

# **NANOVNA VECTOR NETWORK ANALYZER**

**The Simpson 260 for today's HAMs**

# SOURCE AND MEASURE

- A VNA produces a stimulus signal for testing
- The stimulus signal frequency is controllable to test different devices (DUT)
- Frequency can be up to multiple GHz or even THz
- The VNA measures the **magnitude** and **phase** of the signal, either reflected from the input port (s11) or transmitted through the port being tested (s21, etc.)
- Calibration (**Very Important!!**) corrections are applied and the results of the test and calculations done on them are displayed
- The NanoVNA has lower dynamic range (<100db) than much more expensive professional devices (>120db)

# REFLECTION MEASUREMENTS

- For single port devices, Reflection measurements yield:

$\Gamma$  (reflection coefficient from -1 to +1)

$\sigma$  (  $|\Gamma|$  from 0 to +1 )

S11

RL (Return Loss in db)

R+jX (Input Impedance)

VSWR (Voltage Standing Wave Ratio)

# TRANSMISSION MEASUREMENTS

- For 2 port devices like Circuit networks, Filters, Attenuators , Coax, etc. Transmission measurements yield:

Transmission Coefficients ( $T$ ,  $\tau$ ,  $s_{21}$ , etc.)

Gain or Loss

Insertion Phase

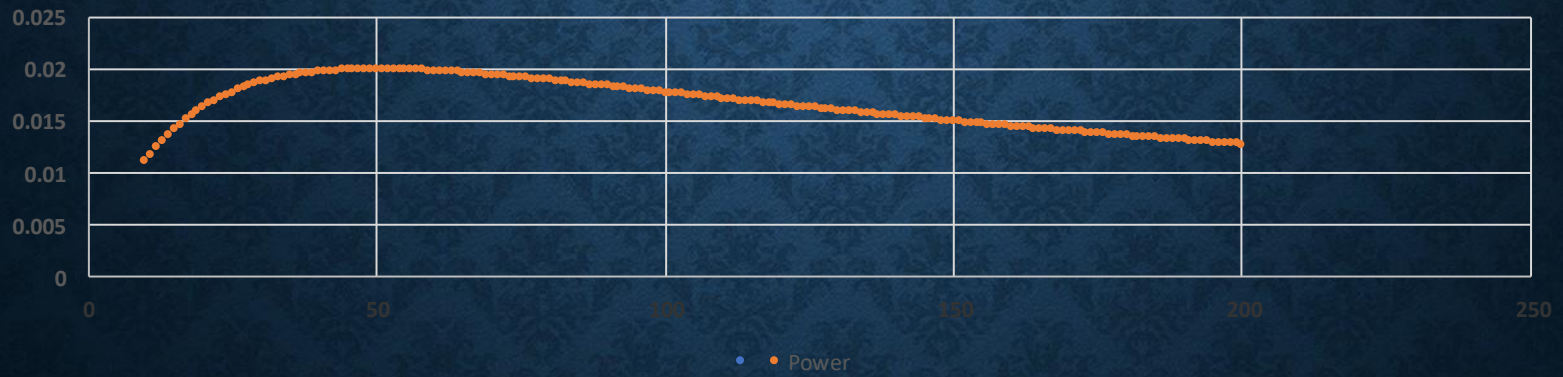
Group Delay

# SOURCE – LOAD CONNECTION

- We normally use a  $50\ \Omega$  system impedance. A  $50\ \Omega$  source impedance matches a  $50\ \Omega$  load and maximum power is transferred. Any other load impedance ( $R+jX$ ) causes some reflection. The VNA senses and measures this reflection. For complex matching we can use conjugate matching ( $R+jX$  matches to  $R-jX$ )

# MATCHING

Power vs Load Resistance



# NOW FOR SOME REAL DATA

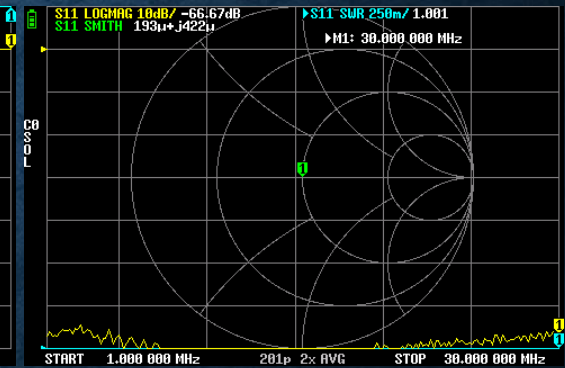
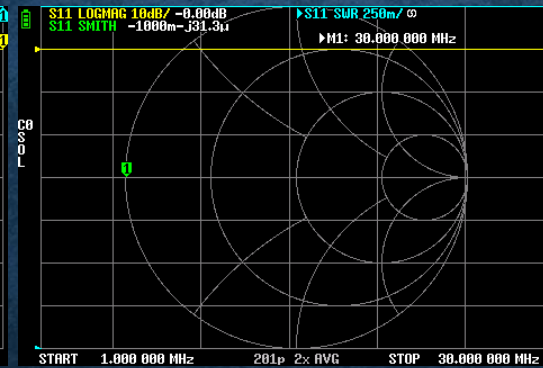
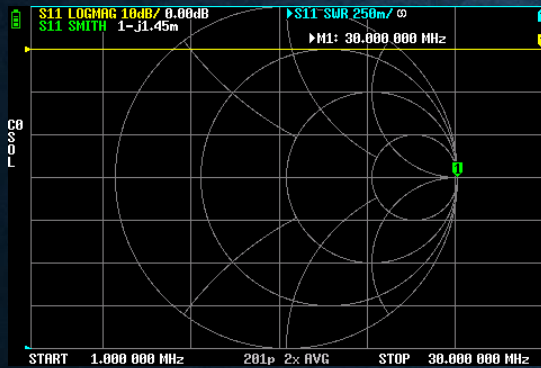
- OSL Calibration Results
- Tri-band Antenna (80m, 40m, 20m)
- 2m Vertical antenna
- Length (TDR) of approx. 30' coax

# CALIBRATION RESULTS

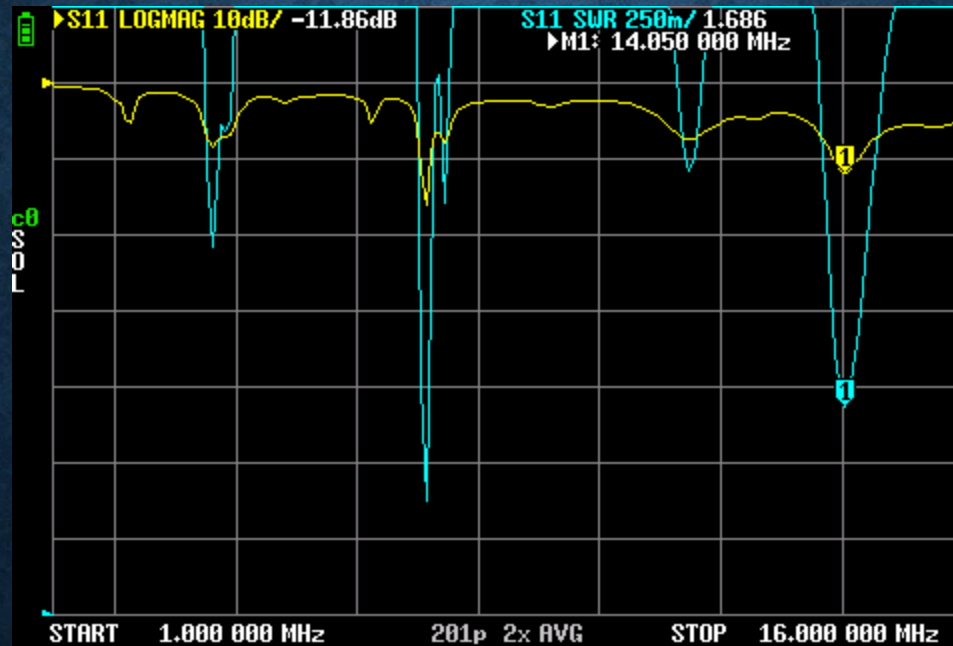
Open

Short

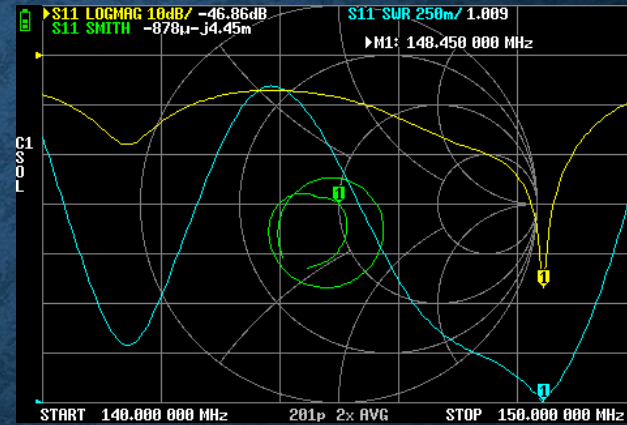
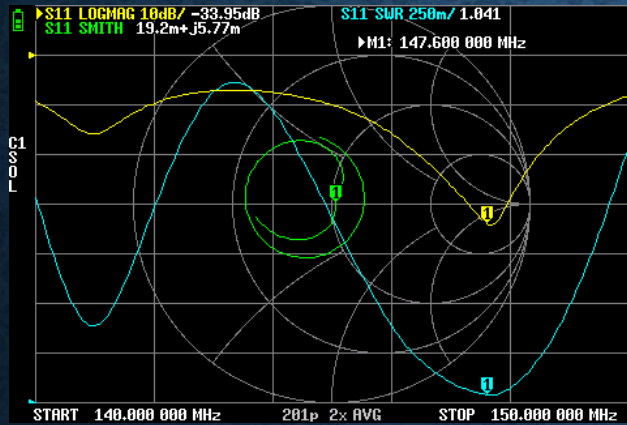
Load



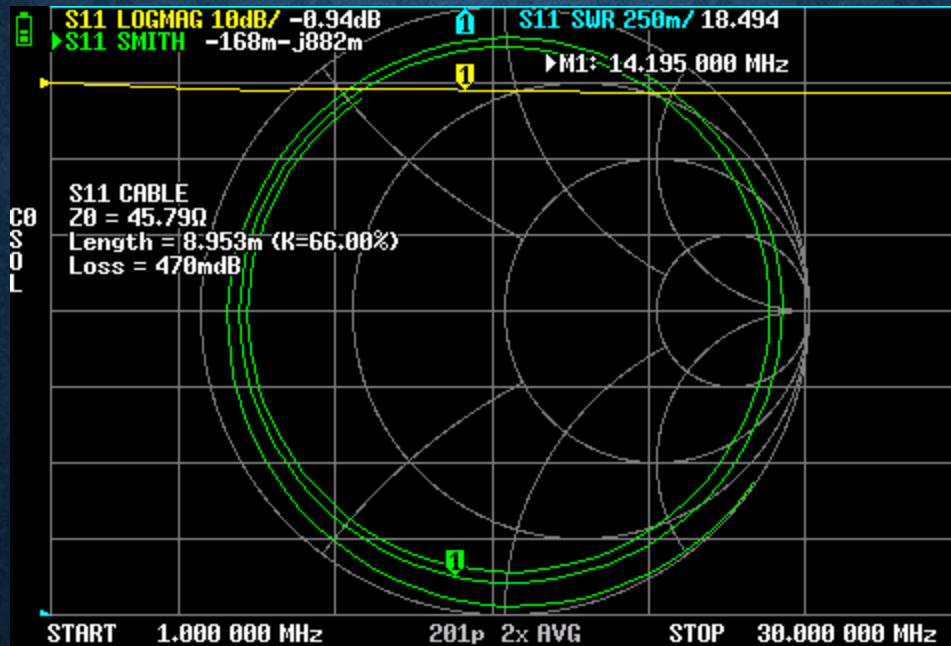
# TRI-BAND 80, 40, 20 M INVERTED V



# 2M VERTICAL



# 30 FT RG8 COAX



# EXTERNAL PROGRAMS

- NanoVNA Saver – run your VNA from your PC giving more points and alternative displays
- SimSmith/SimNEC – gather impedance data either directly from your VNA or import S1P files and use it in a circuit model environment

# TIPS AND TRICKS FOR SUCCESS

- Your NanoVNA is sensitive – be careful not to damage it, that means no input signals, DC, rf or static electricity
- Set the stimulus values carefully remembering that you have limited points, then calibrate
- Check your calibration after you complete it using calibration loads and verify correct display
- Choose your display traces carefully – turn off unnecessary ones and make sure you are using Port 1 for reflections
- Save your calibrations in memory, especially SAVE0
- Calibrate at the end of cables and connectoes to establish the reference plane there
- NanoVNA Saver and other external programs greatly extend the usefulness and capability of your NanoVNA alone

# CREDITS AND REFERENCES

- W2AEW – Alan Wolke

Everything in this presentation is covered in his many excellent NanoVNA/VNA videos. He also has an extensive list of other videos of interest to Hams. I have drawn heavily from Alan's videos

- W0QE – Larry Benko

A great collection of Ham videos including the use of the Smithchart and the SimSmith/SimNEC programs

- AE6TY – Ward Harriman

The SimSmith and SimNEC programs author

Wonderful programs for analyzing your RF circuits

# ADDITIONAL REFERENCES

- <https://www.youtube.com/watch?v=91ZR7FZ40rw>  
An informative video from Andreas Speiss
- <https://www.electronics-notes.com/articles/test-methods/rf-vector-network-analyzer-vna/what-is-a-vna.php>  
A good introductory article about VNAs
- [https://www.youtube.com/@eie\\_for\\_you](https://www.youtube.com/@eie_for_you)  
Ralph Gable – Electronics for the Inquisitive Experimenter

# QUESTIONS FOR THOUGHT

- Two questions for everyone to think about.

In a normal good but not perfect antenna system with a decent match and reasonably low feedline loss:

1) Does the feedline length between the transmitter and the antenna affect the antenna **SWR** as seen at the transmitter?

2) Does the feedline length between the transmitter and the antenna affect the **impedance** of the antenna as seen at the transmitter?