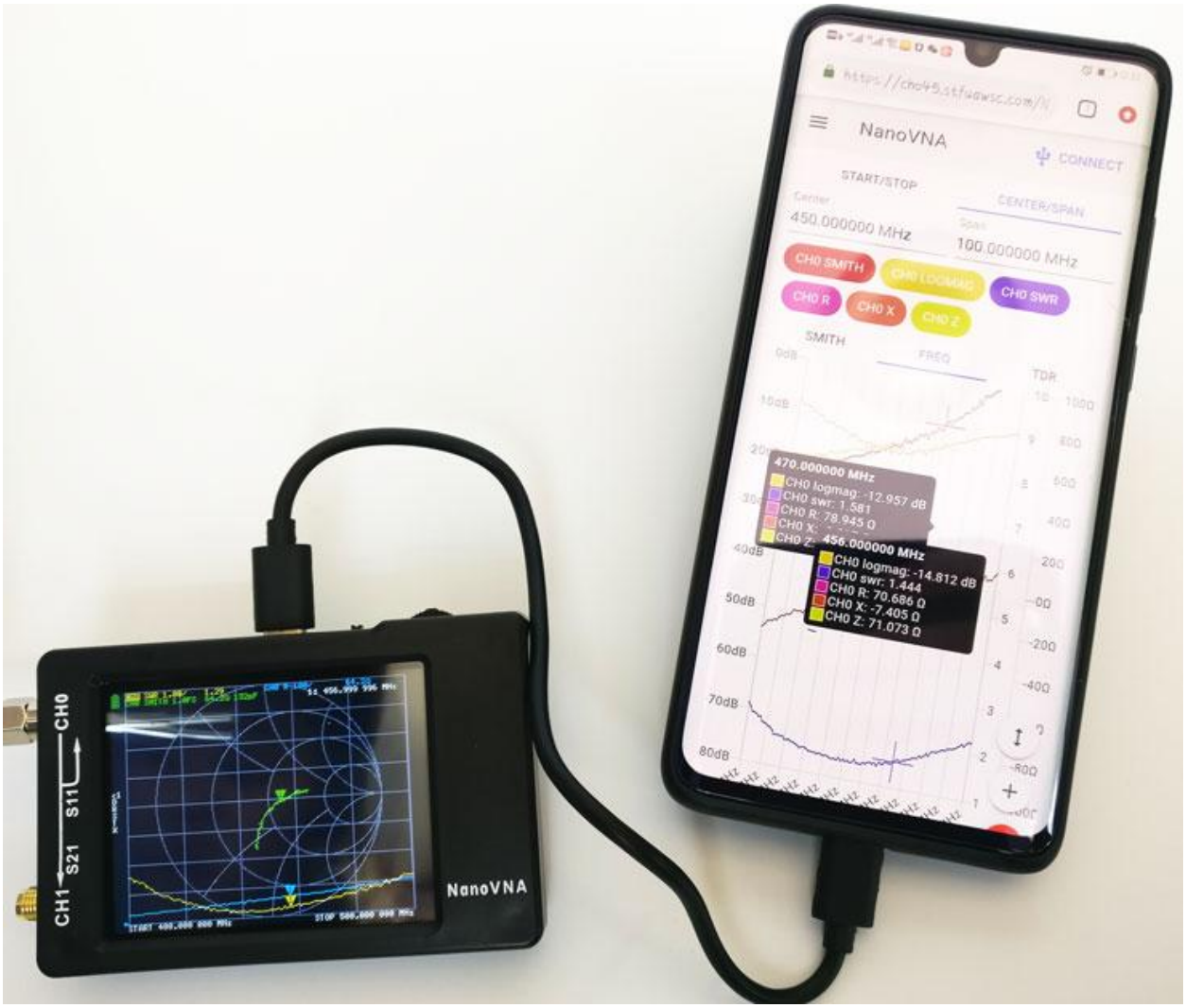
SAVE → Slot 0 (or any slot)

If you don't save it… you just practiced calibration for fun.

What Calibration Looks Like (Screen Example)




PORT 1
S11
PORT 2
S21
10dBm RF
10VDC Max
S11 LOGMAG 10dB/ -0.00dB
M1
1
CALIBRATE
POWER AUTO
SAVE
CAL: 101p
100MHz
500MHz
RESET
APPLY
BACK
START 100.000 000 MHz
STOP



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👉 You should see confirmation that each step is completed before hitting DONE.

PART 2 — TESTING COAX (IS YOUR FEEDLINE LYING?)

Why This Matters

At VHF/UHF:

Your coax can quietly destroy your station.

You might think:

“My antenna sucks”

When really:

Your coax is eating your signal alive.

What You’re Measuring

- Signal loss (S21)
- Cable quality
- Hidden damage

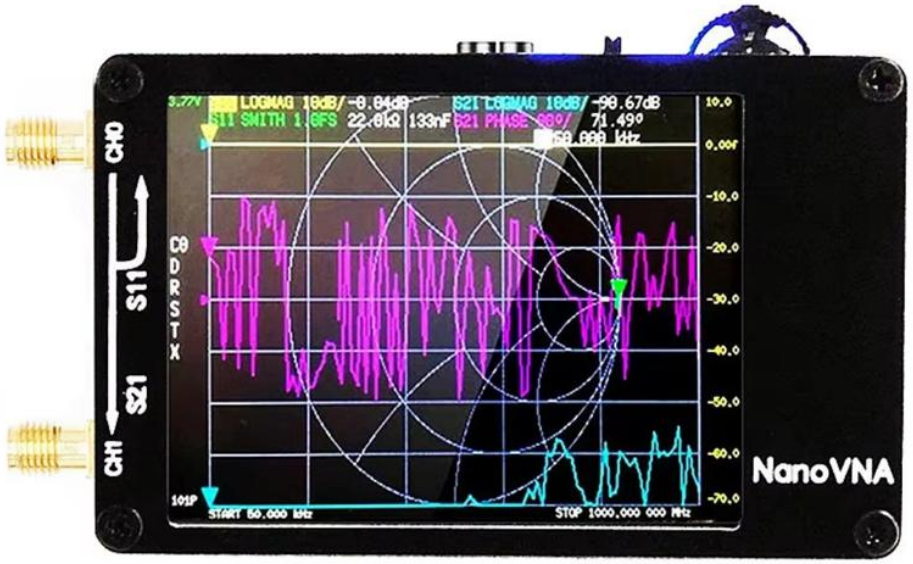
Step-by-Step: Coax Loss Test

1. Calibrate with THRU step
2. Connect coax between Port 1 and Port 2
3. Set display to **S21**
4. Sweep your frequency range

What a GOOD Cable Looks Like

Calibration NanoVNA

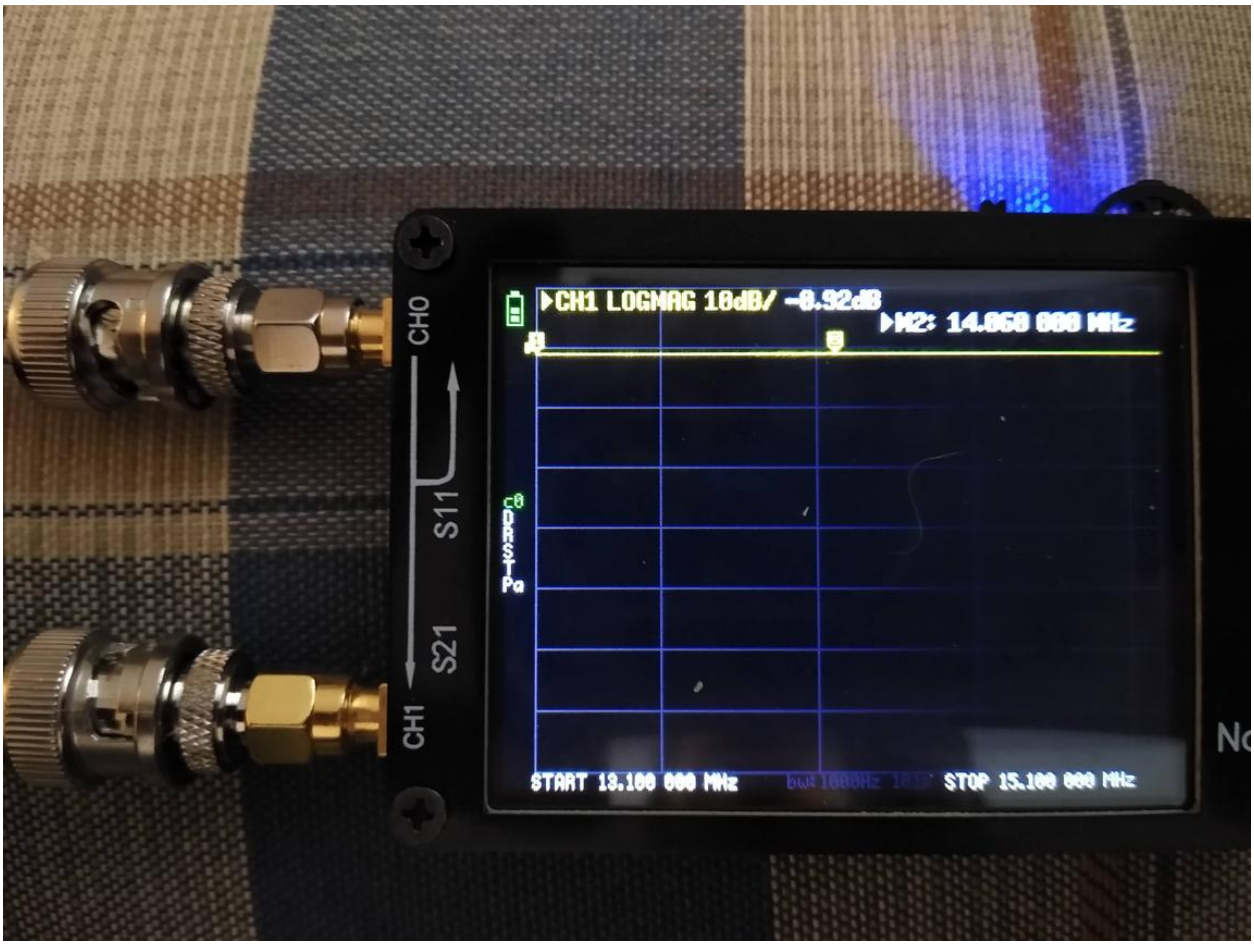
Calibration basically be performed whenever the frequency range to be measured is changed. If the error has been corrected correctly, the calibration status display on the screen will be CnDRSTX.
n is the data number being loaded



Open

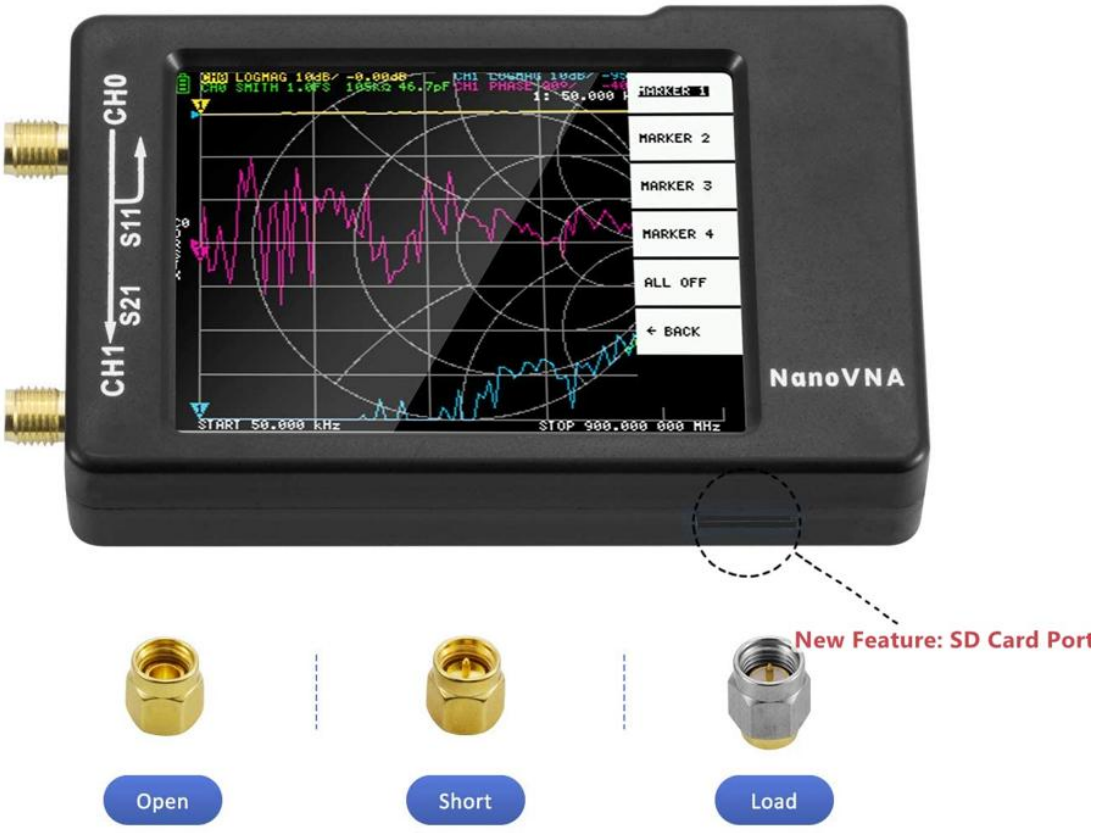
Short

Load


CH0
S11
S21
CH1
CH1 LOGMAG 10dB/ -8.92dB
M2: 14.060 000 MHz
START 13.100 000 MHz
STOP 15.100 000 MHz

Calibration NanoVNA

Calibration basically be performed whenever the frequency range to be measured is changed. If the error has been corrected correctly, the calibration status display on the screen will be CnDRSTX.
n is the data number being loaded



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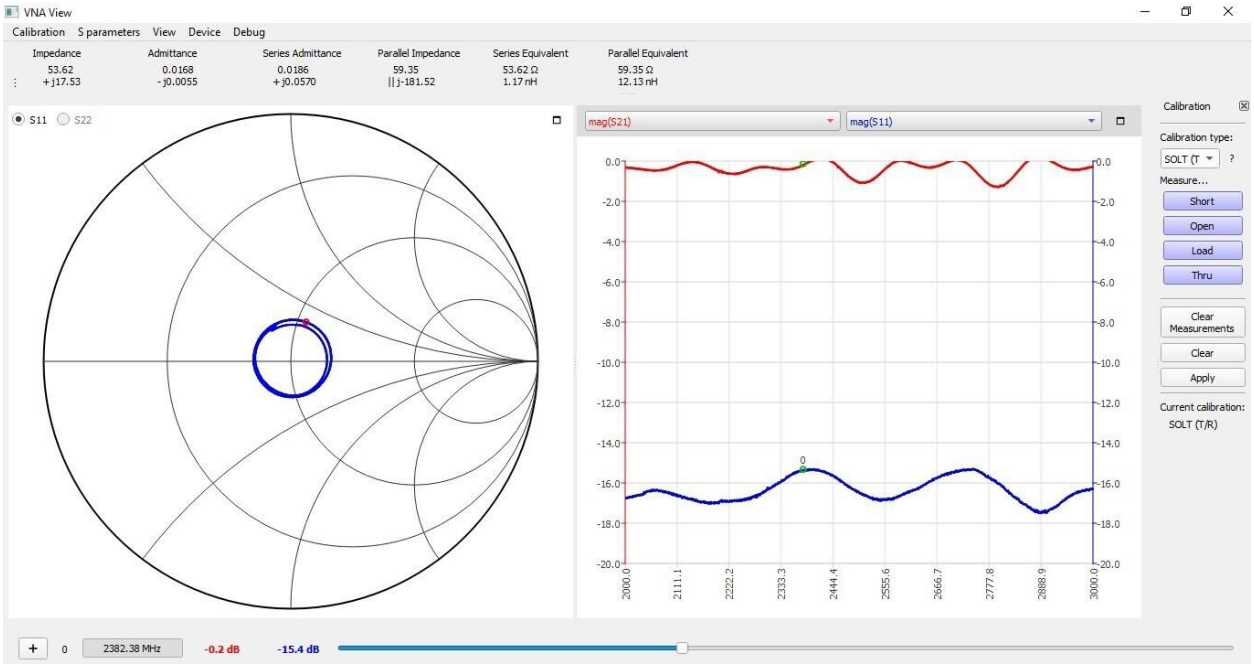
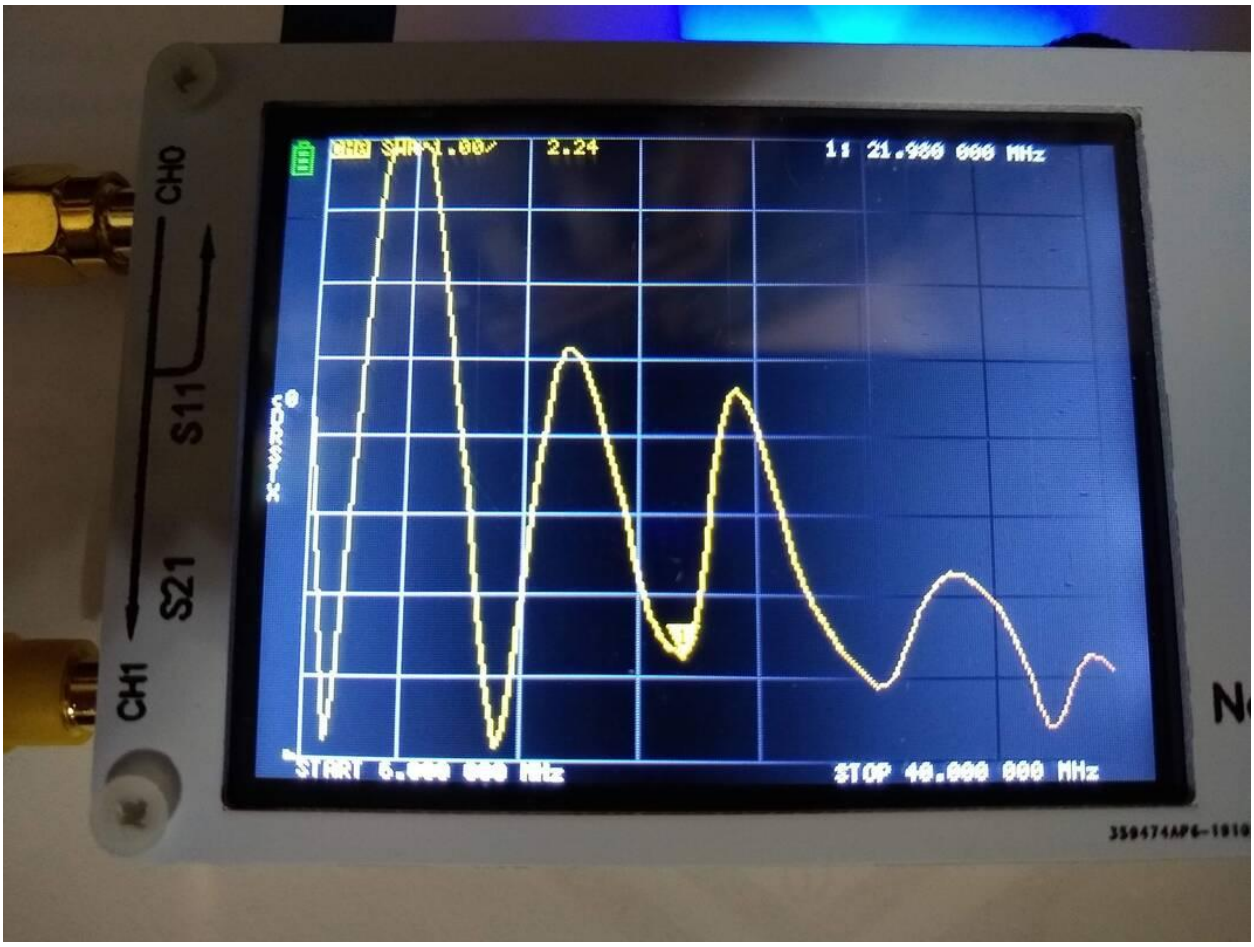
- Smooth downward slope
- No sharp dips
- Predictable behavior

What a BAD Cable Looks Like






NanoVNA-F V2
PORT 2
S21
S11
PORT 1
Lenovo

- Jagged or wavy line
- Sudden drops
- Weird spikes

👉 Usually means:

- Water intrusion
- Bad connector
- Damaged coax

Reality Check

Loss	Meaning
1 dB	Fine
3 dB	Half your power gone
6 dB	You have a serious problem

PART 3 — FINDING PROBLEMS (TDR MODE)

What This Does

TDR shows **where** the problem is in your cable.

Instead of guessing—you get a distance.

Setup

1. Disconnect antenna
2. Connect coax to Port 1
3. Go to:
   Transform → Time Domain

Set Velocity Factor

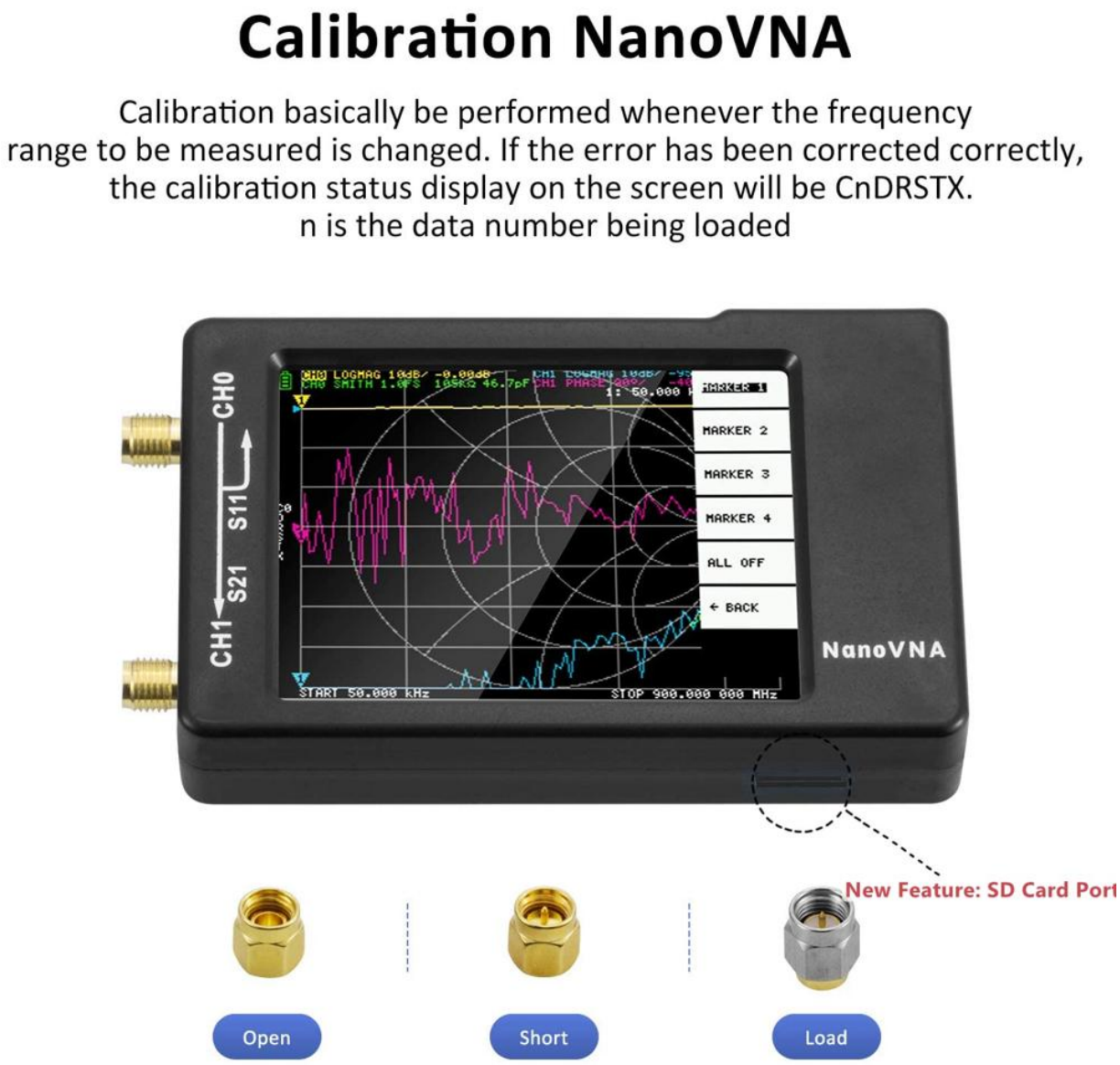
Examples:

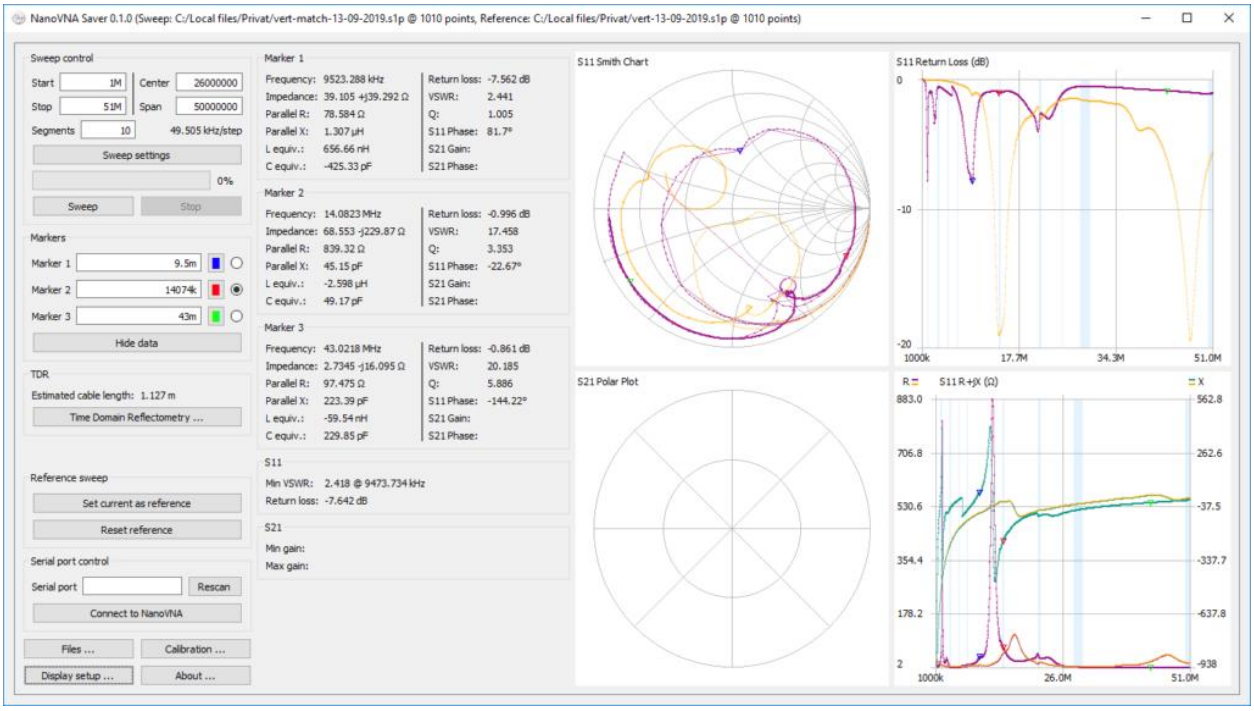
- RG-58 → ~0.66

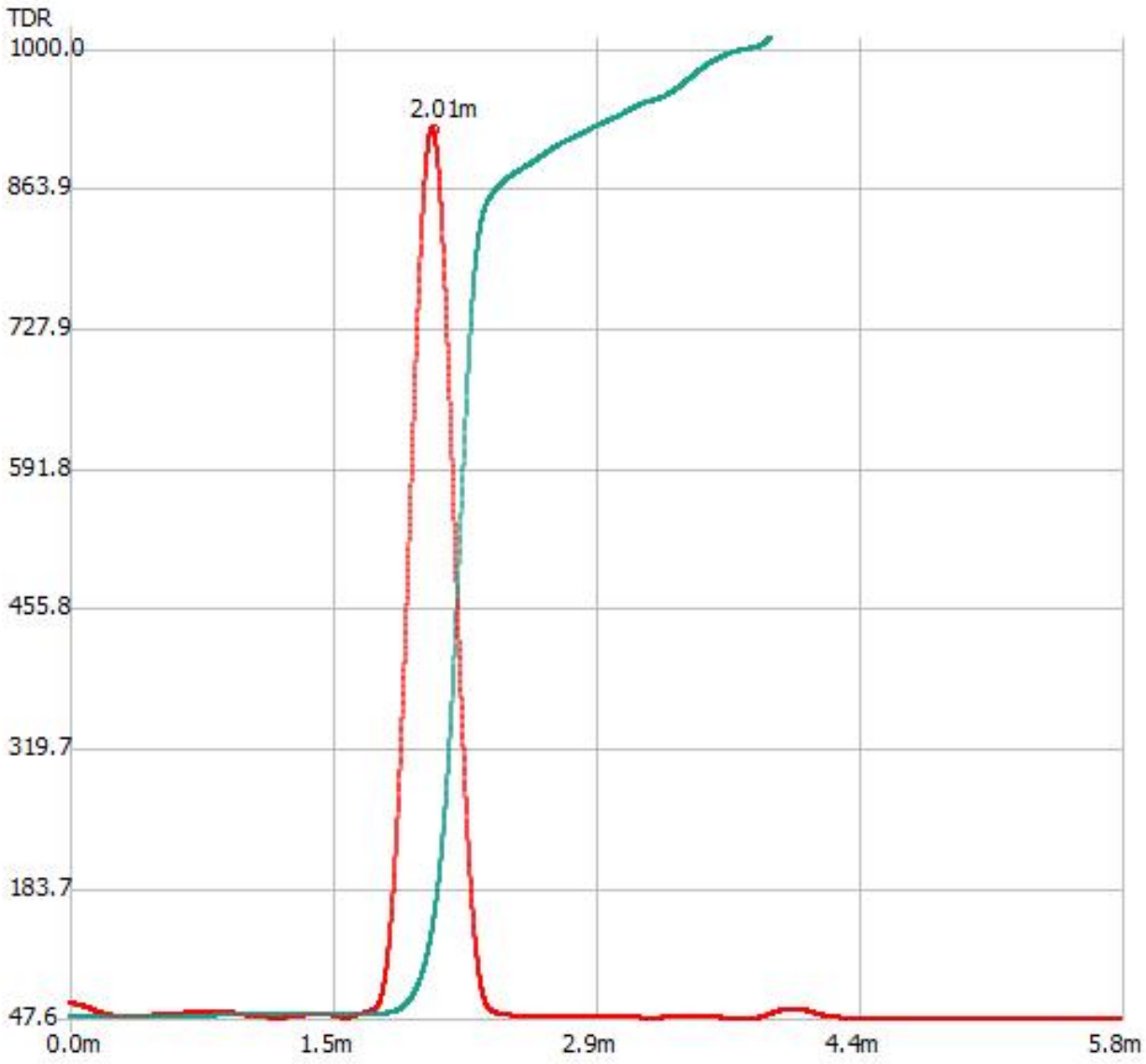
- LMR-400 → ~0.84

👉 If this is wrong, distance will be wrong.

What You'll See




NanoVNA Saver 0.1.0 (Sweep: C:/Local files/Privat/vert-match-13-09-2019.s1p @ 1010 points, Reference: C:/Local files/Privat/vert-13-09-2019.s1p @ 1010 points)
Sweep control
Start 1M
Center 26000000
Stop 51M
Span 50000000
Segments 10
49.505 kHz/step
Sweep settings
0%
Sweep
Stop
Markers
Marker 1 9.5m
Marker 2 14074k
Marker 3 43m
Hide data
TDR
Estimated cable length: 1.127 m
Time Domain Reflectometry ...
Reference sweep
Set current as reference
Reset reference
Serial port control
Serial port
Rescan
Connect to NanoVNA
Files ...
Calibration ...
Display setup ...
About ...
Marker 1
Frequency: 9523.288 kHz
Impedance: 39.105 +j39.292 Ω
Parallel R: 78.584 Ω
Parallel X: 1.307 µH
L equiv.: 656.66 nH
C equiv.: -425.33 pF
Return loss: -7.562 dB
VSWR: 2.441
Q: 1.005
S11 Phase: 81.7°
S21 Gain:
S21 Phase:
Marker 2
Frequency: 14.0823 MHz
Impedance: 68.553 -j229.87 Ω
Parallel R: 839.32 Ω
Parallel X: 45.15 pF
L equiv.: -2.598 µH
C equiv.: 49.17 pF
Return loss: -0.996 dB
VSWR: 17.458
Q: 3.353
S11 Phase: -22.67°
S21 Gain:
S21 Phase:
Marker 3
Frequency: 43.0218 MHz
Impedance: 2.7345 -j16.095 Ω
Parallel R: 97.475 Ω
Parallel X: 223.39 pF
L equiv.: -59.54 nH
C equiv.: 229.85 pF
Return loss: -0.861 dB
VSWR: 20.185
Q: 5.886
S11 Phase: -144.22°
S21 Gain:
S21 Phase:
S11
Min VSWR: 2.418 @ 9473.734 kHz
Return loss: -7.642 dB
S21
Min gain:
Max gain:
S11 Smith Chart
S11 Return Loss (dB)
0
-10
-20
1000k
17.7M
34.3M
51.0M
S21 Polar Plot
R
S11 R+jX (Ω)
X
883.0
706.8
530.6
354.4
178.2
2
562.8
262.6
-37.5
-337.7
-637.8
-938
1000k
26.0M
51.0M



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- Big spike at end → normal
- Spike in middle → problem

👉 That spike is where your issue lives.

PART 4 — TESTING ANTENNAS (WHERE IT GETS FUN)

What You're Measuring

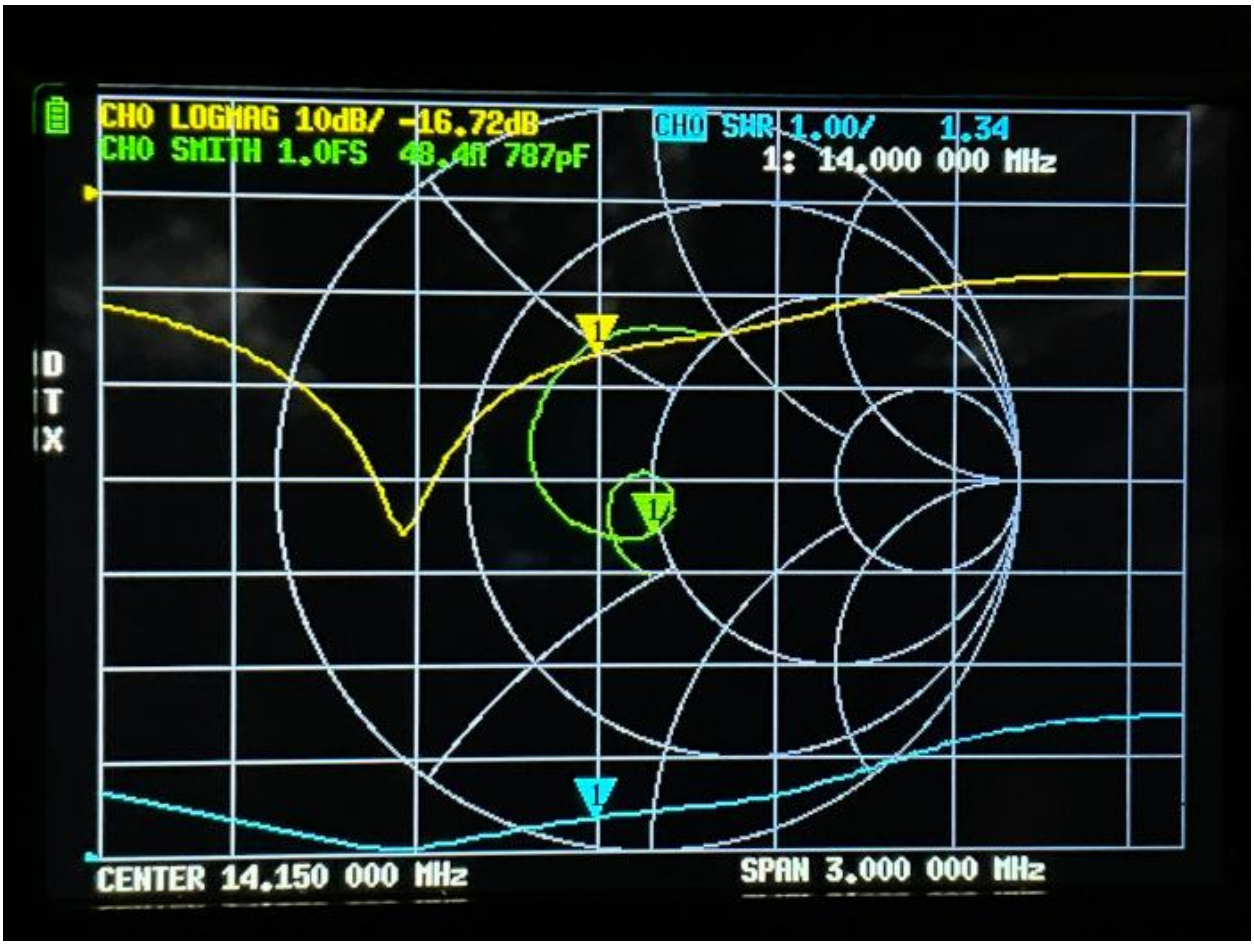
- SWR

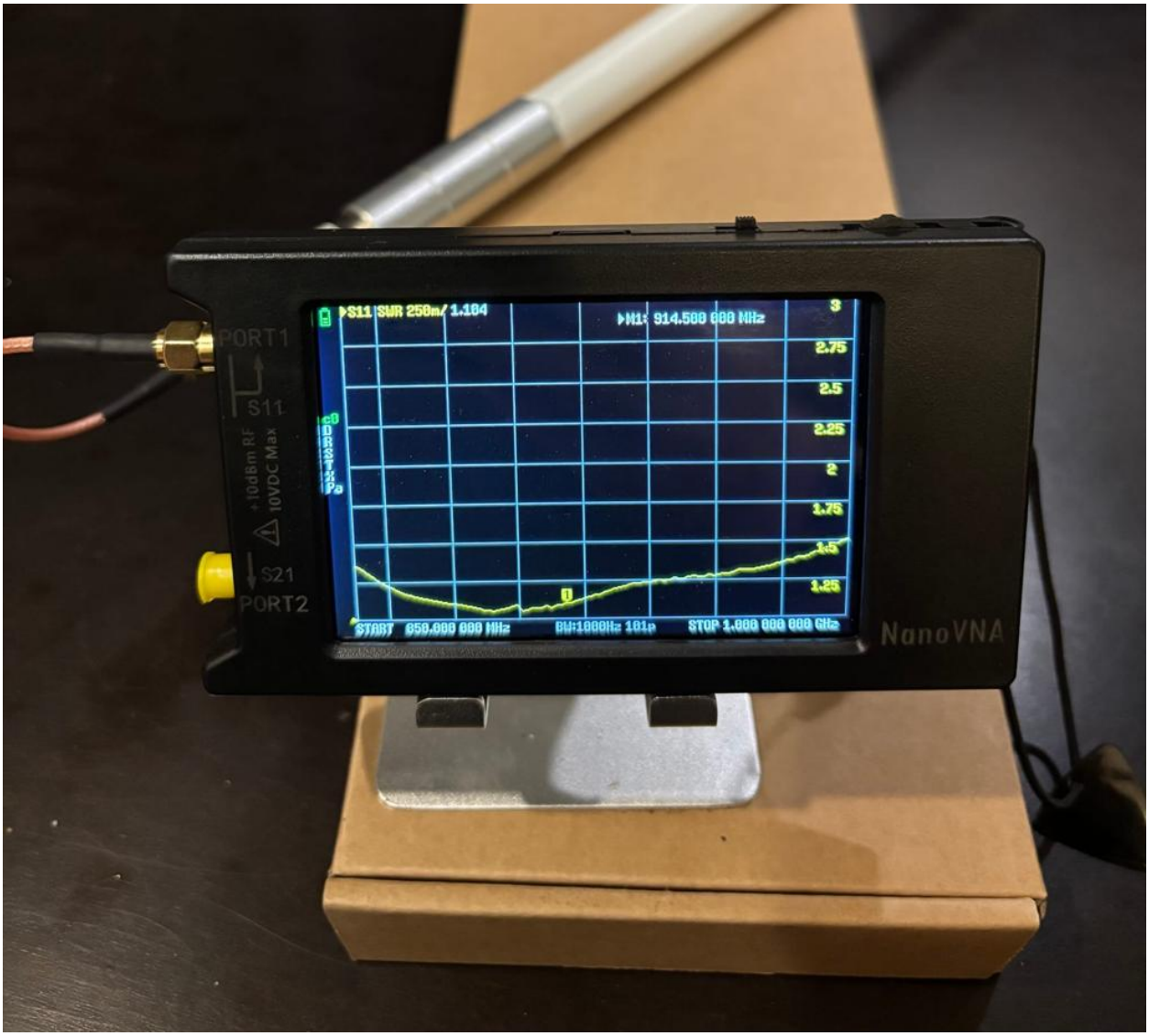
- Resonance
- Matching

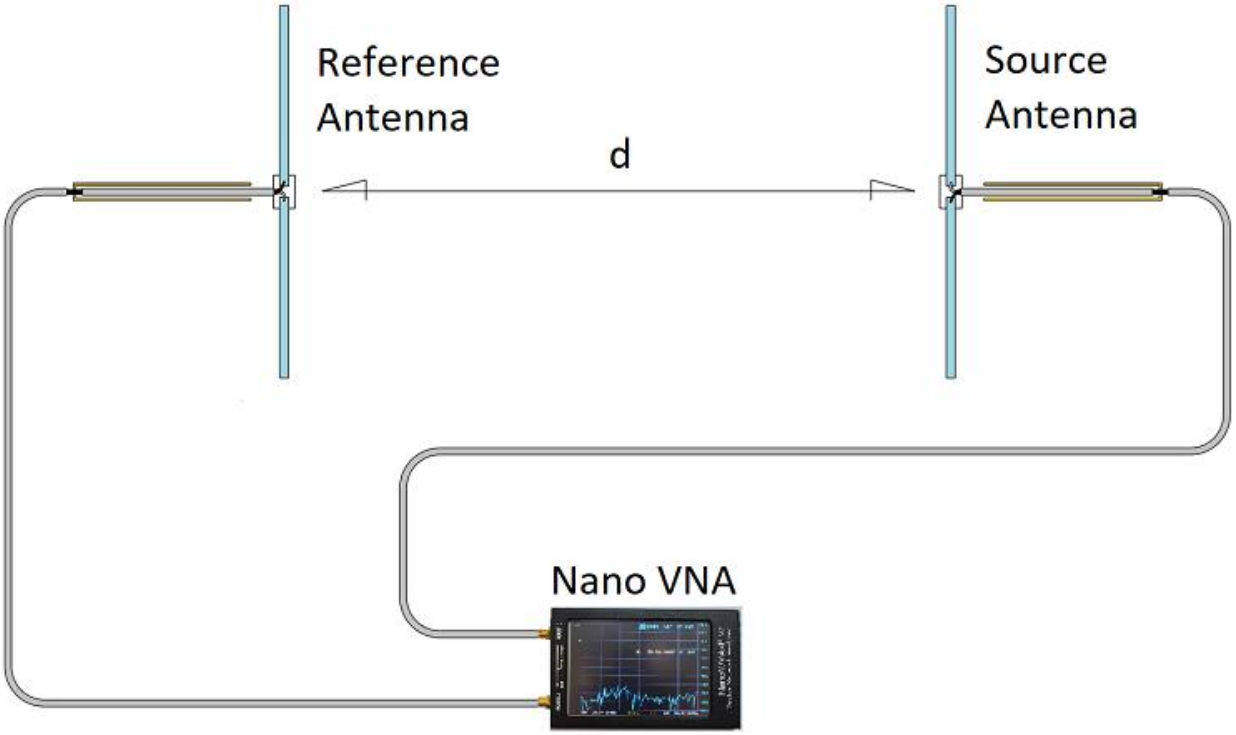
Step-by-Step Antenna Test

1. Calibrate at end of test cable
2. Connect antenna
3. Set display to **SWR or S11**
4. Sweep band

What a GOOD Antenna Looks Like




S11 SWR 250m/ 1.104
914.500 000 MHz
3
2.75
2.5
2.25
2
1.75
1.5
1.25
START 850.000 000 MHz
RBW:1000Hz 101p
STOP 1.000 000 000 GHz
PORT1
S11
+10dBm RF
10VDC Max
S21
PORT2
NanoVNA



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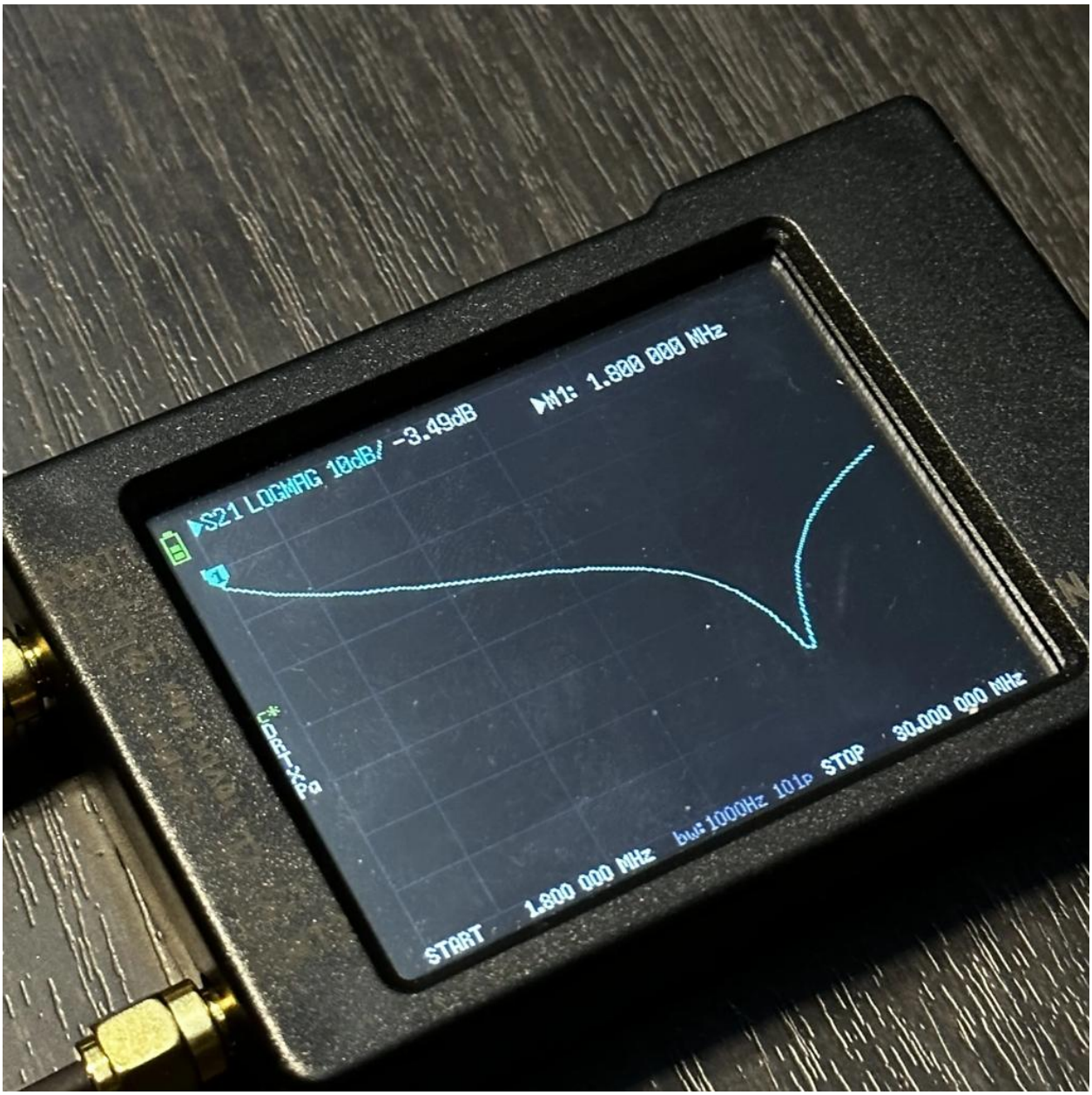
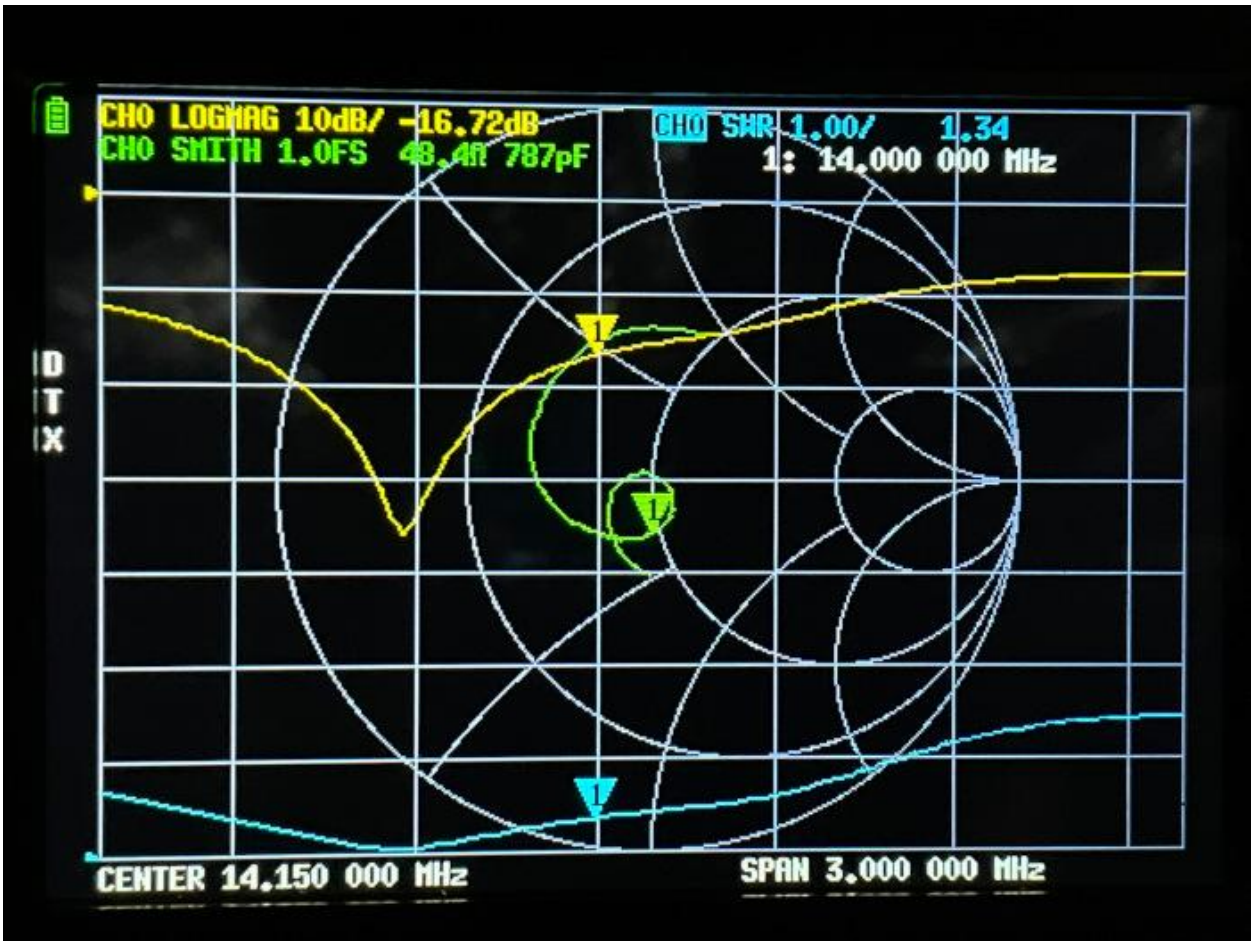
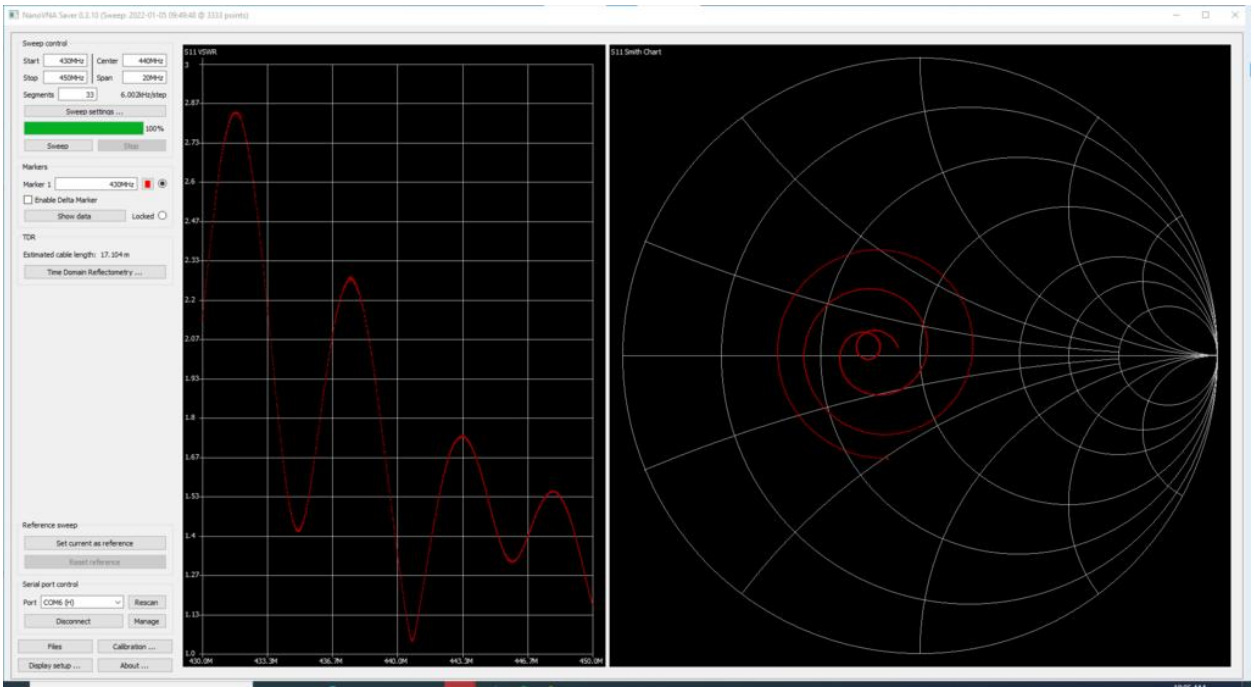
- Nice dip at your frequency
- Smooth curve

What a BAD Antenna Looks Like


S21 LOGMAG 10dB/ -3.49dB
M1: 1.800 000 MHz
1
CORRXPd
START 1.800 000 MHz
bw:1000Hz 101p
STOP 30.000 000 MHz





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- No clear dip

- High SWR everywhere

Tuning Rules (Simple Version)

Problem	Fix
Resonance too low	Shorten antenna
Resonance too high	Lengthen antenna

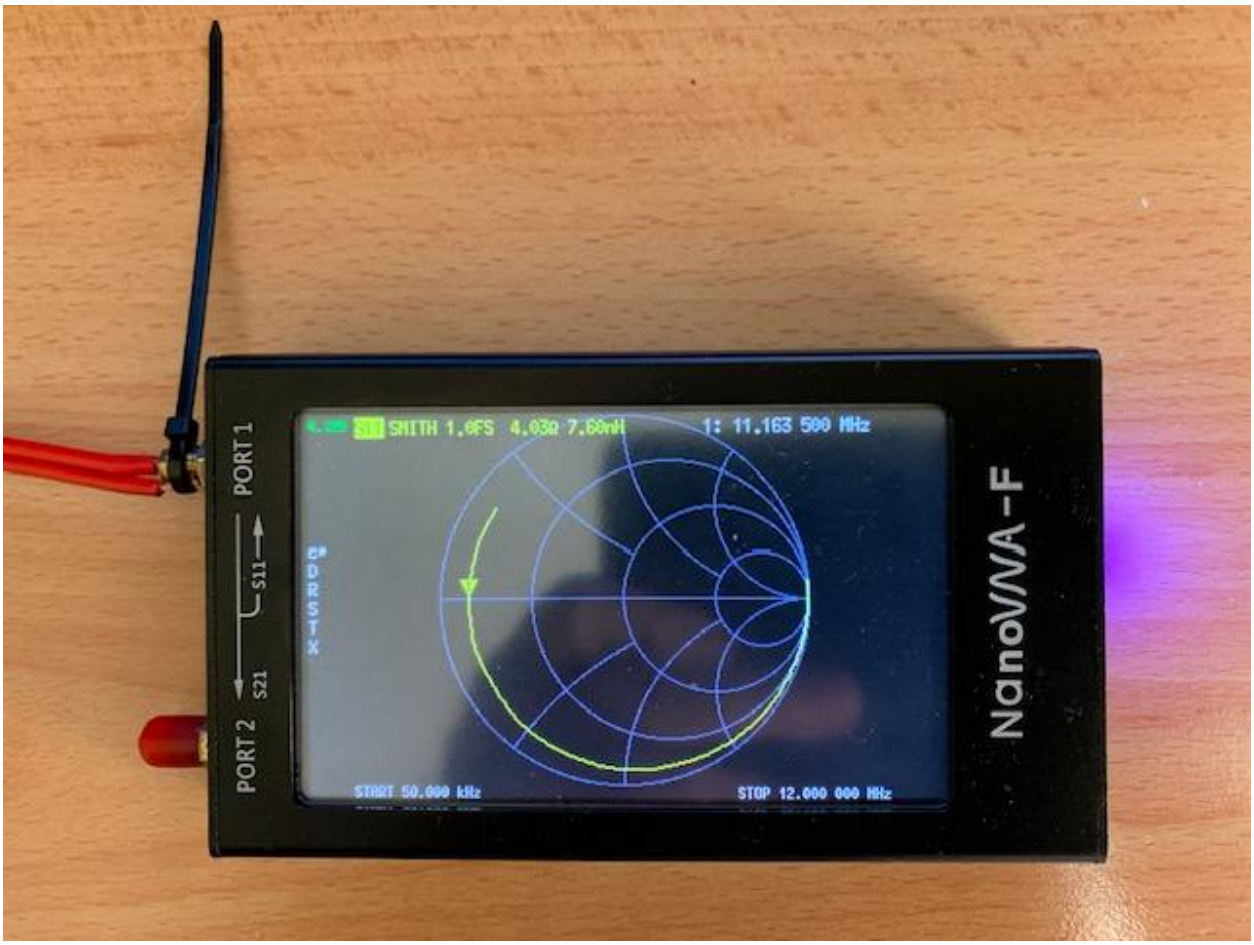
👉 Small adjustments. No chainsaws.

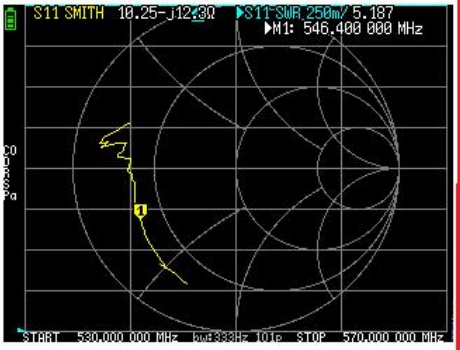
PART 5 — SMITH CHART (NOT AS SCARY AS IT LOOKS)

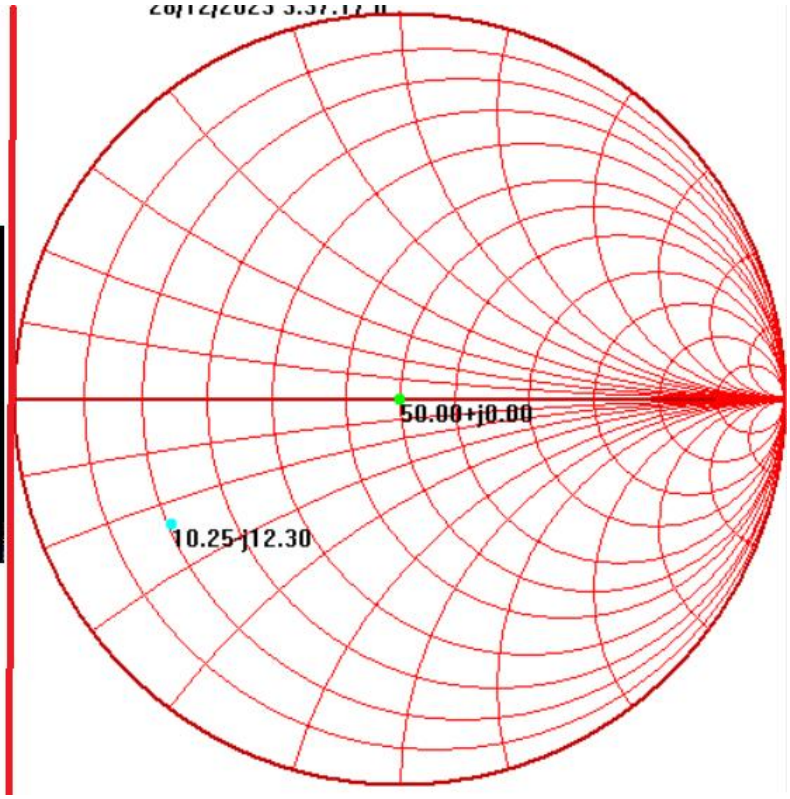
What It Shows

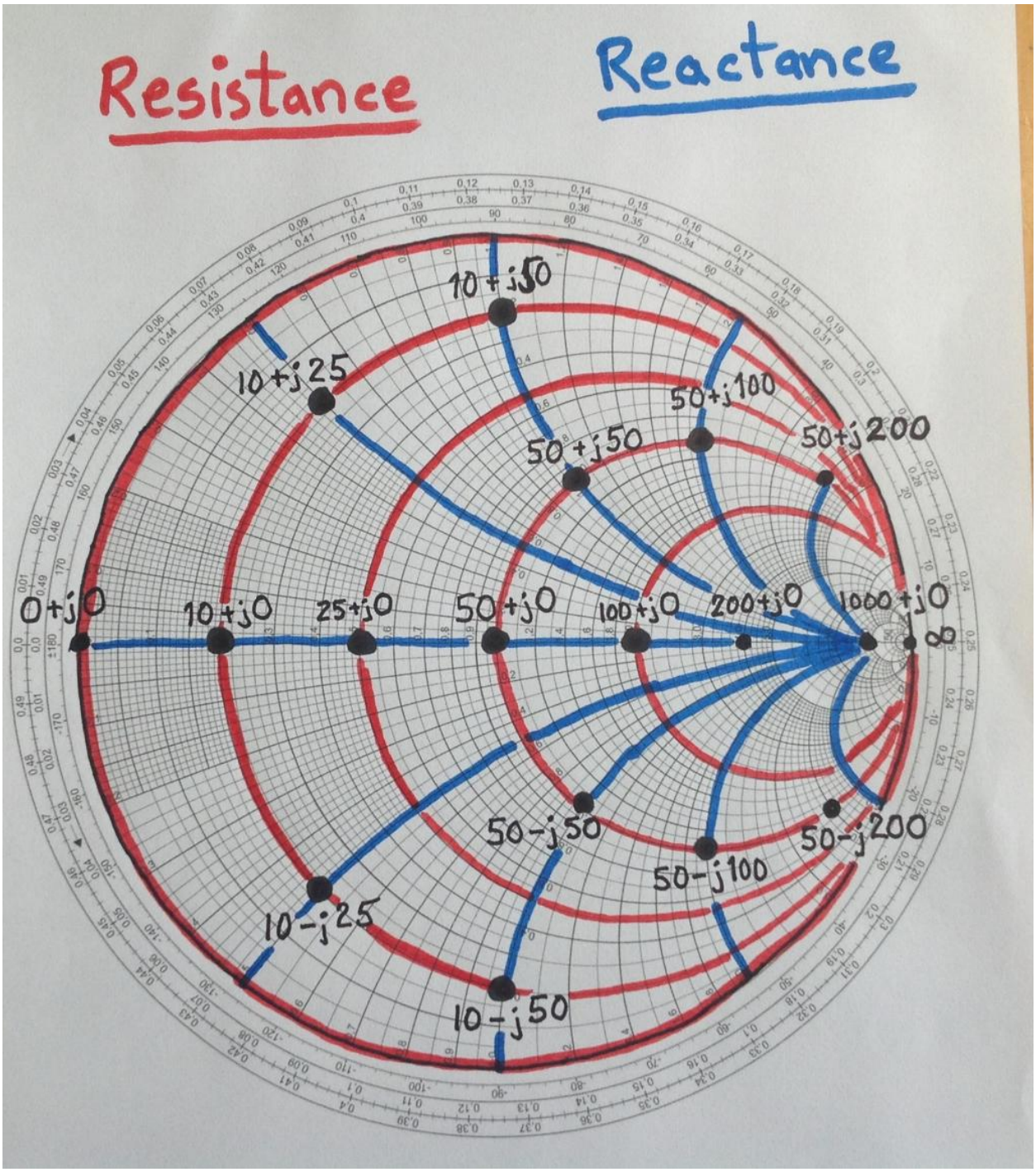
- Center = perfect (50 ohms)
- Above = inductive
- Below = capacitive

Example Display


PORT 1
S11
S21
PORT 2
SMITH 1.0FS 4.03Ω 7.60nH
1: 11.163 500 MHz
START 50.000 kHz
STOP 12.000 000 MHz
NanoVNA-F


S11 SMITH 10.25-j12.3Ω
S11 SWR 250m/ 5.187
M1: 546.400 000 MHz
START 530.000 000 MHz
STOP 570.000 000 MHz


50.00+j0.00
10.25-j12.30



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👉 You want the trace near the center.

Why It Matters

SWR tells you:

“Something’s off.”

Smith Chart tells you:

“Here’s exactly what kind of off.”

PART 6 — COMMON MISTAKES

1. Skipping Calibration

You just measured nonsense.

2. Cheap Adapters

Every adapter adds error.

3. Wrong Frequency Range

Calibration = invalid.

4. Moving the Cable

If readings change → problem exists.

5. Trusting SWR Alone

Dummy loads look perfect… and radiate nothing.

FINAL THOUGHTS

The NanoVNA is one of the most powerful tools a ham can own.

It removes guesswork.

It finds hidden problems.

It makes your station better.

The Truth

Most station problems are NOT:

- Propagation
- Solar cycle
- Bad luck

They are:

- Coax
- Connectors
- Setup mistakes

Bottom Line

Learn this tool, and you will:

- Hear more
- Be heard more
- Fix problems faster

…and spend less time chasing ghosts.

And yes…

You'll still call CQ on **144.200** and wonder where everyone is.

(They're on FT8. Don't get me started.)

— Greg, N5XO