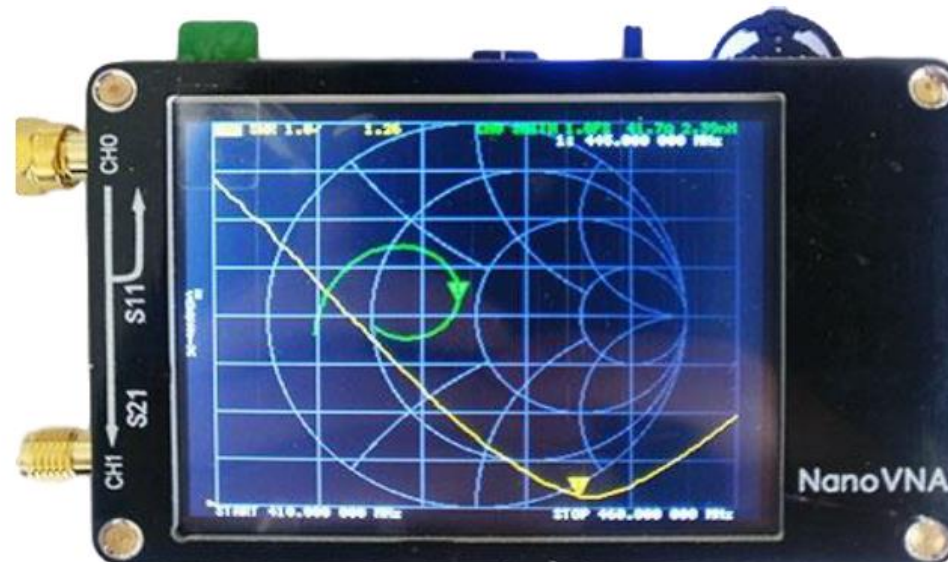


Introduction to the NanoVNA

Greg Algieri
WA1JXR



- **Presentation Outline**
- **What is a Network? One Port, Two Port?**
- **How can we measure in RF networks? S-Parameters**
- **What is a Vector Network Analyzer?**
- **How does the Vector Network Analyzer work?**
- **Why do you need to Calibrate the Network Analyzer**
- **Short, Open, Load, Through Calibration Kit**
- **How to use the Nano VNA Menu and Displays**

. **Bio of WA1JXR**

First licensed as WN1JXR in 1967

Upgraded to General and then Extra class

Ham radio lead me to a career in Electrical Engineering earning BSEE & MSEE from University of Rhode Island.

Retired in Dec. 2019 from Raytheon Co. after 42 years where I worked as a Senior Principal RF/uW Electrical Design Engineer

Not Contester or DX chaser, just Rag Chew OP

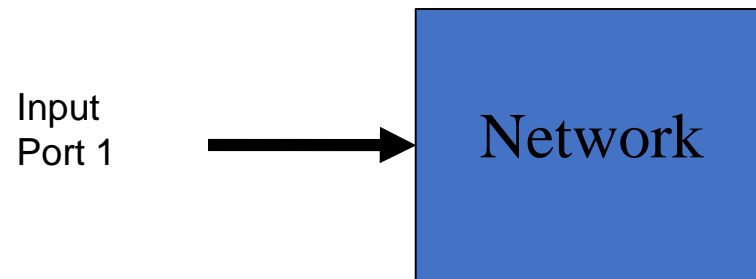
Enjoy restoring 40's, 50's & 60's Old Tube Rigs

Enjoy Teaching new hams, QRP Operation. Instructor and Forum Leader for the Long Island CW Club, CW is the original Digital Mode

ARRL Western Mass Asst. Section Manager and ARRL WMA Technical Coordinator

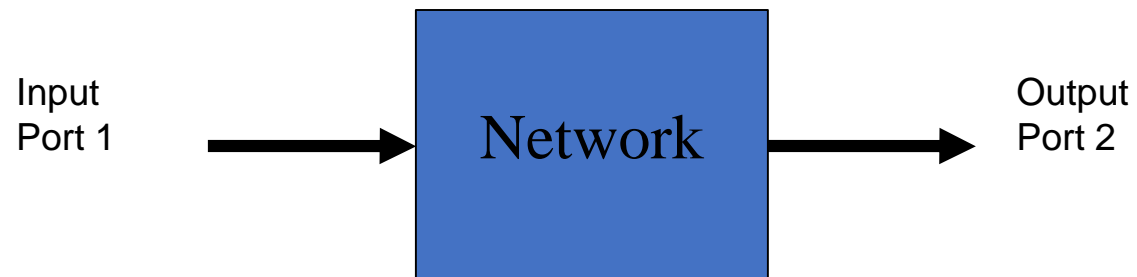
What is a Network?

- **One Port Network**
 - **Typical One Port Network Devices**
 - **Amateur Antenna**
 - **RF Load**
 - **RF Transmission Line Open or Shorted Stub**



What is a Network?

- **Two Port Network**
 - **Typical Two Port Network Devices**
 - **RF Amplifier**
 - **RF Transmission Line (Coax)**
 - **RF Filter**
 - **RF Phasing Stub Lines**



Measuring RF Networks

- With low frequency Audio and IF circuits we can measure the input and output voltage and current. Z, Y, and h parameters.
- With RF circuits we can measure incident, reflected and transmitted power. S (scattering) parameters.

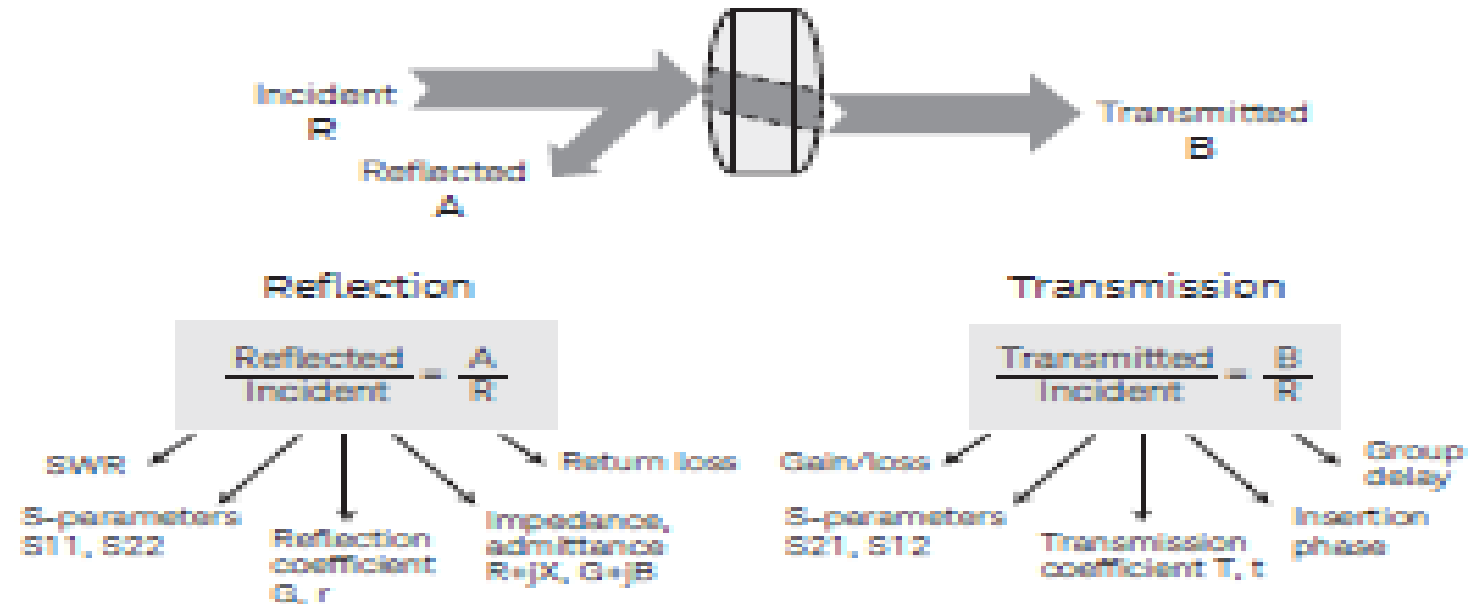
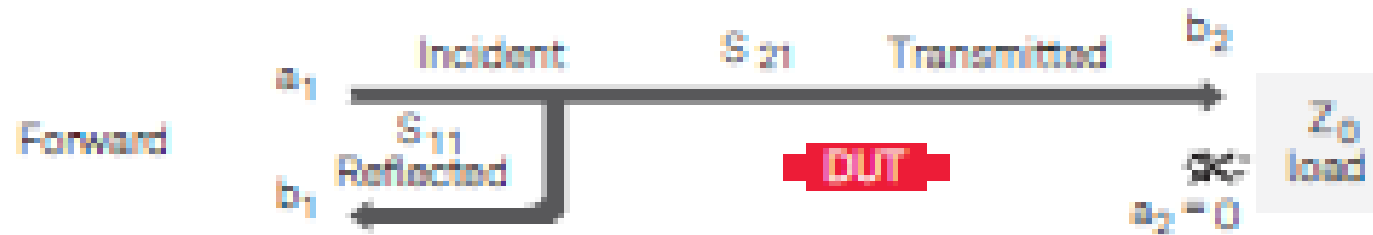


Figure 10. Common terms for high-frequency device characterization

Network S – Parameter Measurement

- Forward (S₁₁, S₂₁) and Reverse (S₂₂, S₁₂) Measurements

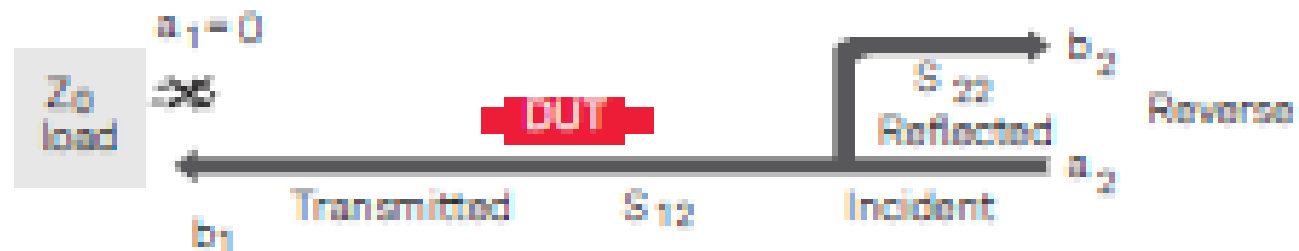


$$S_{11} = \frac{\text{Reflected}}{\text{Incident}} = \frac{b_1}{a_1} \Big|_{a_2=0}$$

$$S_{21} = \frac{\text{Transmitted}}{\text{Incident}} = \frac{b_2}{a_1} \Big|_{a_2=0}$$

$$S_{22} = \frac{\text{Reflected}}{\text{Incident}} = \frac{b_2}{a_2} \Big|_{a_1=0}$$

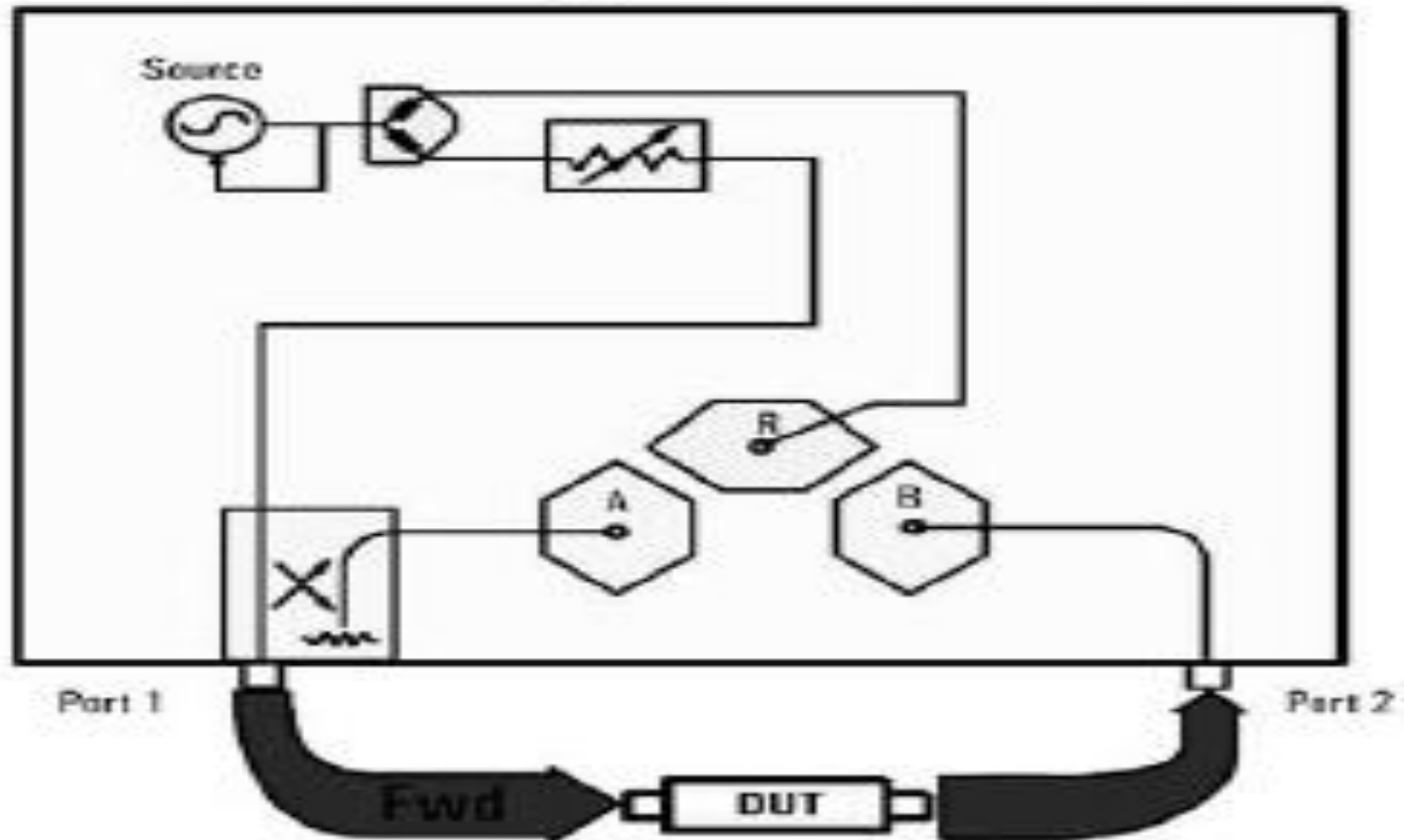
$$S_{12} = \frac{\text{Transmitted}}{\text{Incident}} = \frac{b_1}{a_2} \Big|_{a_1=0}$$



How a Vector Network Analyzer works

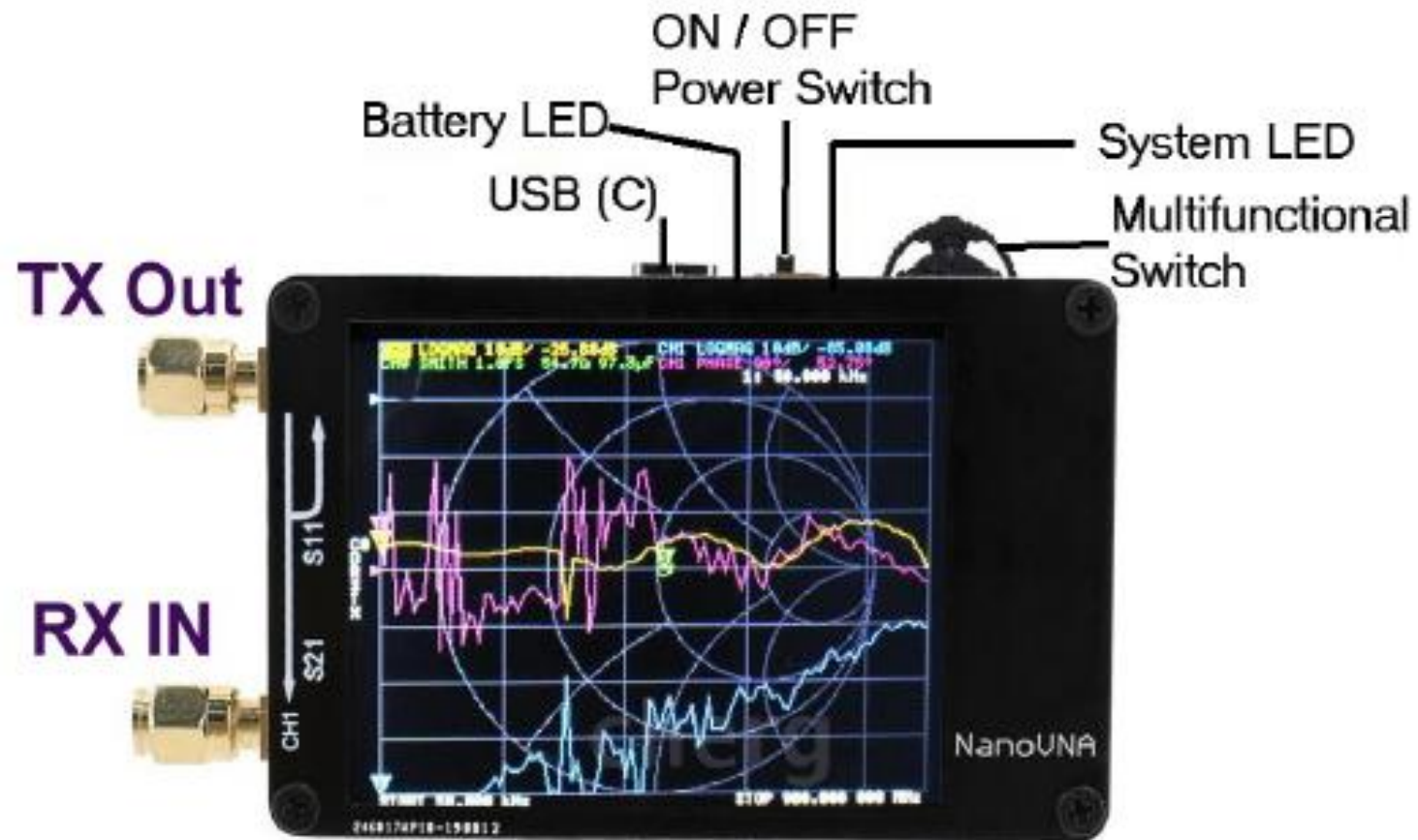
- A, B, & R are RF Measurement Receivers that measure signal magnitude (strength) and phase (phase of the measured signal compared to reference signal)

Transmission/Reflection Test Set



The Nano VNA

- Controls and Connectors on the Nano VNA



The Nano VNA

- **Use of “Connector Savers” on the SMA Connectors**



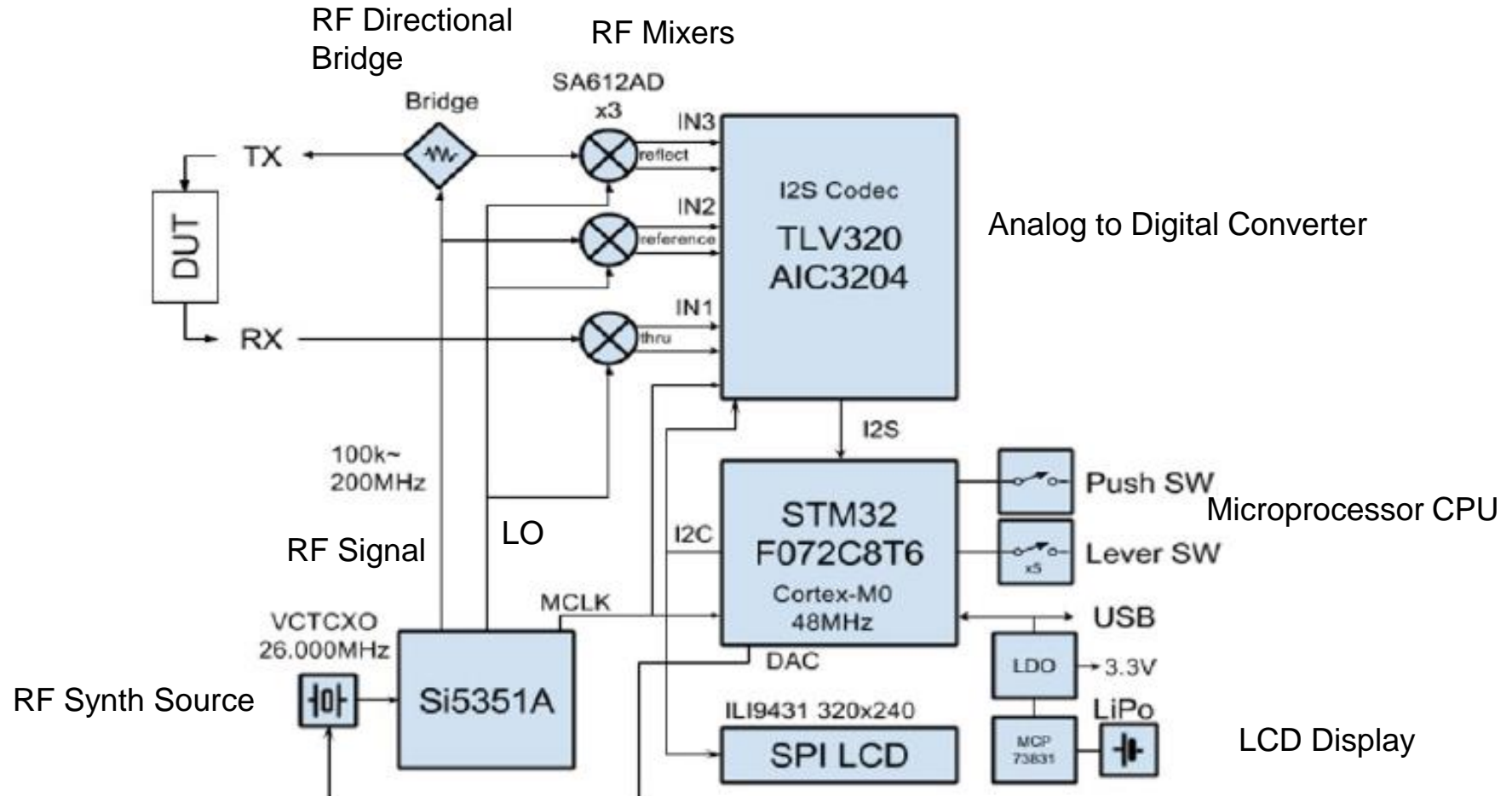
SMA Male to Female adapters on the two Ports of the Nano VNA is highly recommended to save wear and damage to the instrument ports from multiple connects and disconnects.

The Nano VNA H4 Specifications

- Frequency range : 10kHz to 1500MHz (300 - 1500MHz with harmonics)
- RF output: 0 dBm (maximum 2 dBm) , so approx. 1.0 mW
- Dynamic range : 70dB (50kHz - 300MHz), 60dB (300MHz - 900MHz), 40dB (900MHz - 1500MHz)
- Display: 4.0 inch TFT, resolution 320x240 ... like the “new” Nokia 3310 !
- USB interface: USB type C (power/charging + data connection to PC)
- Power: USB 5V 120mA , LiPo battery +/- 500 mAh
- Number of points : **101/401 (fixed)** □ **biggest disadvantage !**
- Display : 4 traces, 4 markers + **5 memories for calibration & settings (C0-C4)**
- Frequency error : < 0.5 ppm (e.g. 50 Hz error at 100 MHz)

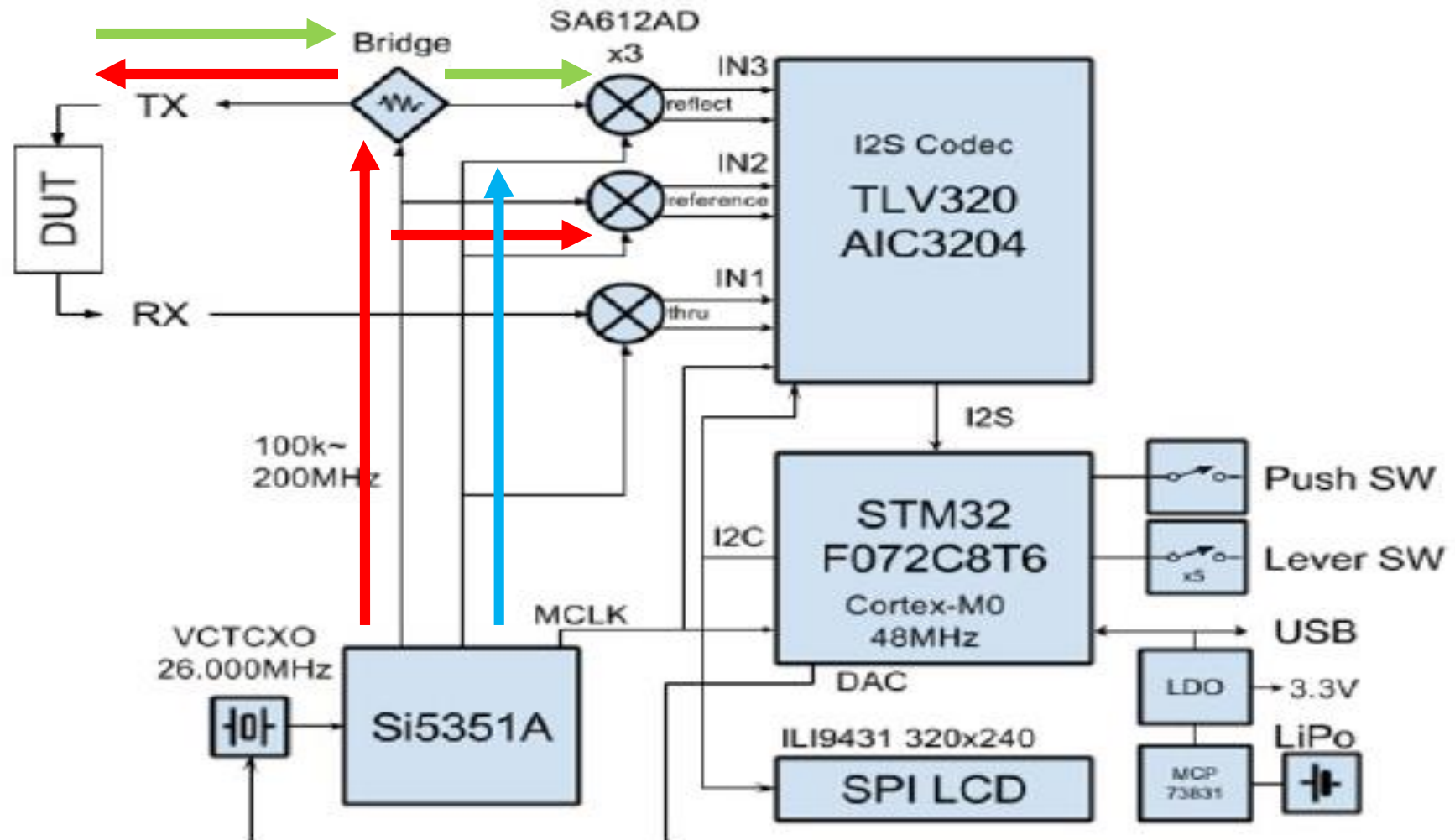
Block Diagram of the Nano VNA

What's Inside



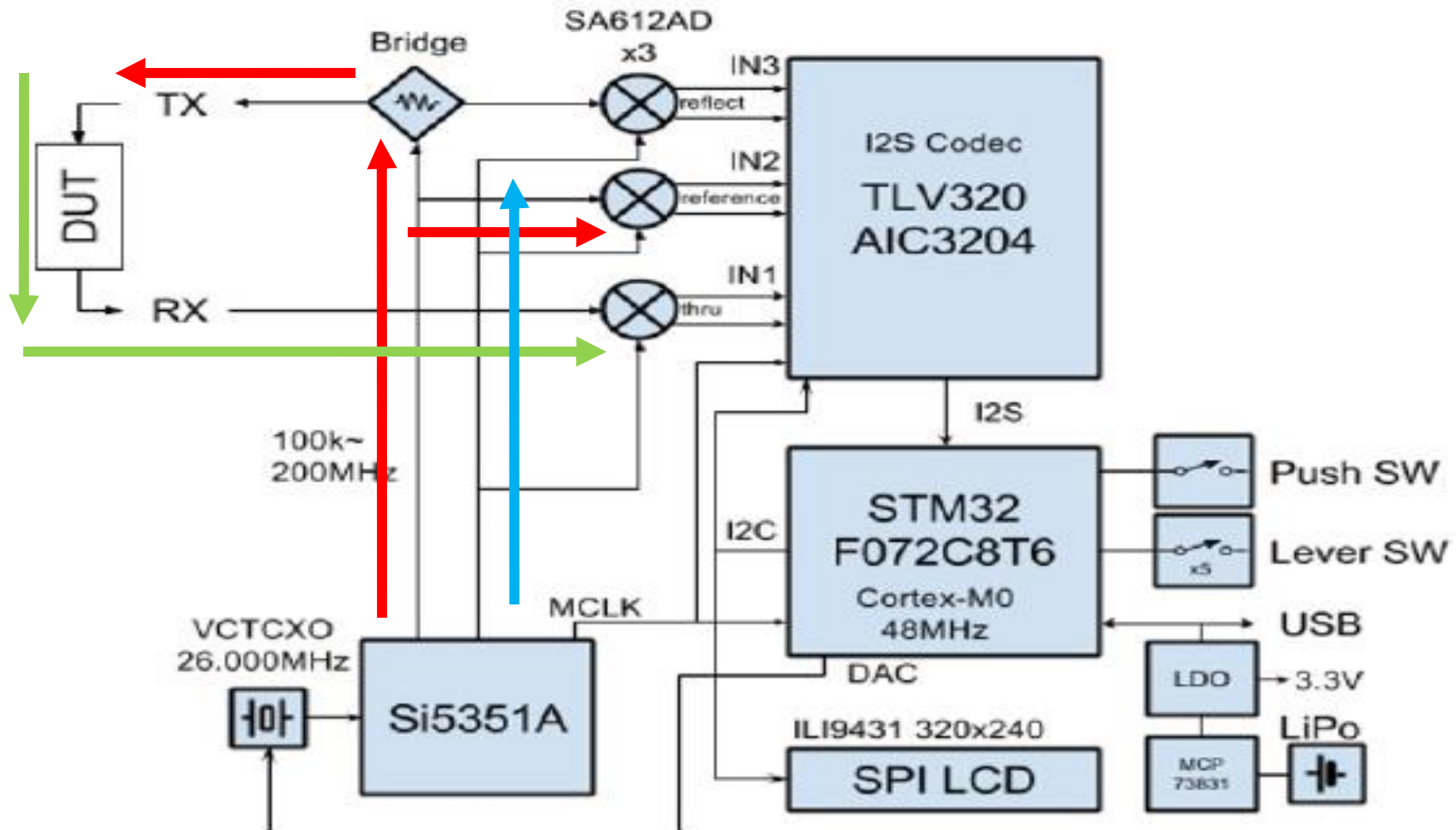
Block Diagram of the Nano VNA

- How it works – reflection measurement S11



Block Diagram of the Nano VNA

- How it works – transmission measurement S21



The Nano VNA

- A look at the inside of the Nano VNA

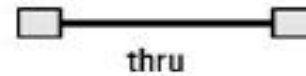


Nano VNA Vector Calibration

• Short, Open, Load, Thru (SOLT) Calibration of Vector Network Analyzer

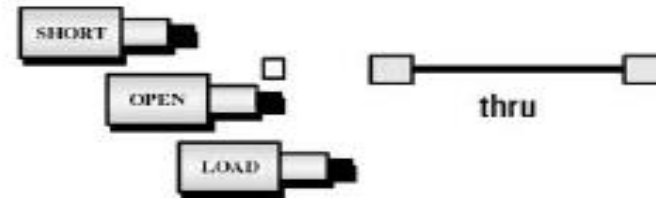
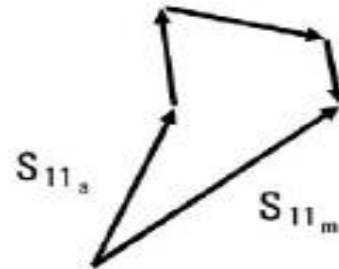
- **response (normalization)**

- simple to perform
- only corrects for tracking errors
- stores reference trace in memory, then does data divided by memory



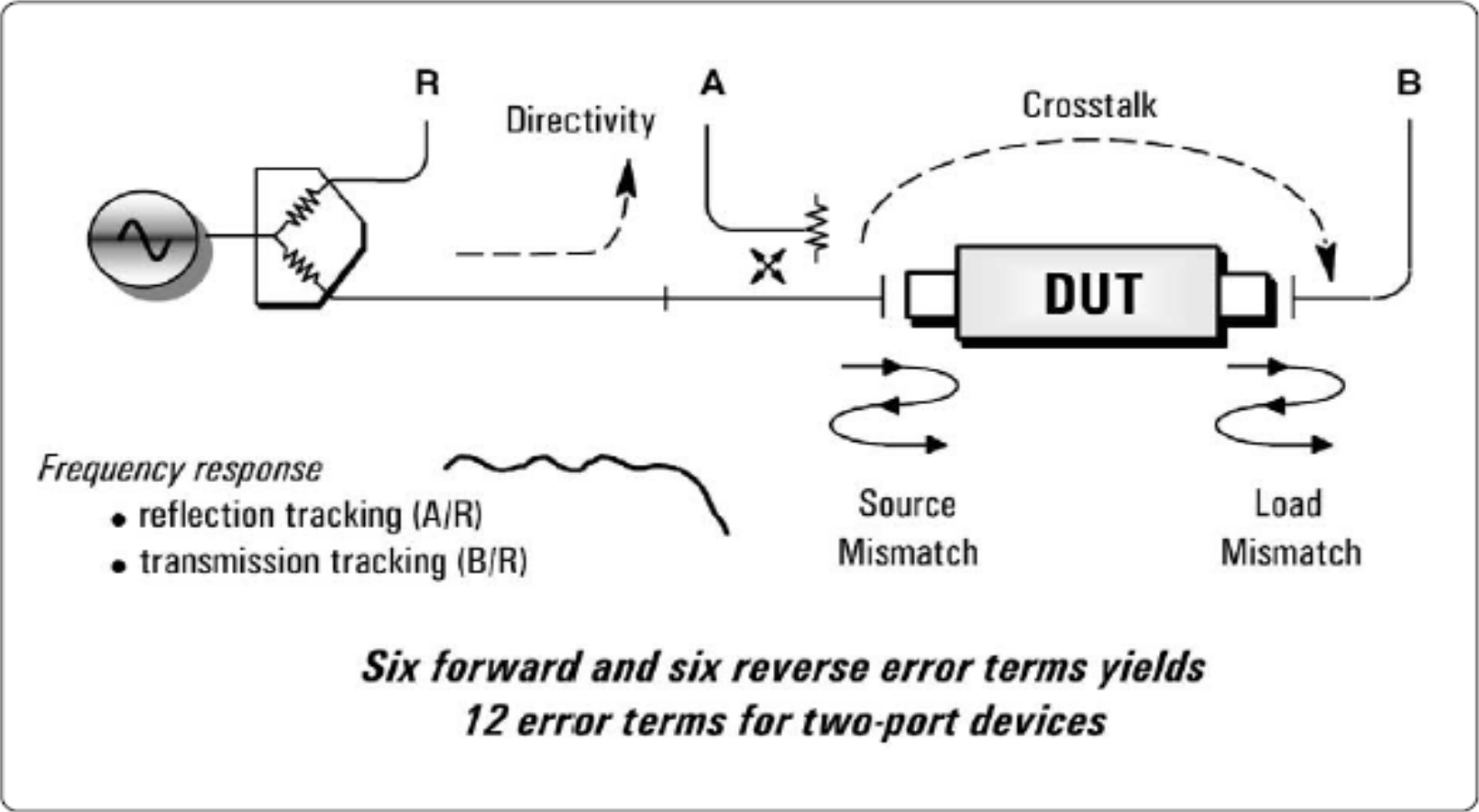
- **vector**

- requires more standards
- requires an analyzer that can measure phase
- accounts for all major sources of systematic error

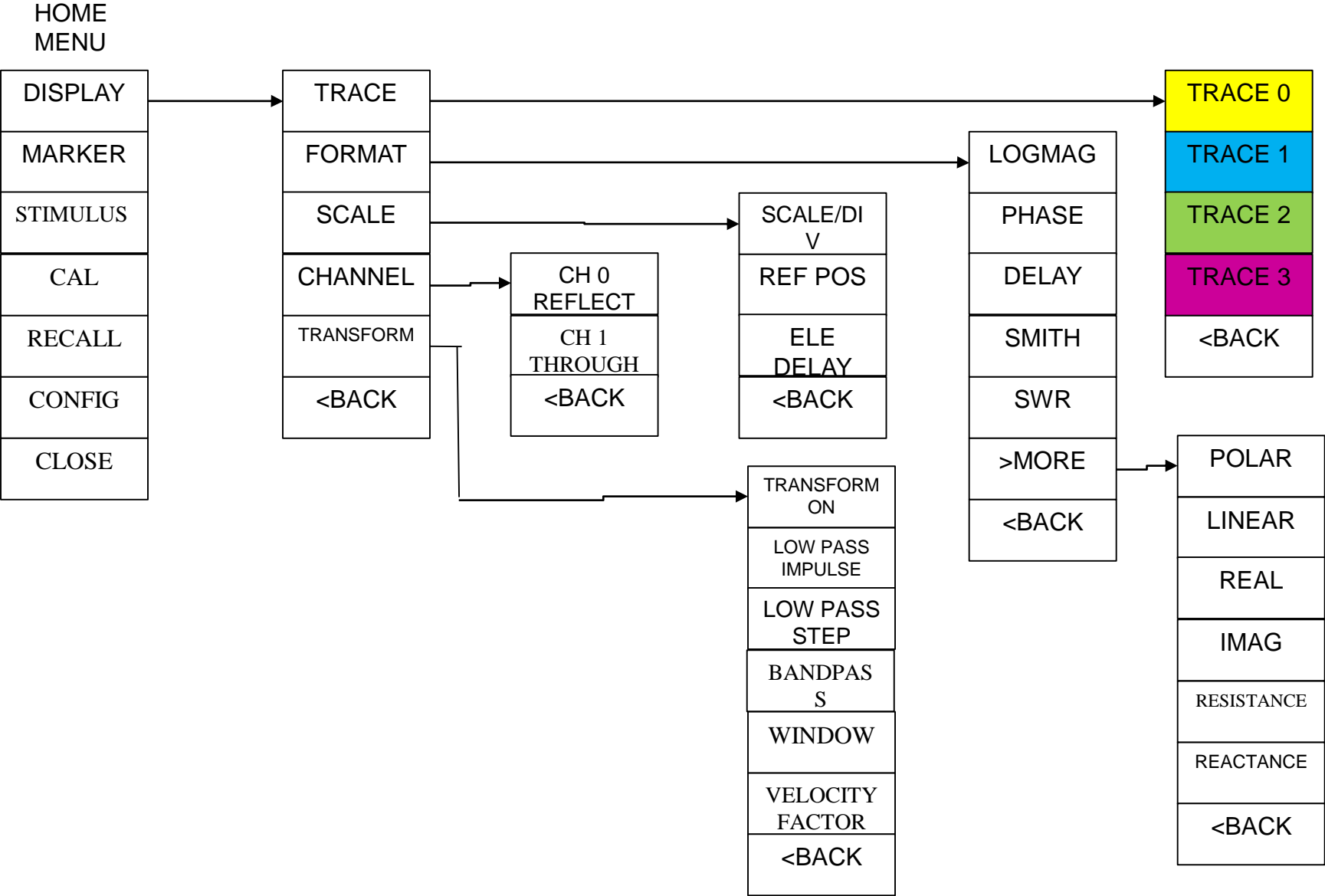


Calibration Error Terms

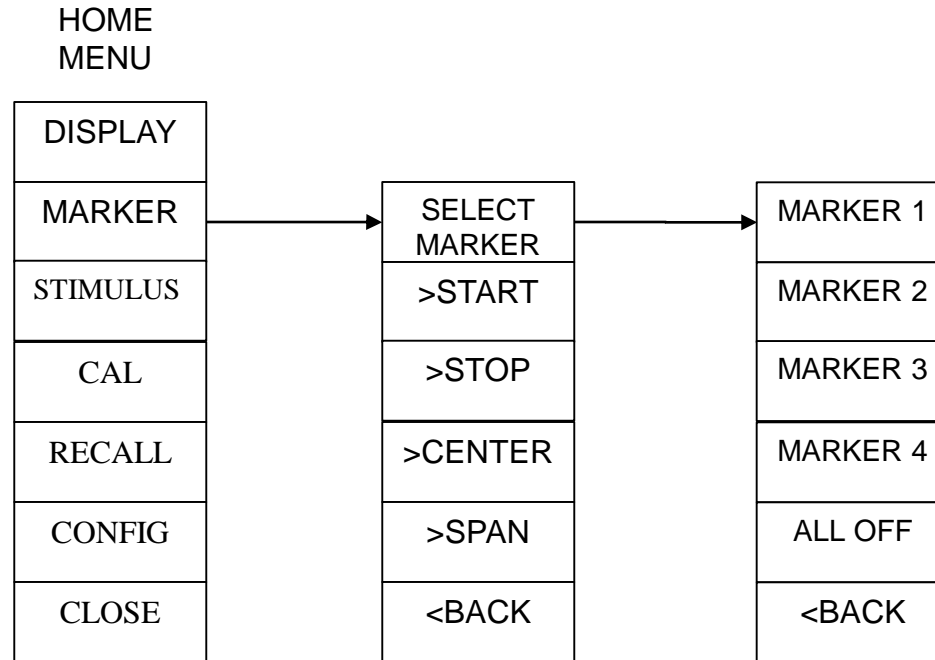
- **Vector Network Analyzer Calibration Error Terms**



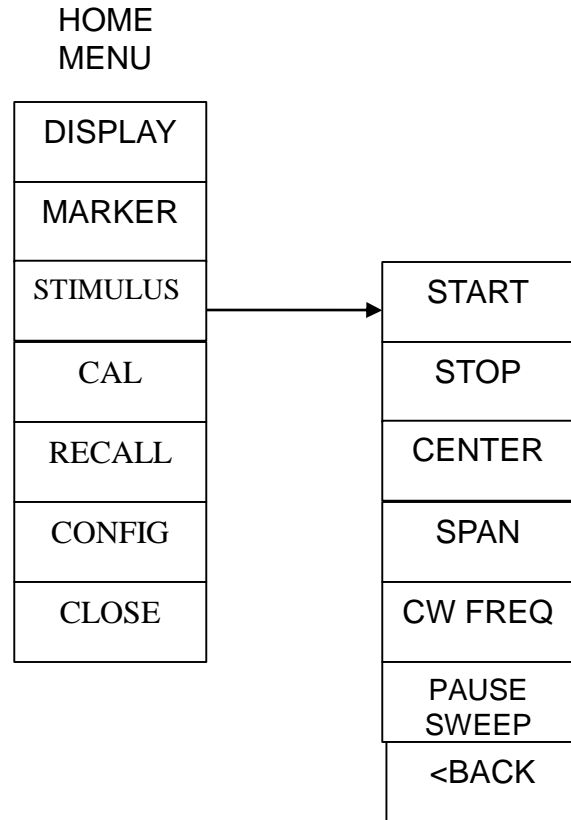
DISPLAY MENU MAP



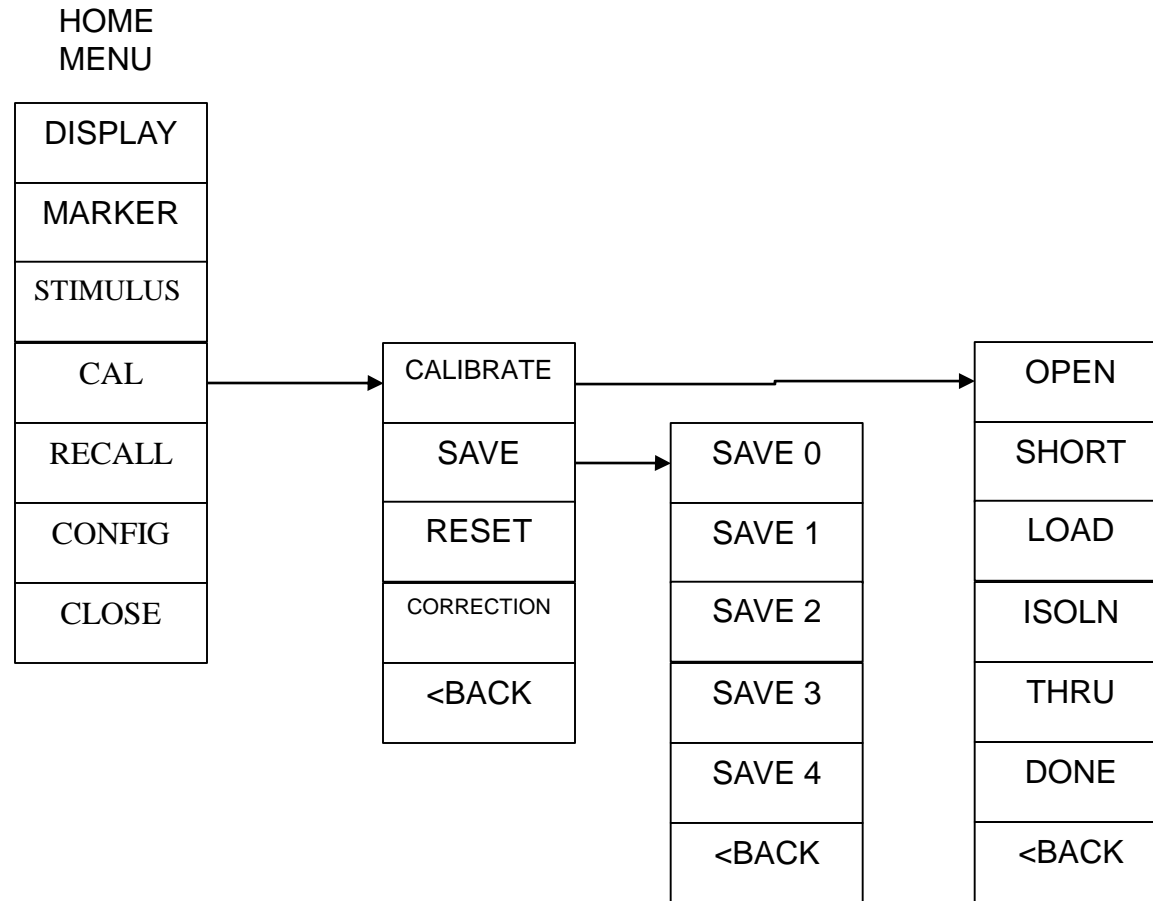
MARKER MENU MAP



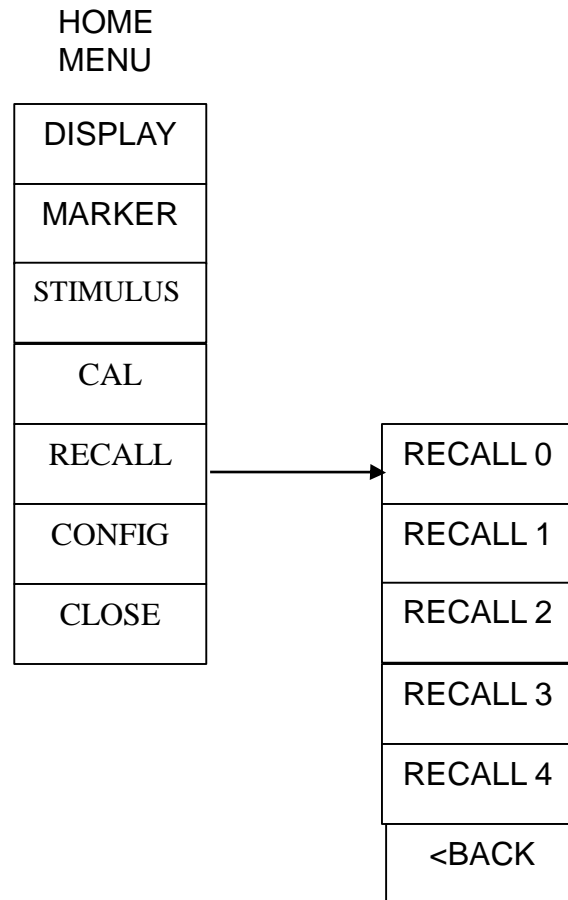
STIMULUS MENU MAP



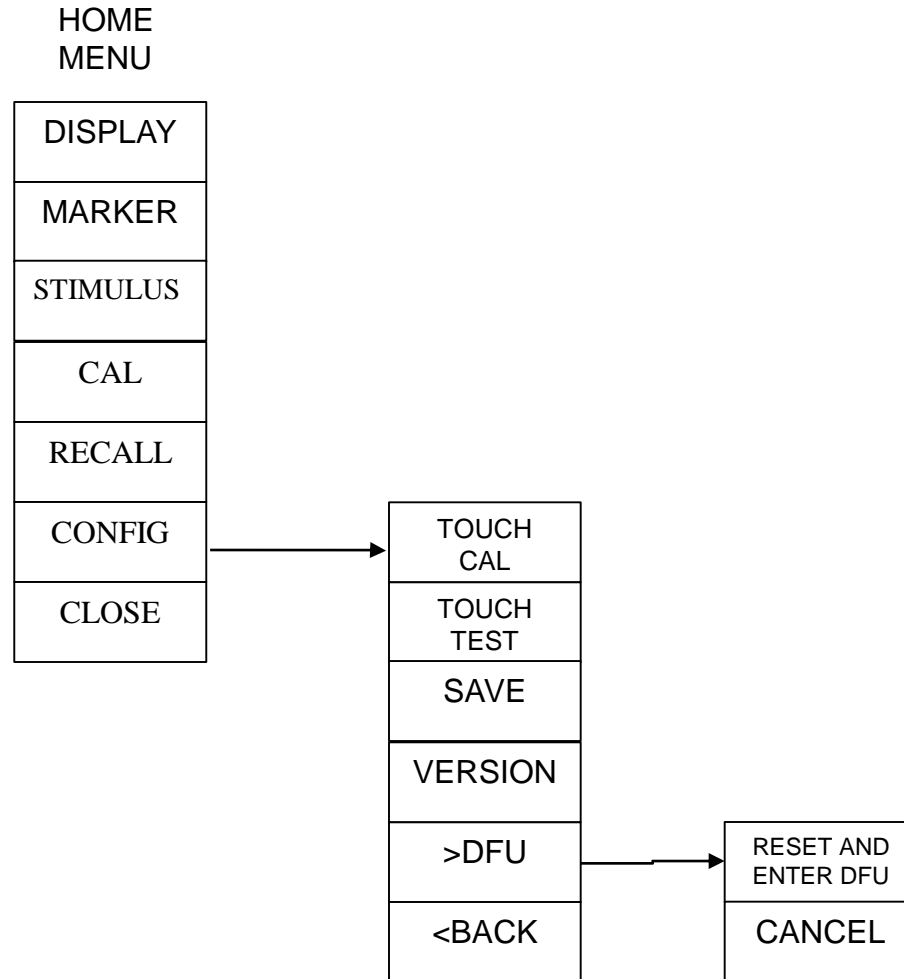
CALIBRATION MENU MAP



RECALL MENU MAP

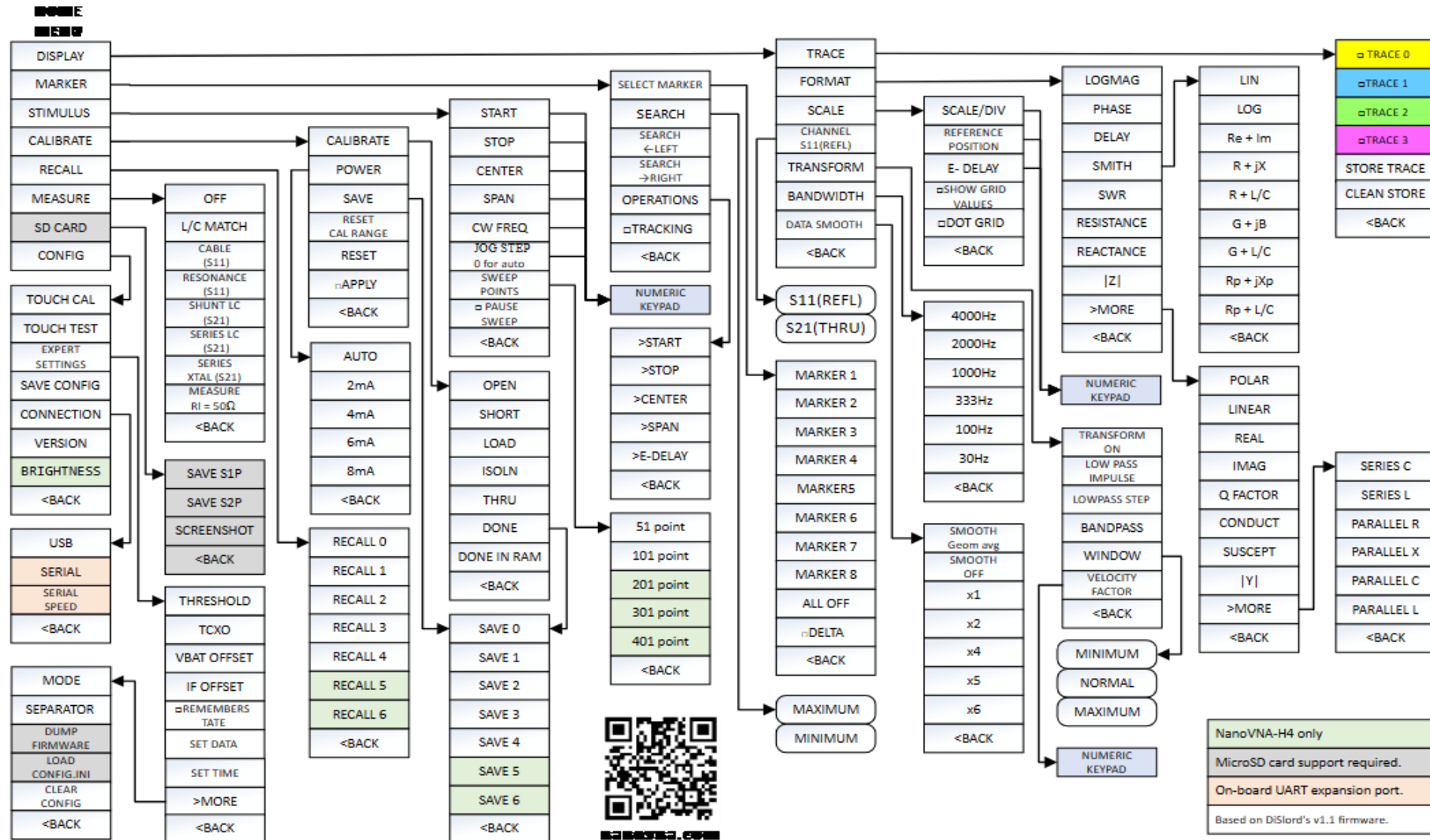


CONFIG MENU MAP



NanoVNA H4 Menu

NanoVNA Menu Structure Map



Nano VNA Users Group

- Documentation that comes with the Nano VNA is almost nothing so you need to join the User Group
- nanovna-users@groups.io

nanovna users nanovna-users@groups.io

Group Description

Users of nanovna small VNA

Files: <https://groups.io/g/nanovna-users/files>

Wiki: <https://groups.io/g/nanovna-users/wiki>

Group Information

 2,605 Members

 726 Topics, Last Post: 8:42am

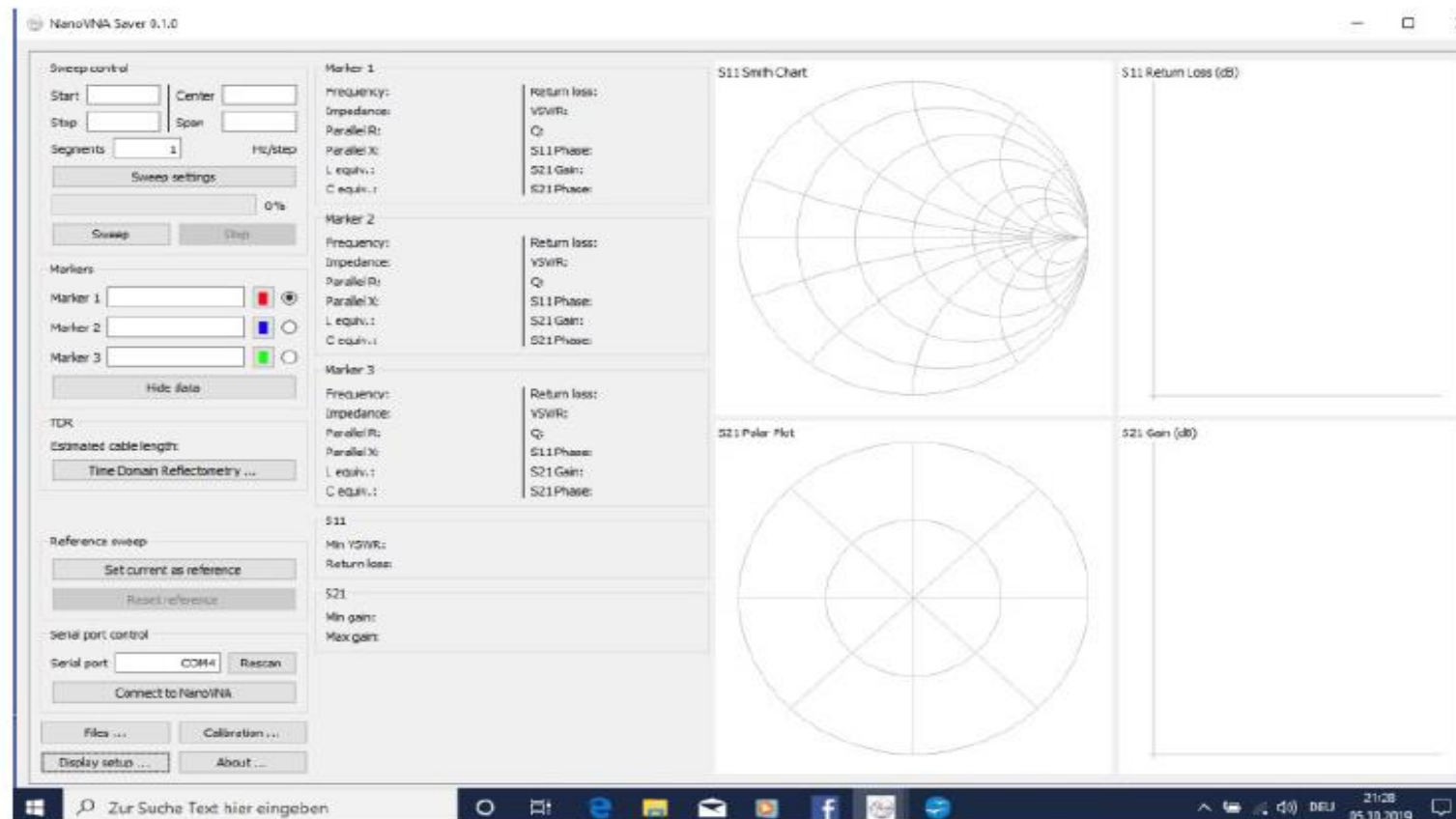
 Started on Jun 3

 Feed

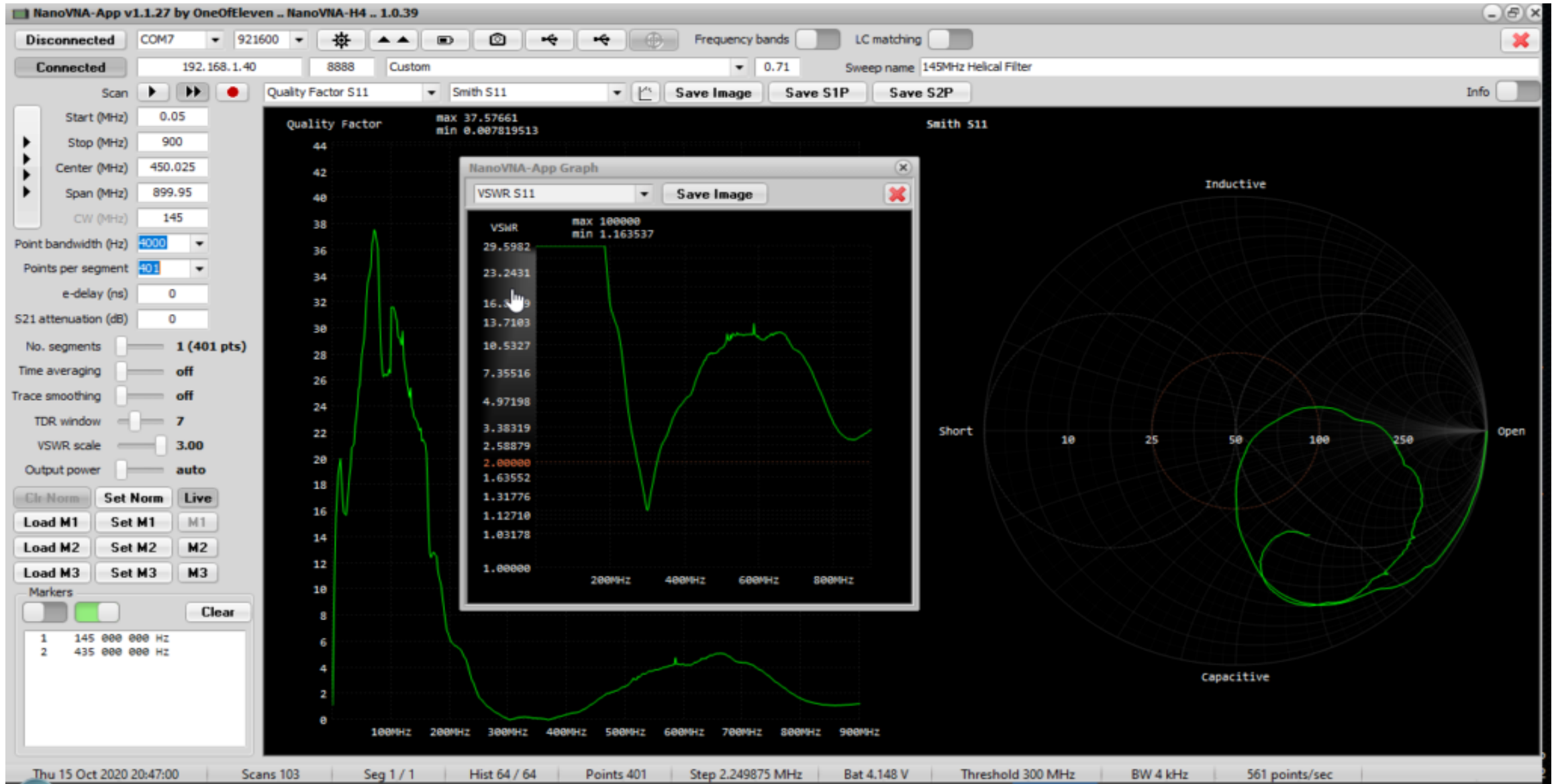
Nano VNA – Saver Software

NanoVNA - saver v0.2.0.exe

It can easily be copied to a USB stick and operated from there. After starting the program, wait 10 seconds because a dark DOS Screen appears followed by this picture:



Nano VNA App Software



Summary

- **This is end of NanoVNA Part1 Introduction**
- **Stay tuned for Measurements & Workshop**
- **Hope this presentation provided you with what the Nano VNA is and how it works.**
- **Where to get support for the Nano VNA.**
- **If you have questions after you can reach me via e-mail at wa1jxr@comcast.net or wa1jxr@arrl.net**
- **Questions??**

- **73's Greg WA1JXR**

Questions and Answers

Beginning now

