NanoVNA

Antenna Modeling

Lee Johnson
N4WYE

RARS Hamfest
April 5, 2025

Thanks for the Invitation

KH6DAK in Hawaii 1957

Charter Member Raleigh Amateur Radio Society 1969

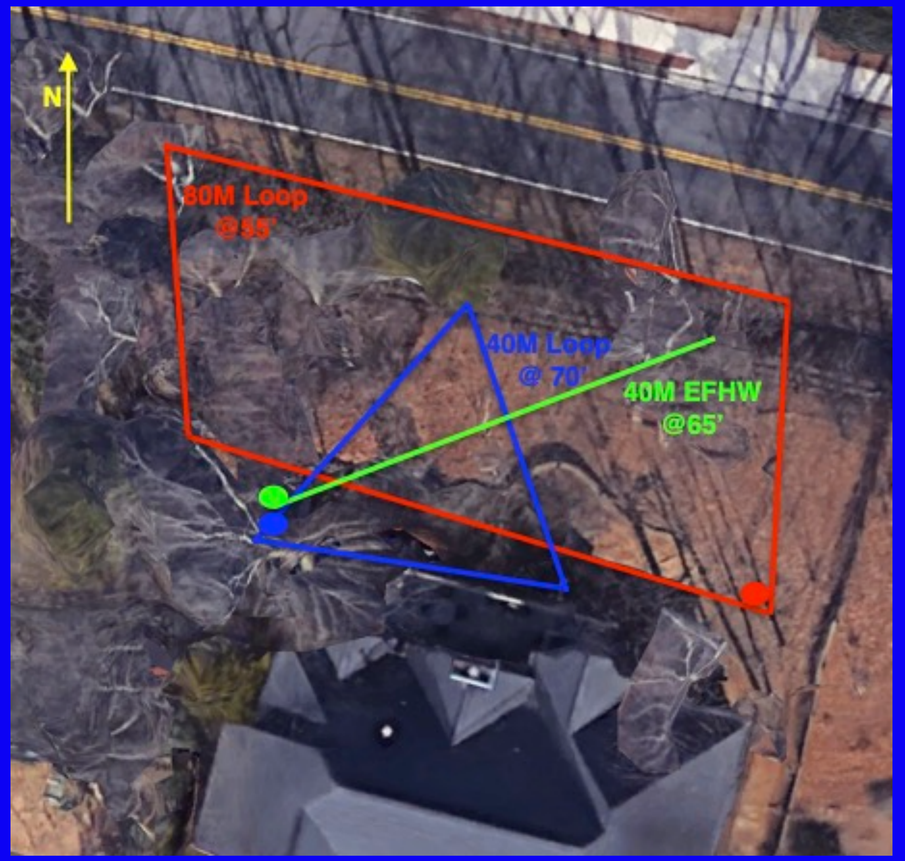
W4DW Repeater 146.64 MHz in Raleigh 1975

Retired after 40 years in high tech systems

HF, VHF, SDR, home brew & antennas

NFARL & RARS member

N4WYE Lee



NanoVNA
Antenna Modeling

NanoVNA

- SWR vs Frequency
- Impedance

Modeling

- What is it and why use it?
- Demonstration
- Optimize antenna within your constraints

Propagation

- hf.dxview.org
- Reverse Beacon Network

Match & Tune

Analyze & Predict

Getting out Where?

NanoVNA SWR Setup

So What is a NanoVNA?

Vector Network Analyzer

Measures the magnitude and phase of the reflection and transmission properties of a device over a frequency range.

Vector Network Analyzer = Instrument used to characterize RF devices

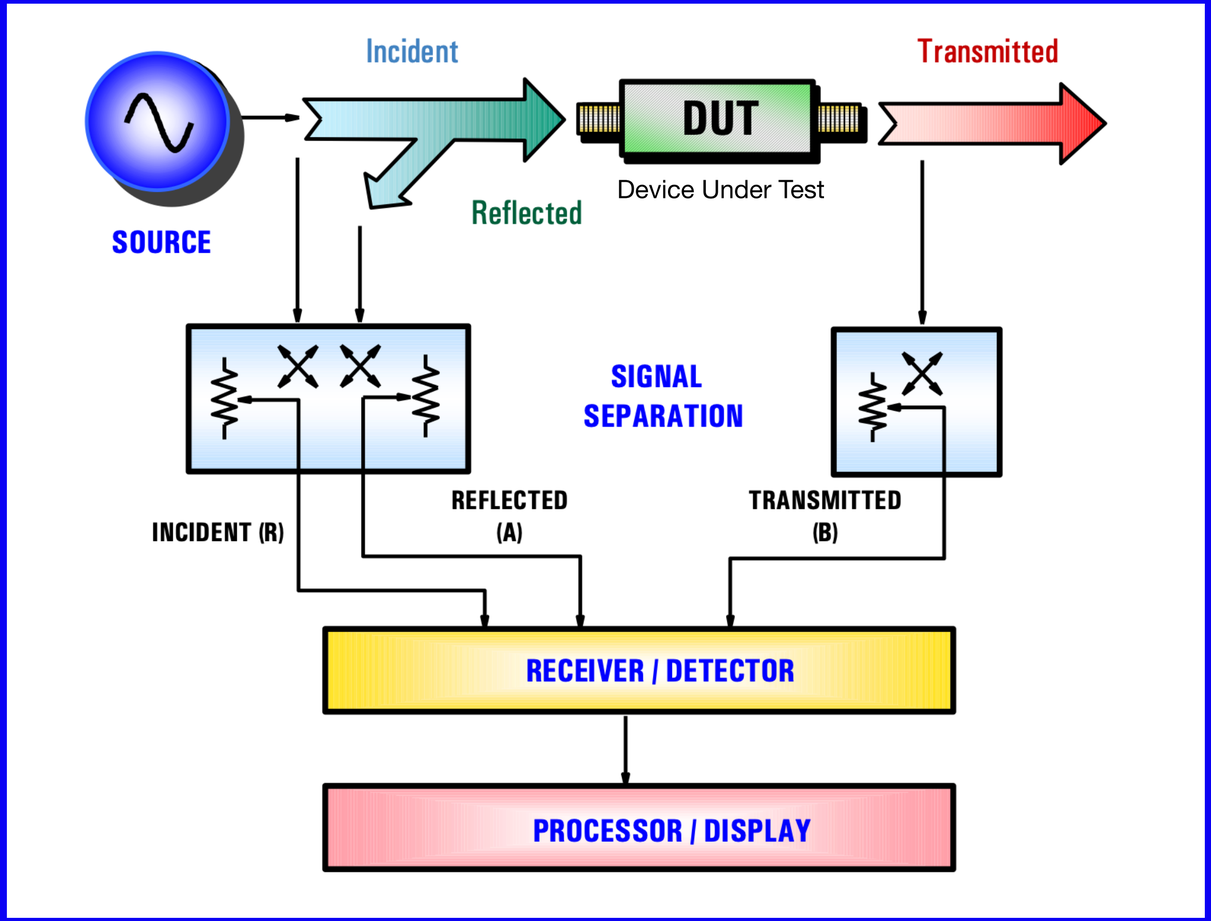
NanoVNA Measurements

Handheld, low cost Vector Network Analyzer "RF-multimeter" capable of measuring electrical parameters of antennas, filters & components to 1.5 GHz

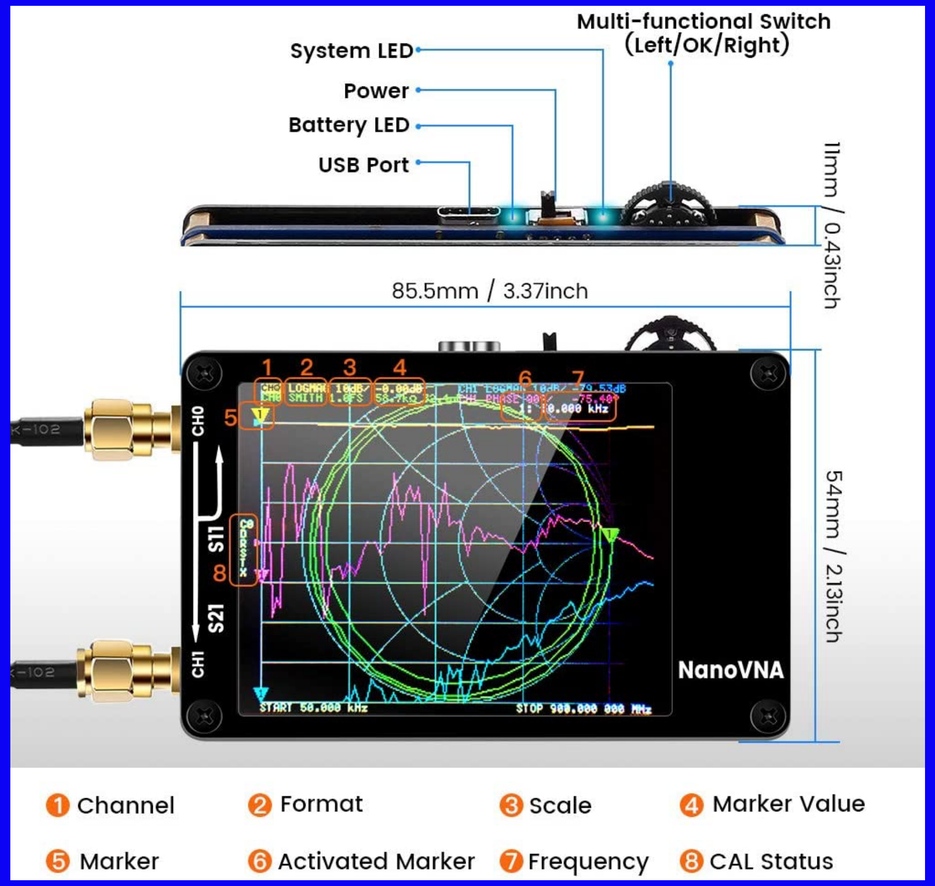
S11 Reflection	S21 Transmission
– Antenna measurements-VSWR	– Baluns, Chokes
– Complex load impedance	- Frequency response
– Power splitters, Diplexers	- Attenuators (flatness, delay)
– Filter return loss	– Power splitters
– Amplifier return loss	– Phasing networks
– Cable impedance	– Crystals, Resonances, Impedances
– Feed line length	– Amplifier gain, Delay
– Distance to fault	– Cable loss, length, velocity factor

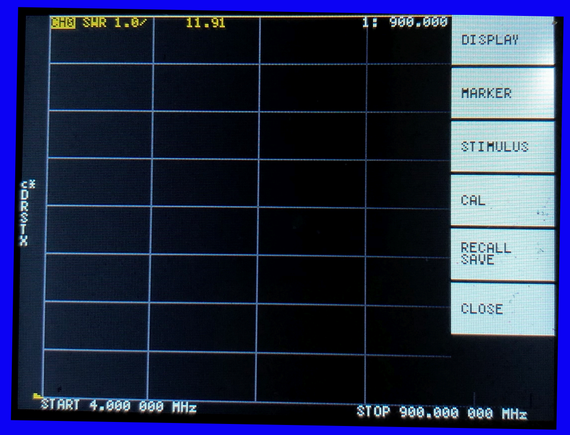
Signal Generator!

Vector Network Analyzer Block Diagram

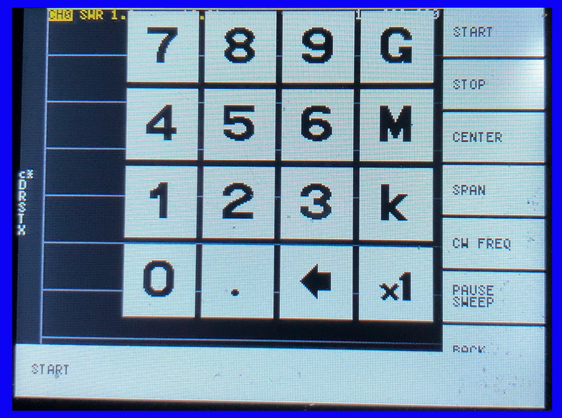


NanoVNA User Interface





Traces, Formats, Scale, Channels
Add, Function, Search
Start, Stop, Center, Span
Calibration



Data Entry

Words To Know

- Display (root menu)
- Trace (one of four possible line/chart drawings)
  -Traces can be toggled on and off
- Format (goes with a trace-how you want the data displayed)
- Stimulus (goes with a trace-sets the limits on the data display)

NanoVNA Measurement Configuration*

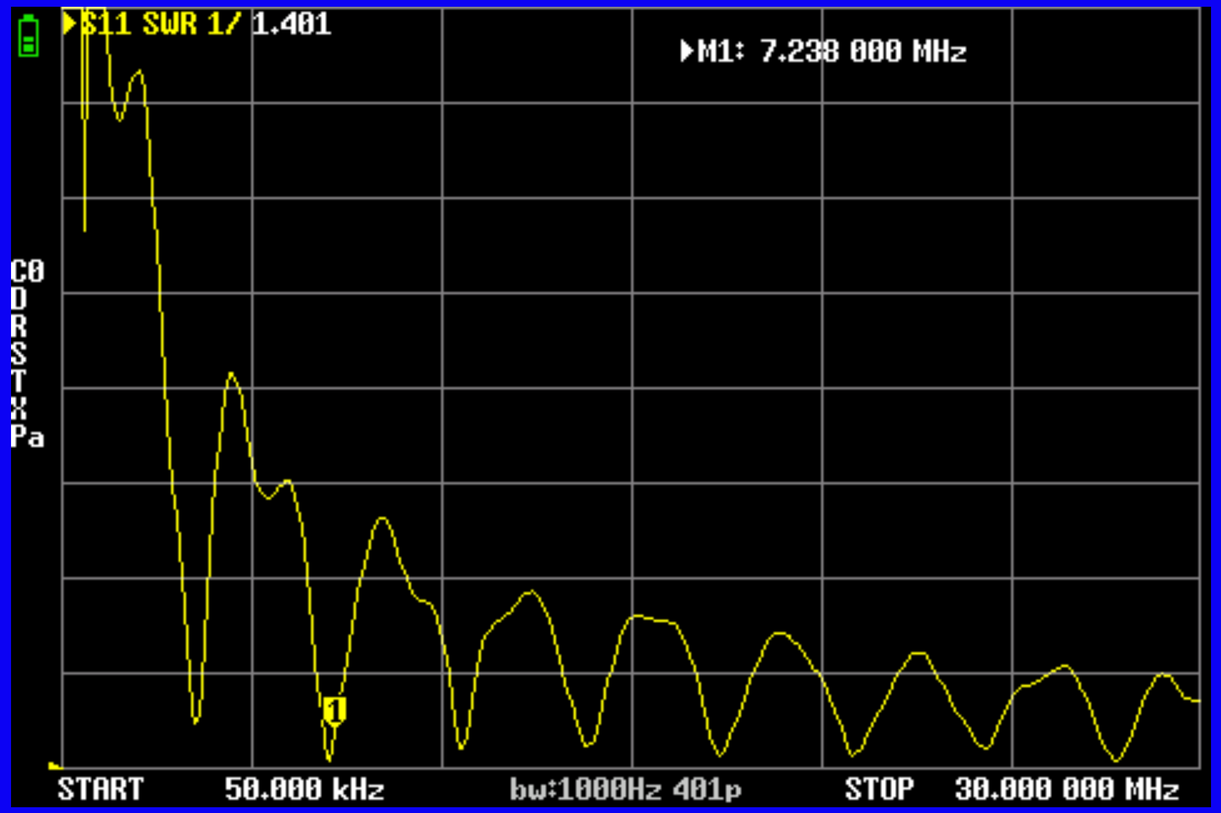
Configure NanoVNA for the type of measurement:

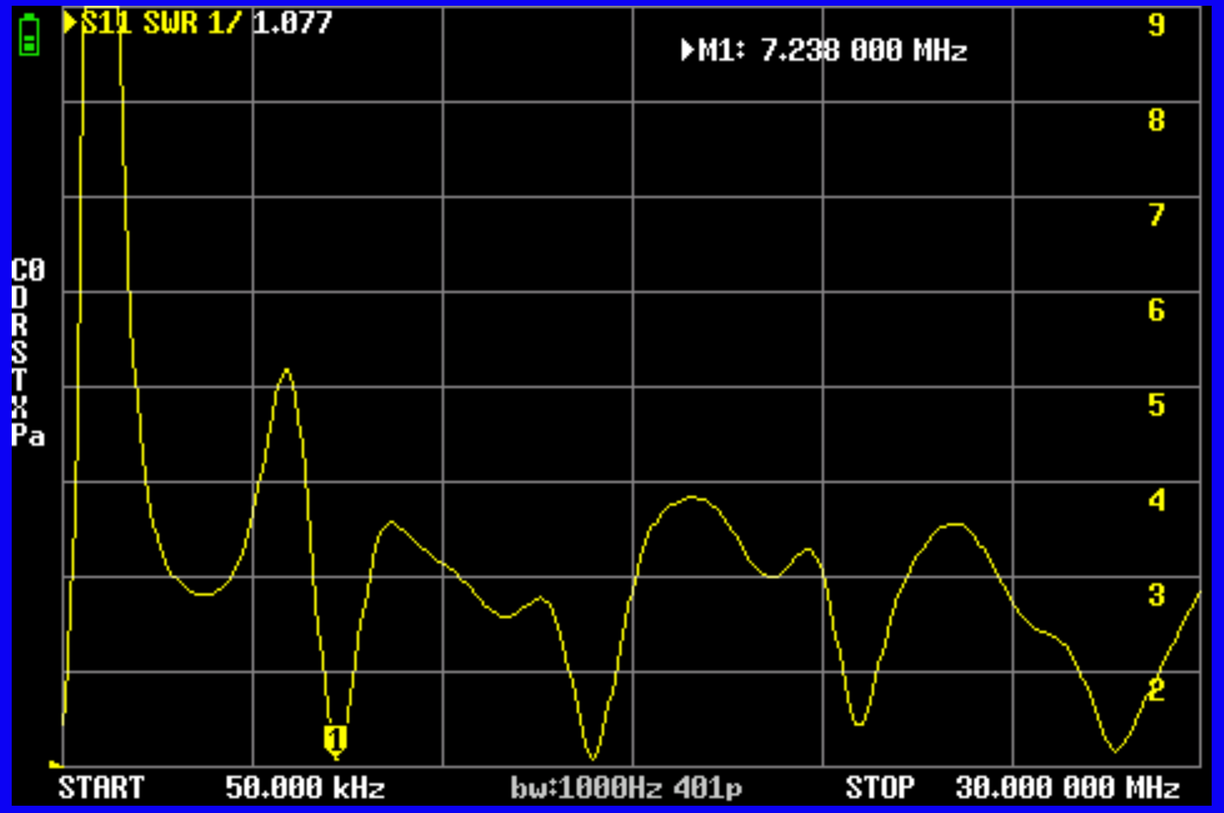
- Traces to display (up to four)
- Format
- Channel (CH0 REFLECT or CH1 THROUGH)
- Scale for each trace separately
- Reference position
- Stimulus frequency range (sweep frequency)
- Calibrate the NanoVNA

Calibration (done last) also saves the settings, so you can “recall” a whole setup e.g. SWR

* Absolute Beginner’s Guide to NanoVNA , Martin Svaco, 9A2JK

SWR
80 & 40 M Loops





NanoVNA References

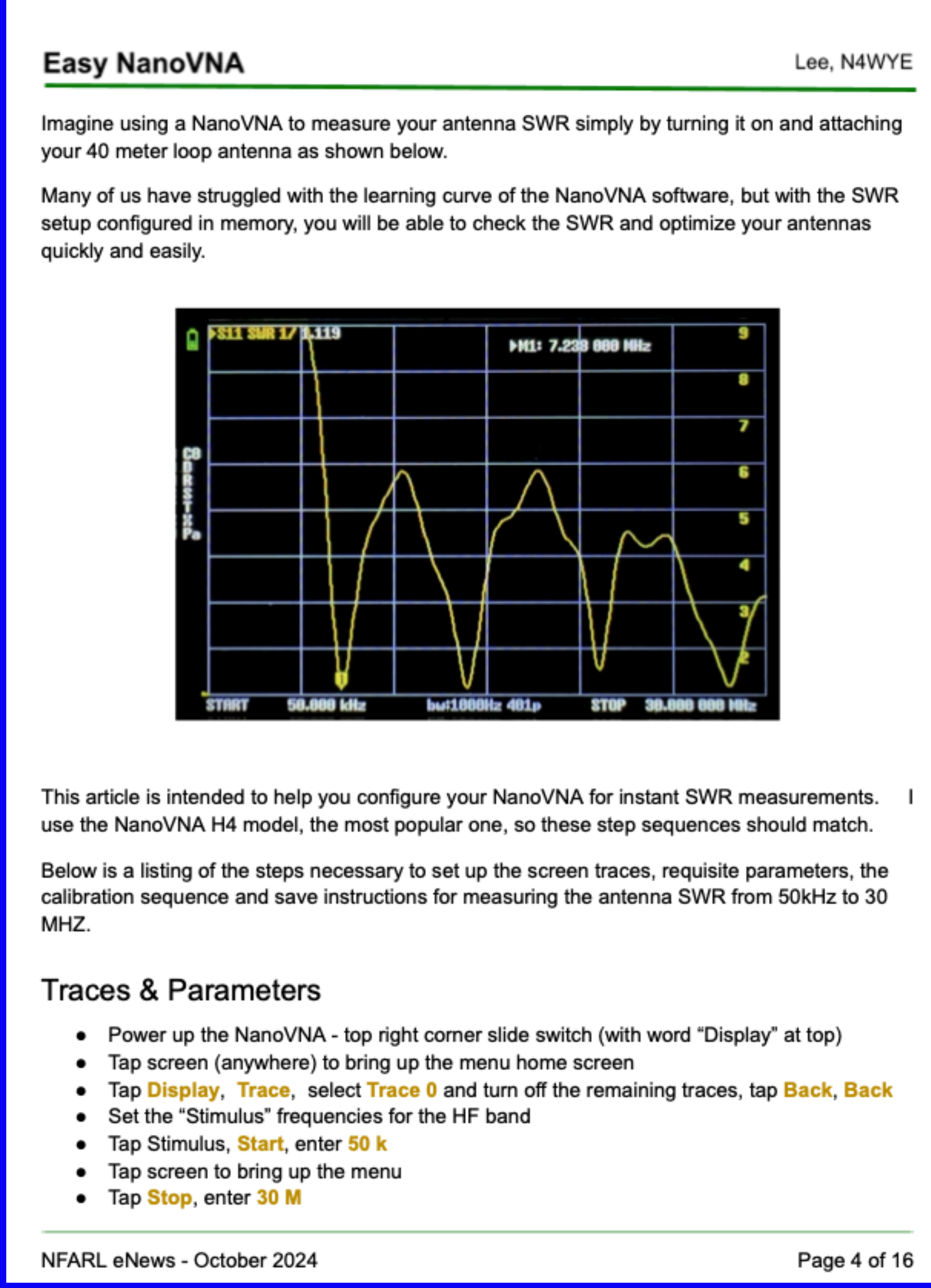
Links to “Easy NanoVNA” set up on NFARL.org

- https://nfarl.org/enews/eNews_2024-10.pdf
- https://nfarl.org/enews/eNews_2024-11.pdf

NanoVNA Made Simple
https://www.youtube.com/watch?v=QJYeFpiqY8c&t=435s

How to use the NanoVNA to sweep / measure antenna SWR
https://www.youtube.com/watch?v=xa6dqx9udcg

NanoVNA groups.io Forum
https://groups.io/g/nanovna-users



Easy NanoVNA Lee, N4WYE

Imagine using a NanoVNA to measure your antenna SWR simply by turning it on and attaching your 40 meter loop antenna as shown below.

Many of us have struggled with the learning curve of the NanoVNA software, but with the SWR setup configured in memory, you will be able to check the SWR and optimize your antennas quickly and easily.

This article is intended to help you configure your NanoVNA for instant SWR measurements. I use the NanoVNA H4 model, the most popular one, so these step sequences should match.

Below is a listing of the steps necessary to set up the screen traces, requisite parameters, the calibration sequence and save instructions for measuring the antenna SWR from 50kHz to 30 MHZ.

Traces & Parameters

- Power up the NanoVNA - top right corner slide switch (with word “Display” at top)
- Tap screen (anywhere) to bring up the menu home screen
- Tap Display, Trace, select Trace 0 and turn off the remaining traces, tap Back, Back
- Set the “Stimulus” frequencies for the HF band
- Tap Stimulus, Start, enter 50 k
- Tap screen to bring up the menu
- Tap Stop, enter 30 M

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Getting out Where

Finite-difference time-domain

Why Model an Antenna?

- It's difficult to calculate, assemble, raise, adjust and optimize a physical antenna.
- It's time-consuming to measure the gain, radiation pattern, and efficiency of a real antenna.
- Antenna models can tell us much about efficiency, pattern, gain and input impedance.
- It's FAST - We can iterate through a lot of models and quickly focus on those that are the most useful.
  - Properly done, it very accurate
  - Improperly done, it can generate nonsense

MMANA-GAL Functionality

Create multi-element antenna designs and evaluate for matching and radiation pattern

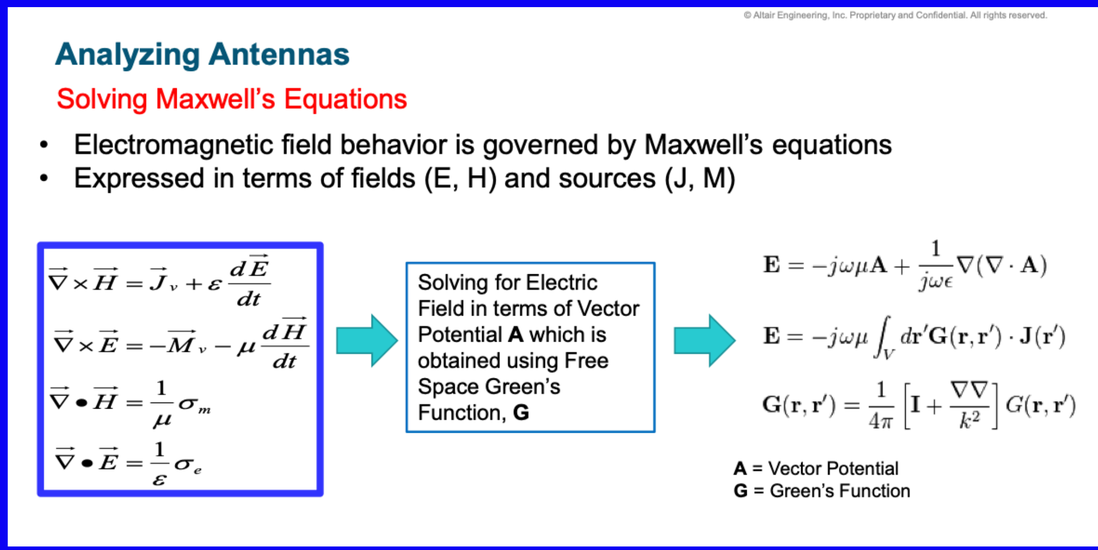
Graphical User Interface

Automatic antenna optimizer for SWR, R, jX, F/B, Elevation & Current

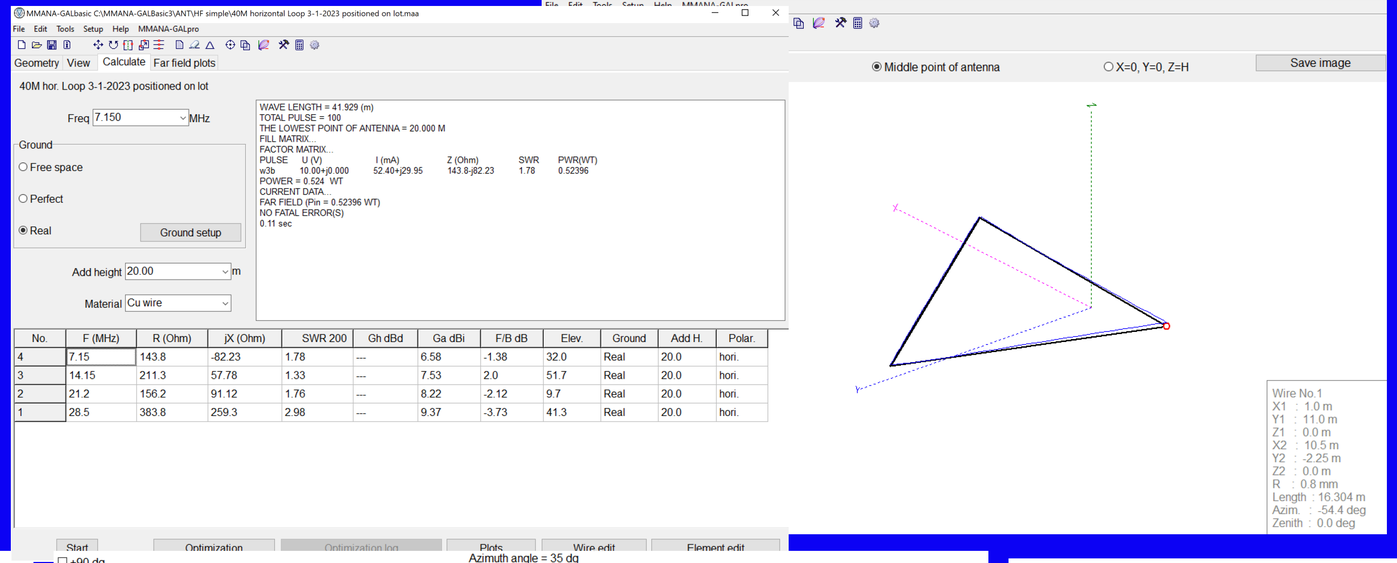
Plots for horizontal, vertical and 3D beam radiation patterns

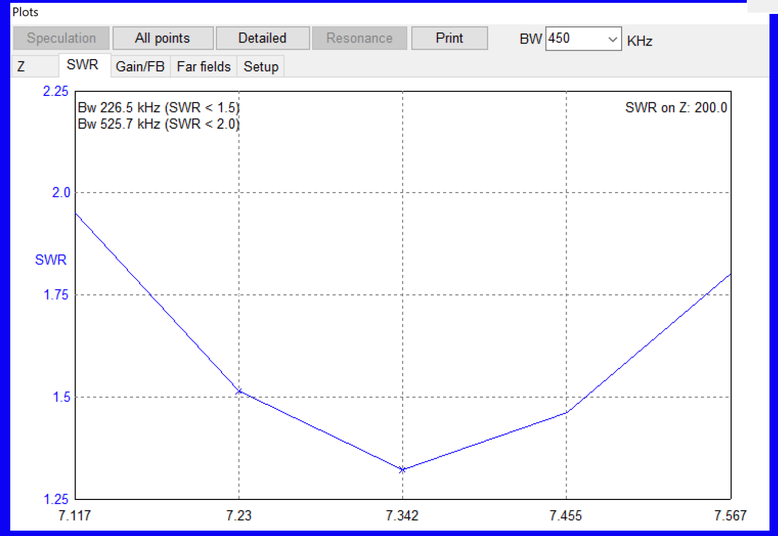
Frequency characteristics plots

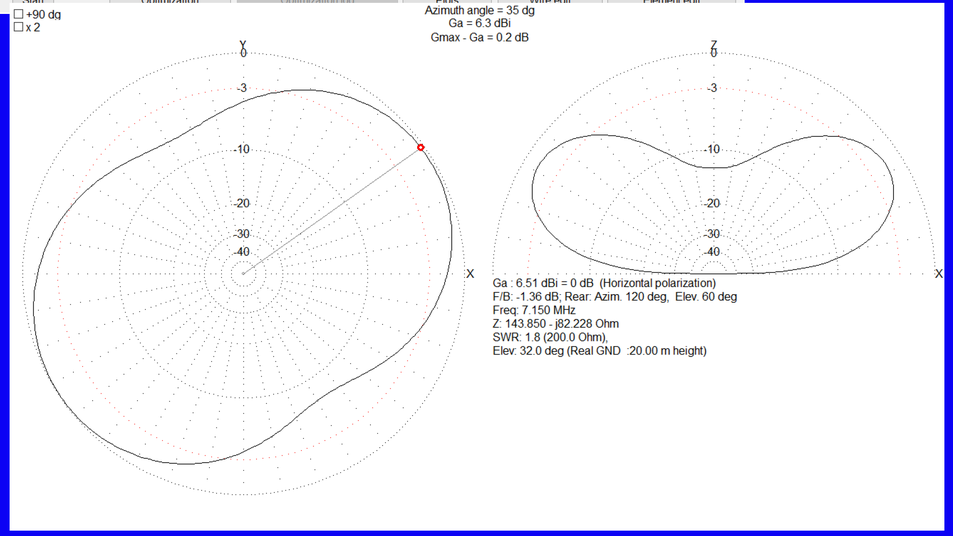
Data file generator-library

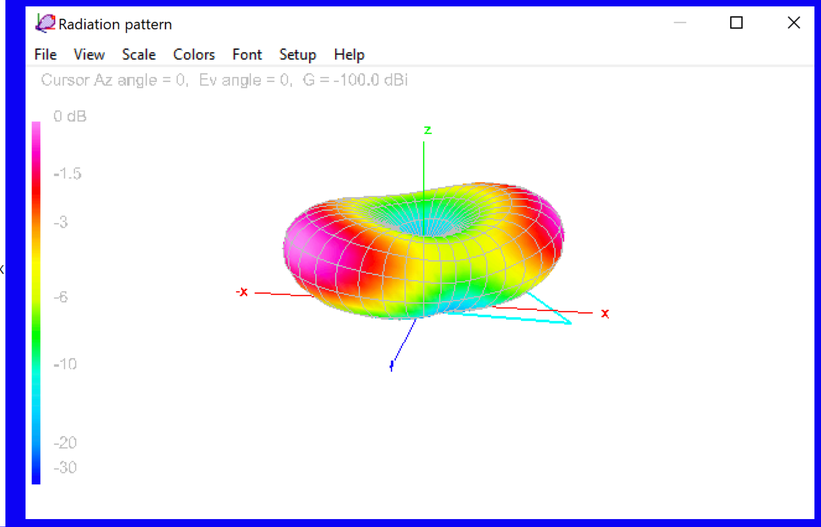


40M Horizontal Loop Antenna

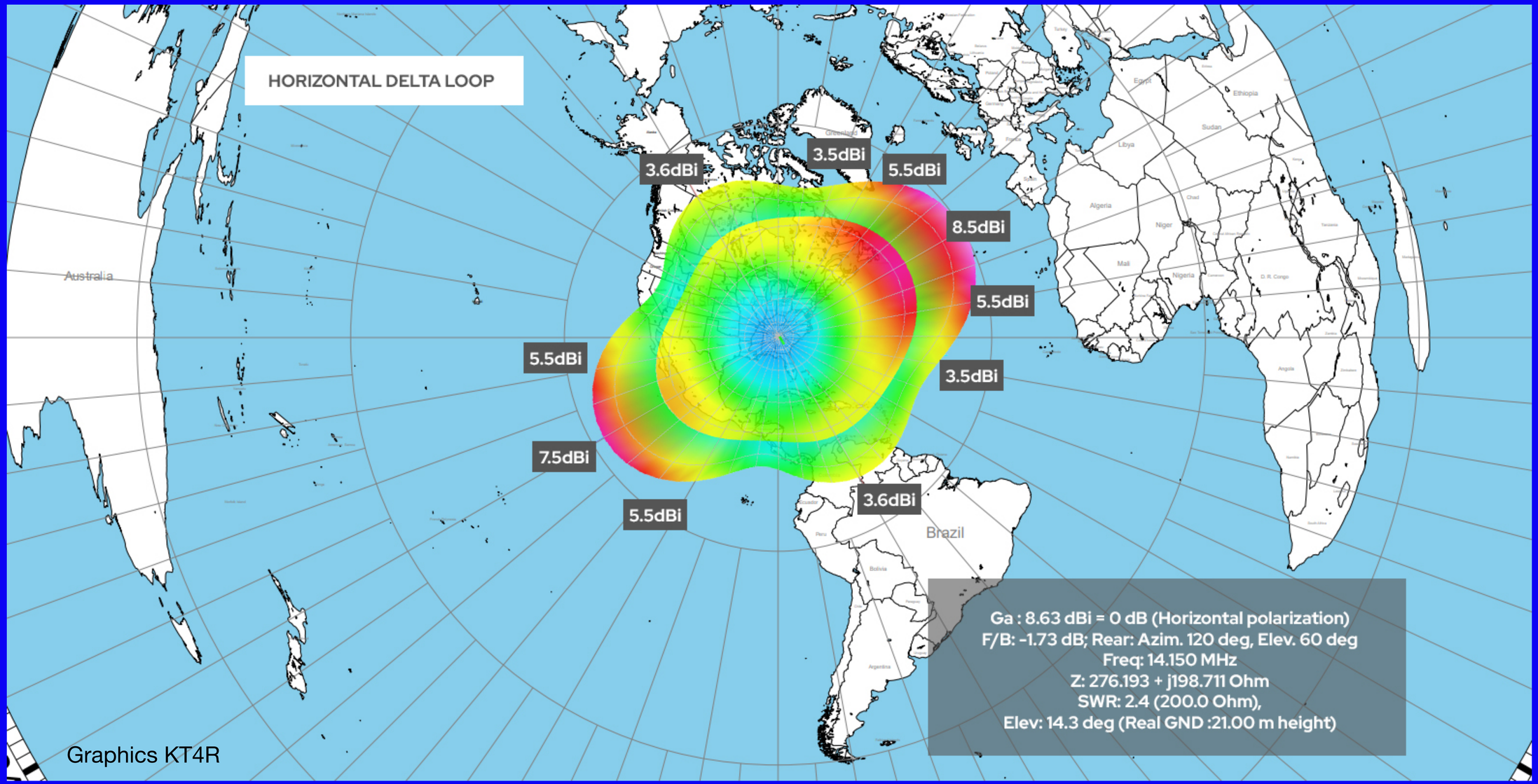




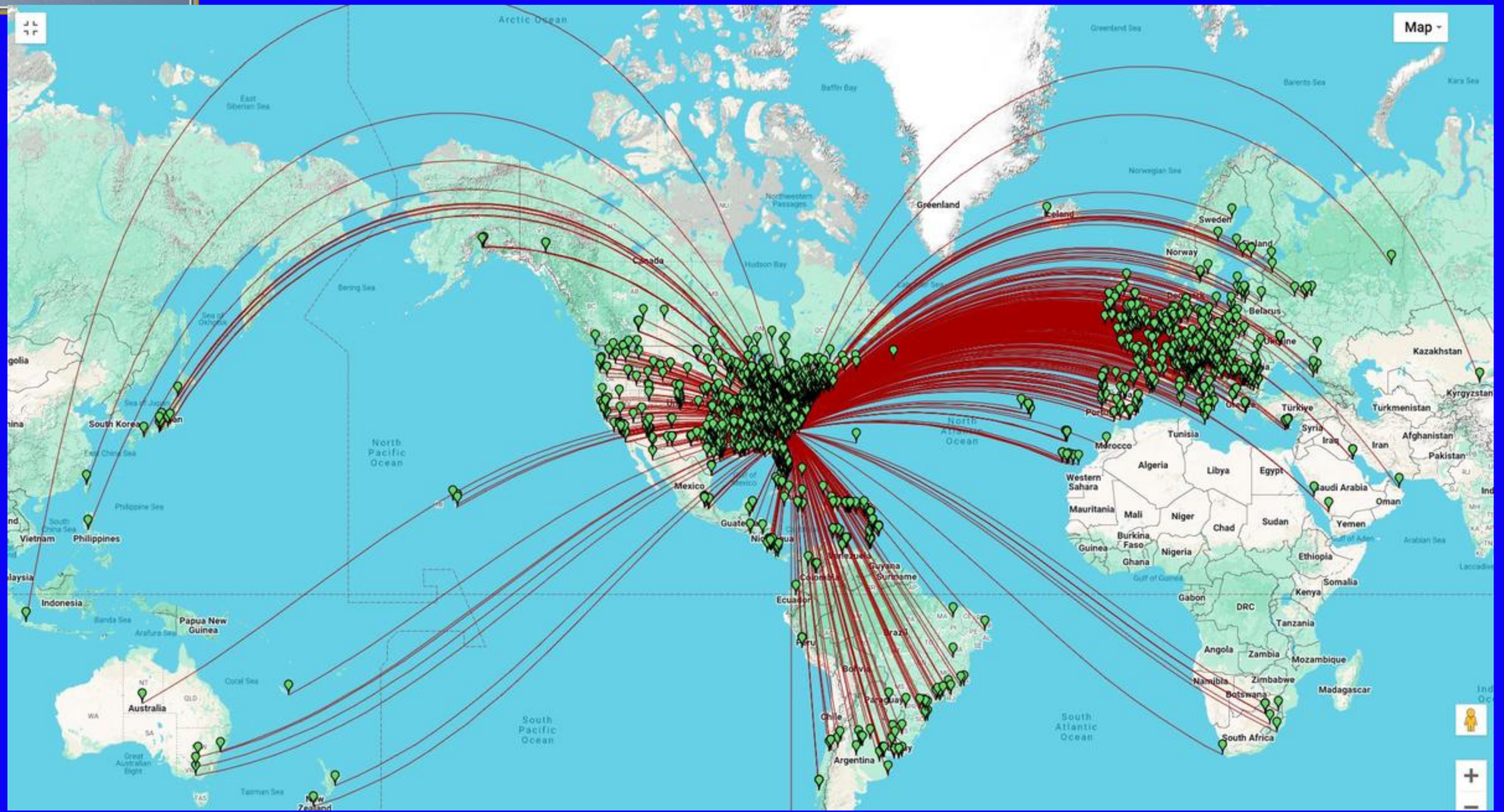




20M Propagation Pattern
40M Loop

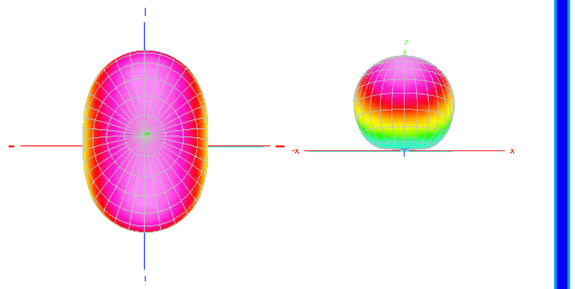


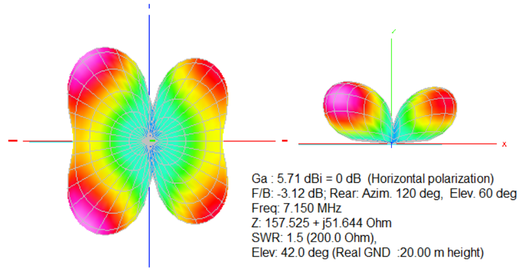
ARRL International DX Phone Contest
40M Low Power Winner KT4R

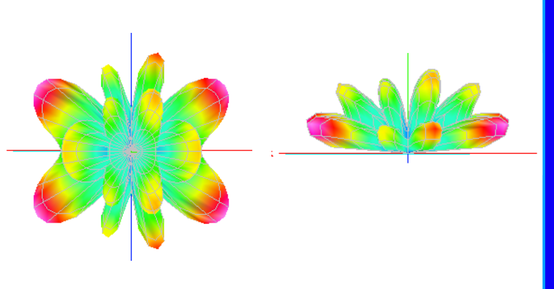


Optimize Your Antennas

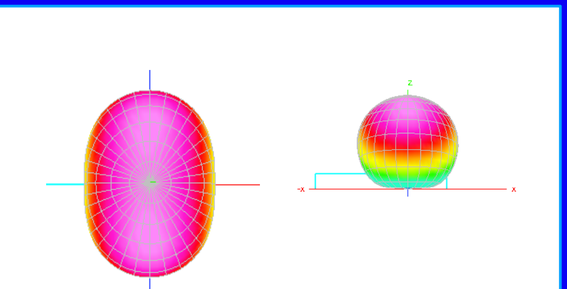
Horizontal
OCF Dipole

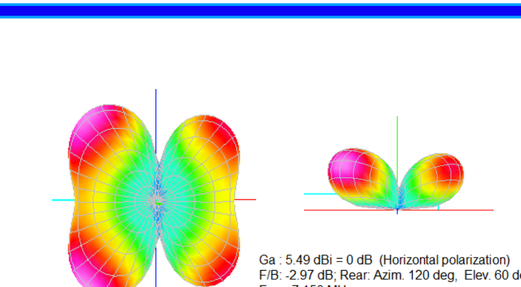


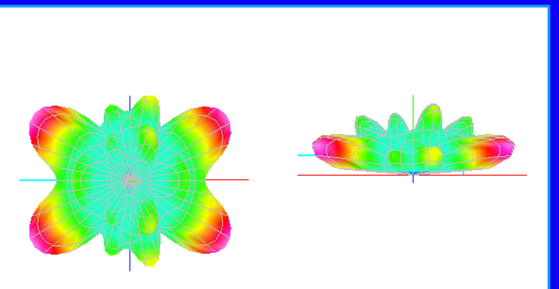




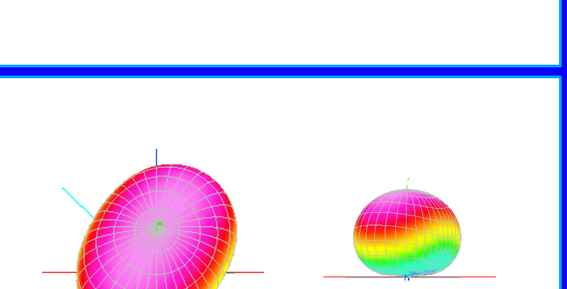
Horizontal
13’ vertical ends



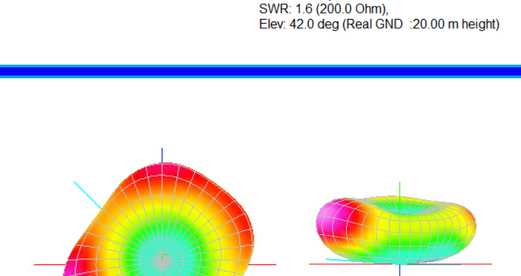




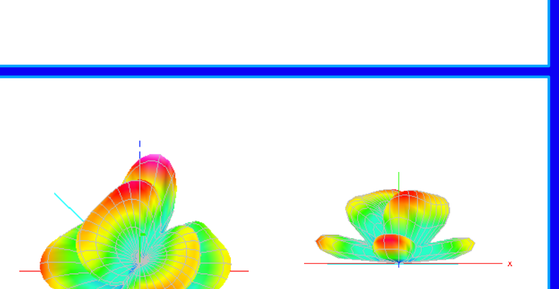
Horizontal
legs @135 degrees



80M



40M



20M

MMANA-GAL
What It Does

You describe the antenna to the program…..

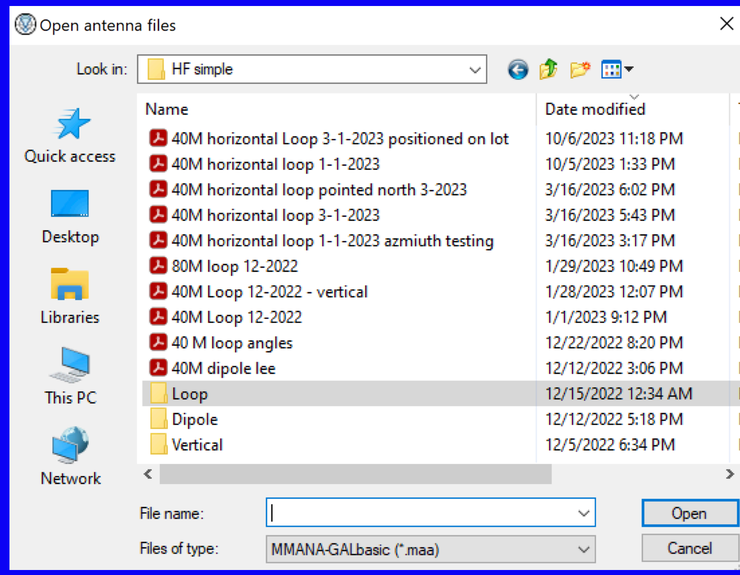
- Wire lengths, diameters, positions
- Source placement
- Loads, transformers, L networks
- Non-radiation transmission lines (incl. loss if desired)
- Ground

Program tells you

- Radiation Patterns 3D
- Automatic Optimizer (SWR, jX, Gain, F/B, Elevation)
- Frequency characteristics charts
- Antenna comparison
- Interaction with other antennas and conductors*

Practice the Familiar

- Start with “known-good”models
- Familiar antennas (dipoles, verticals, loops)
- Study beam basics (Yagis & phased arrays)
- Reproduce validated results
- Small changes in design should result in small changes in performance
- Add small features to “known-good” models



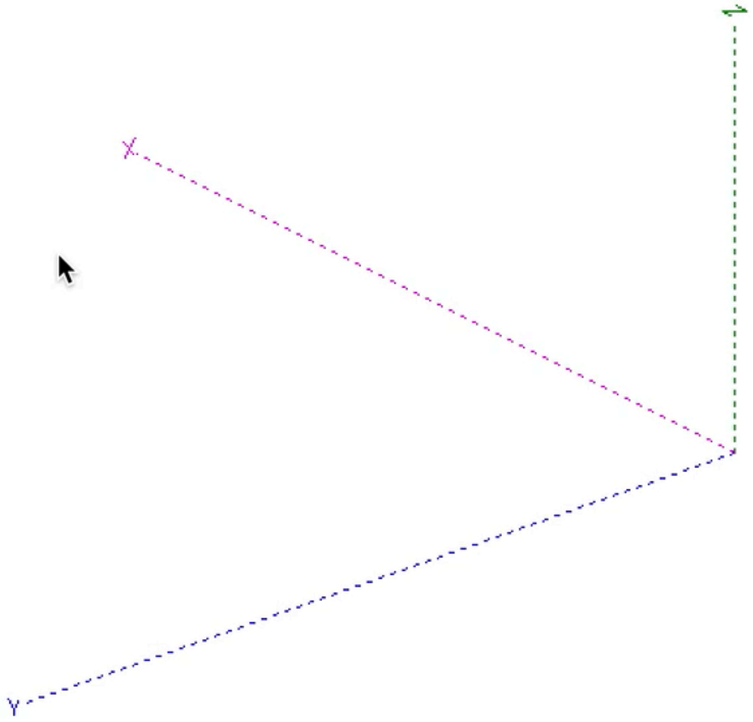
MMANA-GALbasic

File Edit Tools Setup Help MMANA-GALpro

Geometry | View | Calculate | Far field plots

Rotate around : ○ Selected wire ◉ Middle point of antenna ○ X=0, Y=0, Z=H Save image

○ Source
× Load



Zoom currents

☑ Currents
☐ Segments

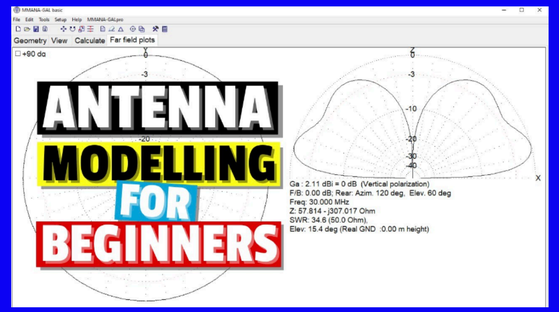
Zoom

Selected wire 0 ☐ Pen width x 2

Where to get MMANA-GAL Basic

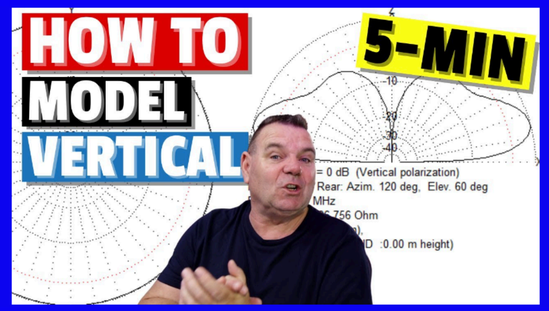
- Tutorials available on YouTube @ DX Commander
  https://www.youtube.com/results?search_query=DX+Commander+MMANA-GAL
- MMANA-GAL Basic version is free only for private, Non-commercial use
- Official Website http://gal-ana.de
- To get the basic version go to http://gal-ana.de/basicmm/en/ and click on “Download”
- Select “Download MMANA-GAL basic version”
- User Group: https://groups.io/g/mmana-gal
- Quickstart guide: http://gal-ana.de/basicmm/en/

MMANA YouTube videos
Callum, M0MCX - DX Commander



https://www.youtube.com/watch?v=dgBcYy6kwWs

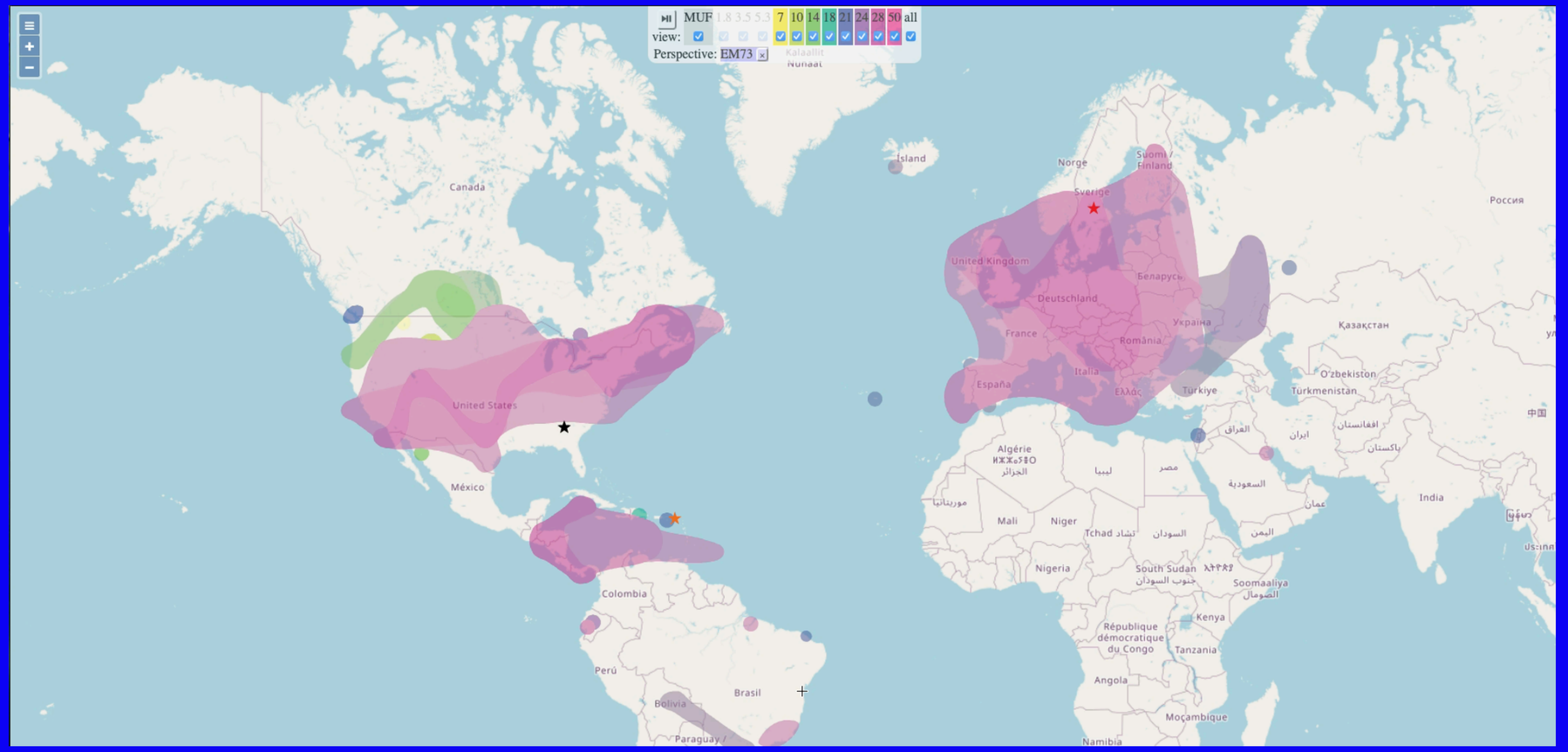
https://youtube.com/watch?v=iMBQiFAvcRo



https://youtube.com/watch?v=Dxedmw0dfjg

https://www.youtube.com/watch?v=AbKqqBmeacQ

Real-Time HF Propagation Visualization Tool



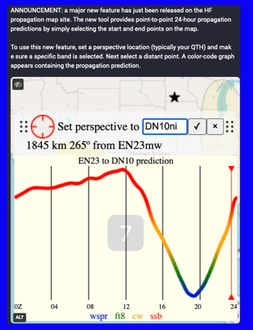
Real time HF Band Openings from the last 15 minutes

Point-to-point 24-hour propagation predictions by simply selecting the start and end points on the map.

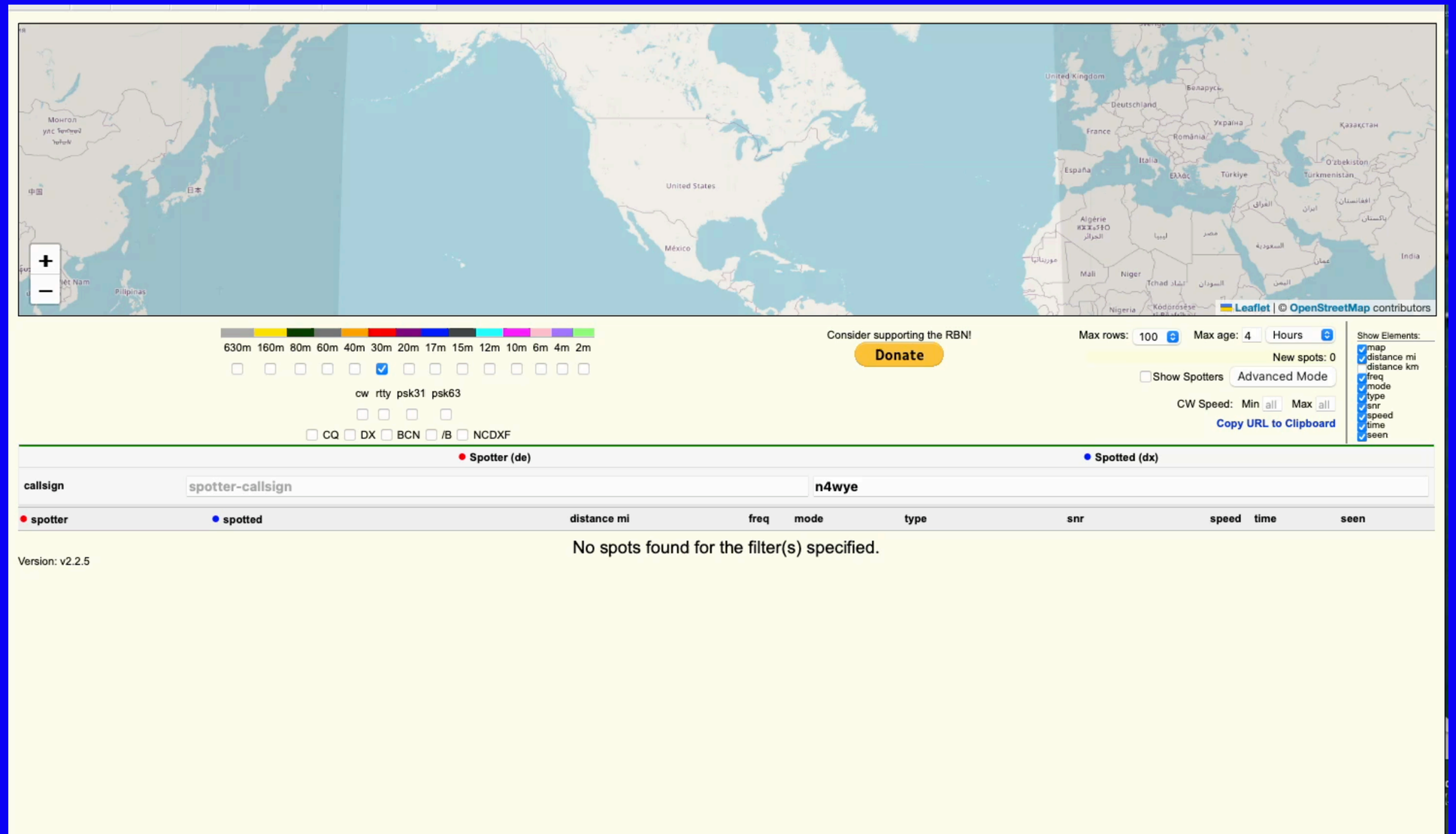
Data sources: WSPRnet, Reverse Beacon Network, PSKReporter & DX Cluster

Jon Harder, NG0E Also creator of the VHF Propagation Map Tool

https://hf.dxview.org/perspective/EM73hm



Reverse Beacon Network



Thank You

Q & A