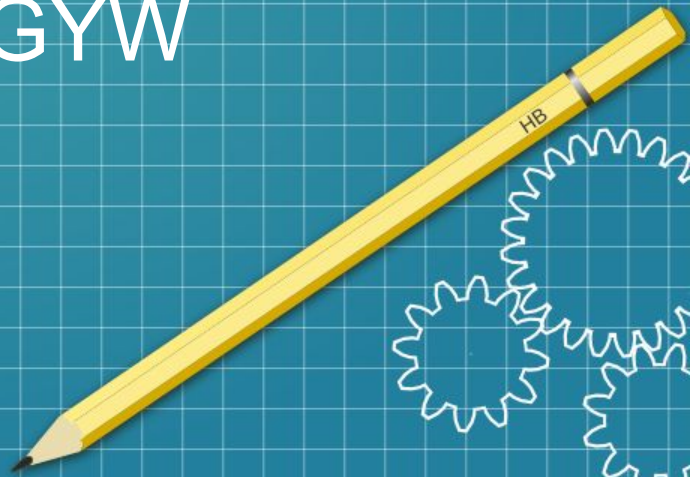
A multiband HF antenna for a small garden

Mike Dunstan G8GYW



Choosing the antenna

The Station Manager's Rules:

- No towers
- No guy ropes
- No dangling feeders

What does that leave?

- Magnetic loop – expensive, narrow band, high voltages
- End fed random wire– needs external ATU, high CM current on feeder
- End fed half wave – no ATU needed, low CM current

The challenges

Antenna design software

MMANA-GAL by DL2KQ & DL1PBD
Download from http://gal-ana.de/basicmm/en/ (basic version free)

4nec2 by Arie Voors
Download from https://www.qsl.net/4nec2/ (free)

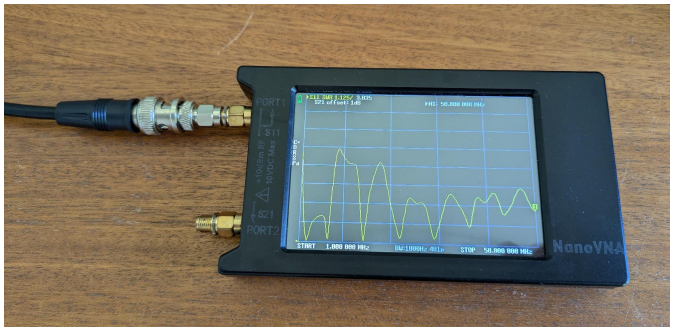
EZNEC by W7EL
Download from https://www.eznec.com/ (free)

AutoEZ Excel front end for EZNEC by AC6LA
Download from https://ac6la.com/autoez.html ($79)

AN-SOF
Download from https://antennasimulator.com/ (free trial)

Antenna test equipment

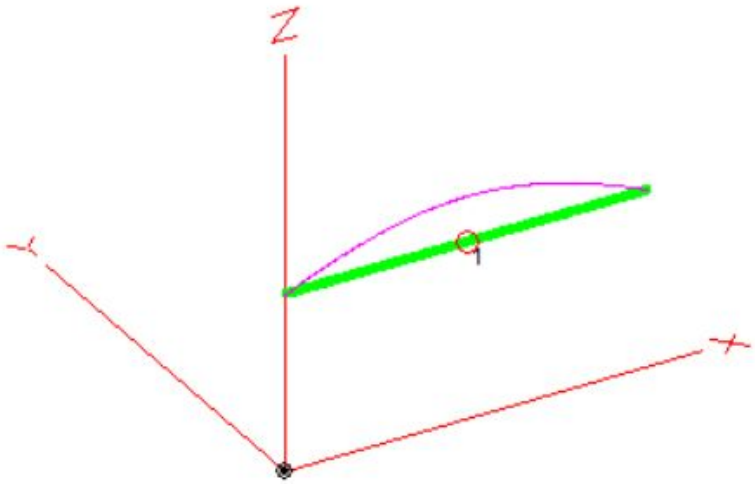
NanoVNA Vector Network Analyser with NanoVNA-App software

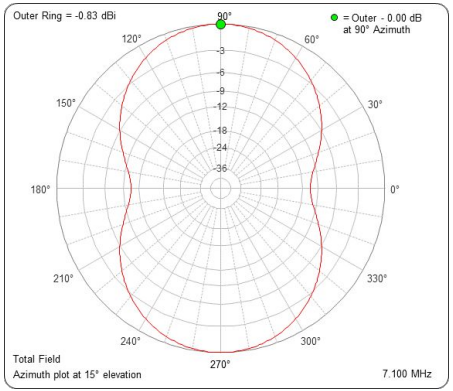


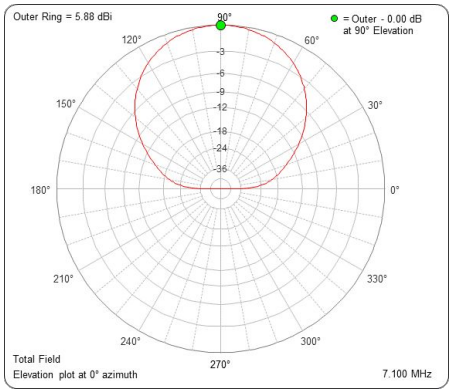
SDR-Kits FA-VA5 Vector Antenna Analyser with VNWA software



A basic 40m dipole



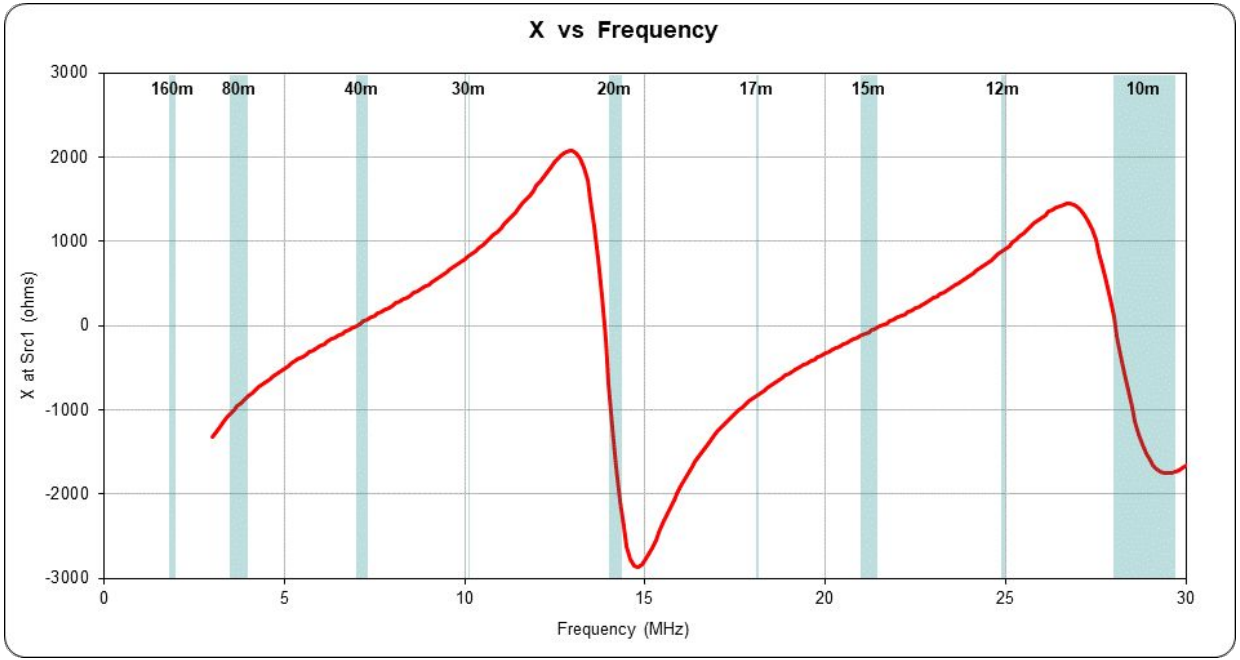




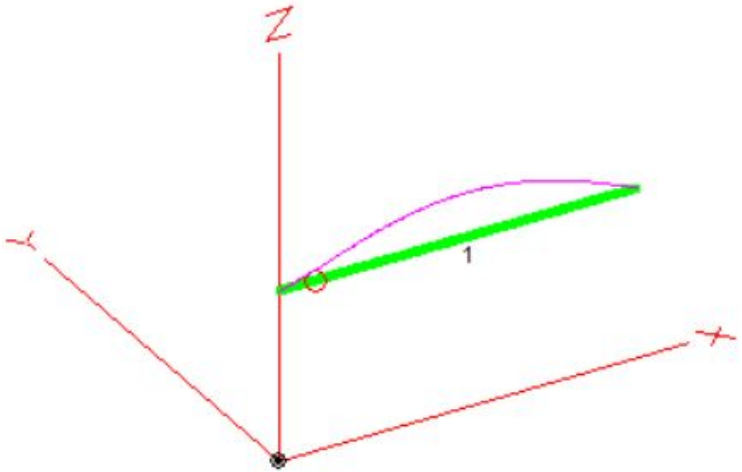
Height above average ground = 10m

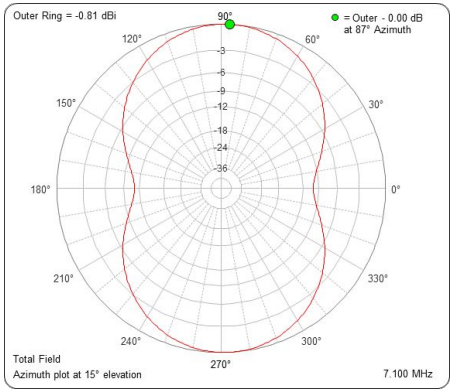
Wire length for 7.1MHz = 20.3m

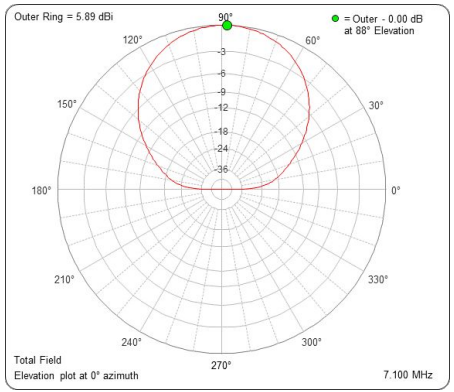
How many bands?



What if we move the feed point?



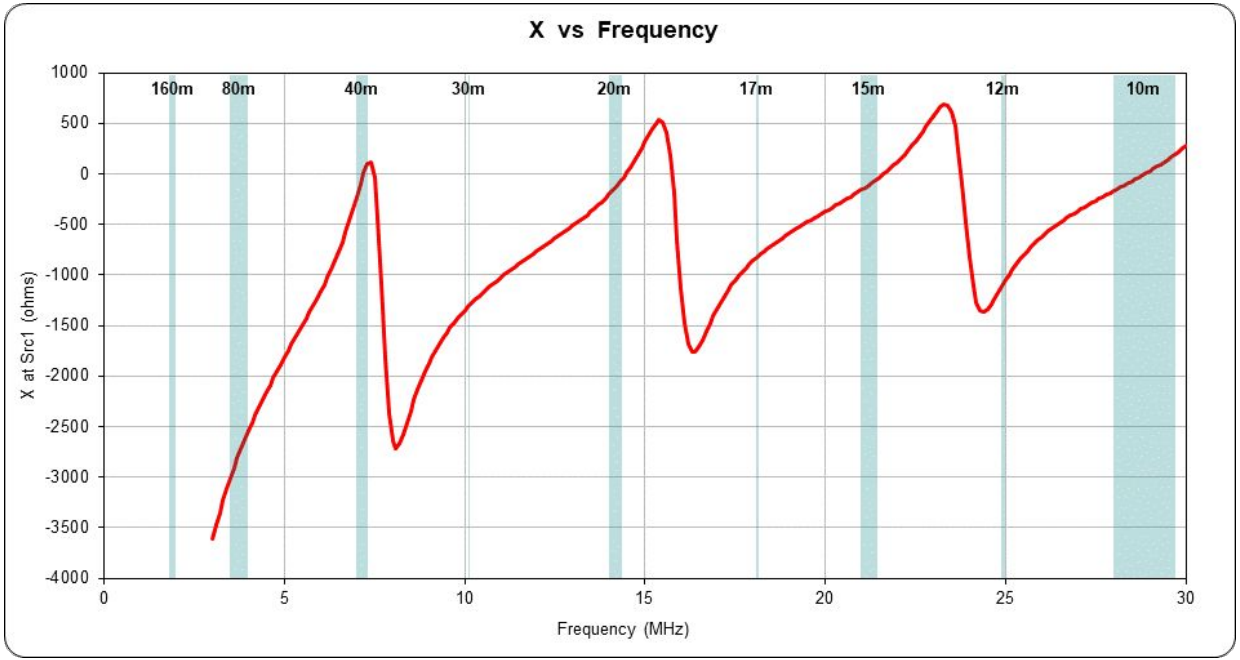




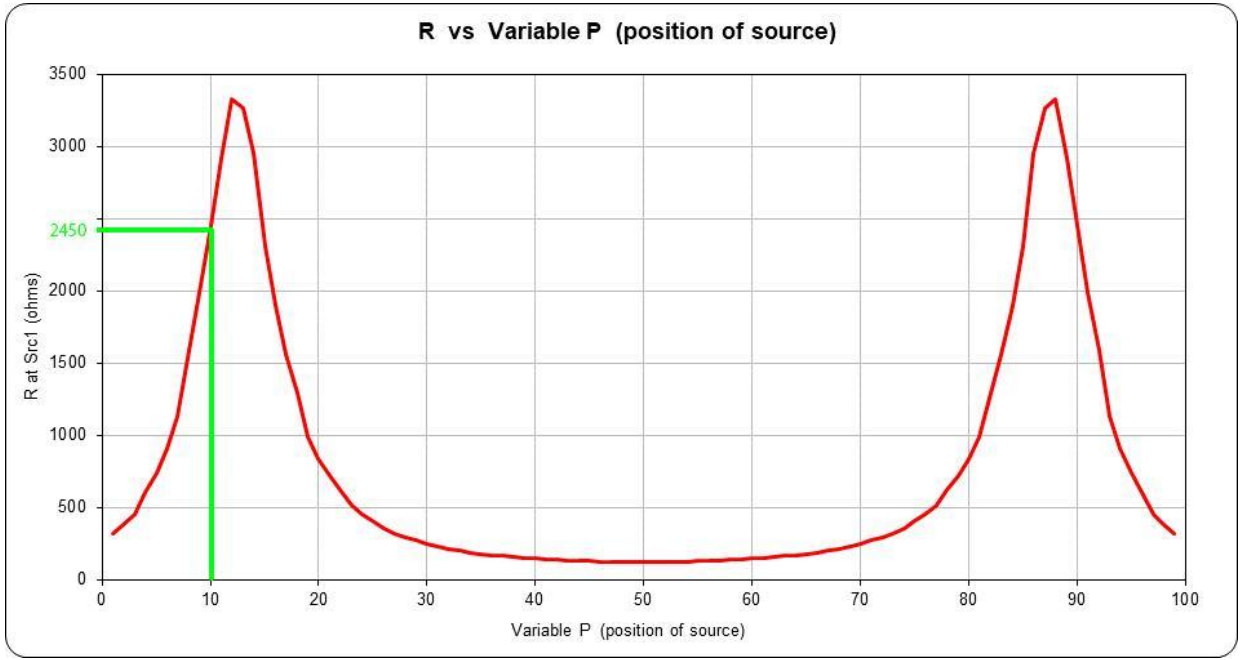
Height above average ground = 10m

Wire length for 7.1MHz = 20.8m

The resonances of an EFHW



Source resistance vs position



What is an UNUN?

An UNUN is an Unbalanced to Unbalanced transformer

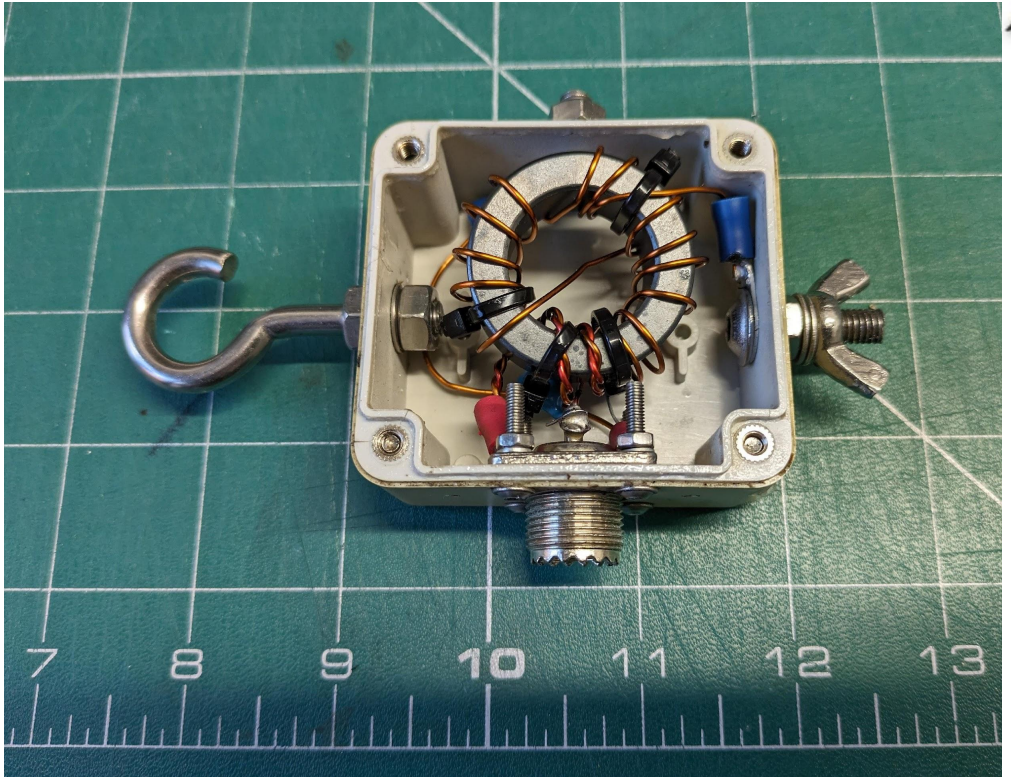
It is used to impedance match an unbalanced feeder (coax) to an unbalanced antenna (e.g. an End Fed Half Wave)

To match 2450 ohms to 50 ohms requires an impedance transformation of 49:1

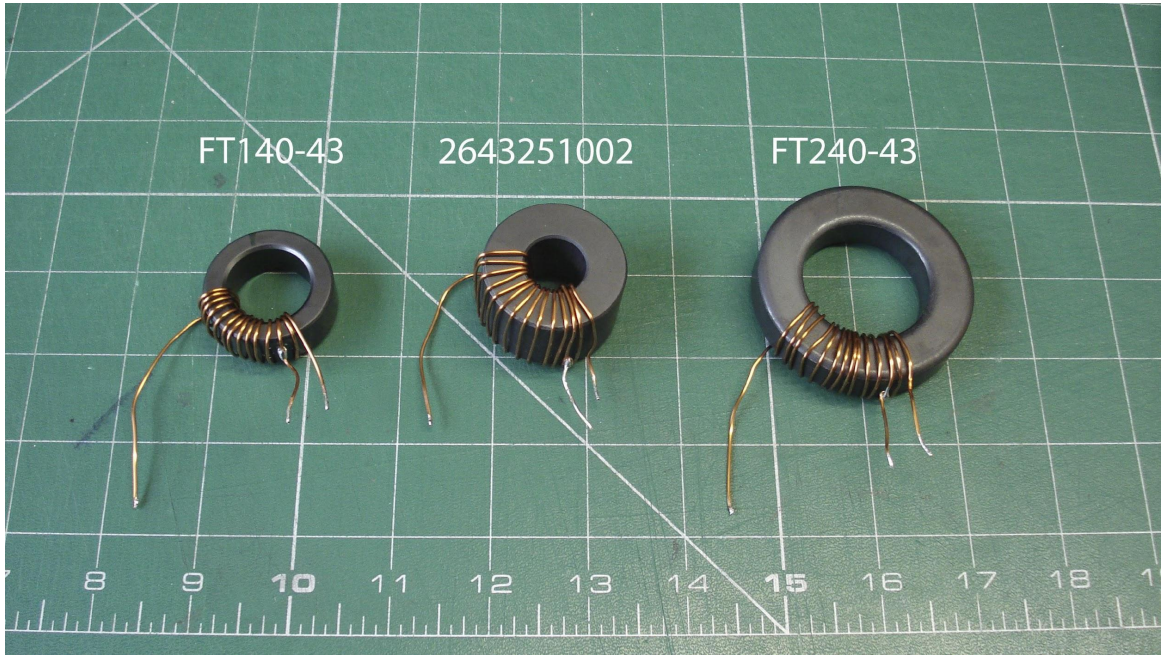
This is provided by a transformer turns ratio of 7:1

In practice, 14:2 is used to obtain the optimum primary inductance

A typical unun

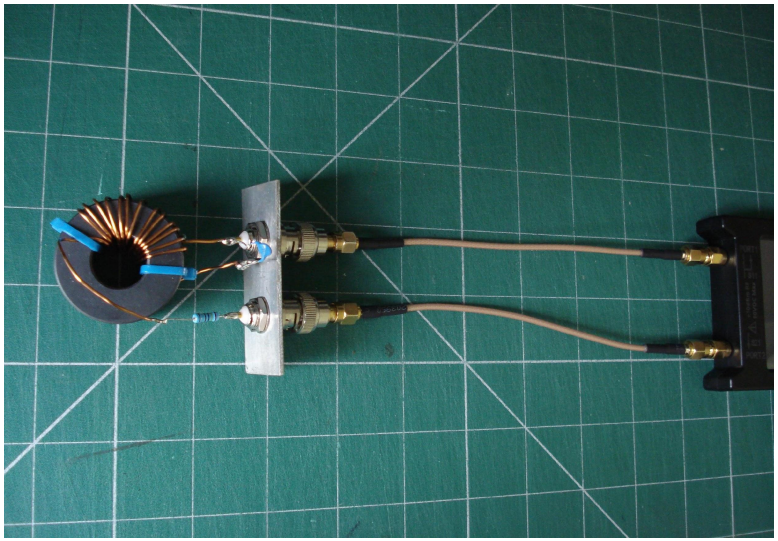


Fair-Rite Type 43 toroids



Testing the ununs

Measure the Return Loss and S21 Gain



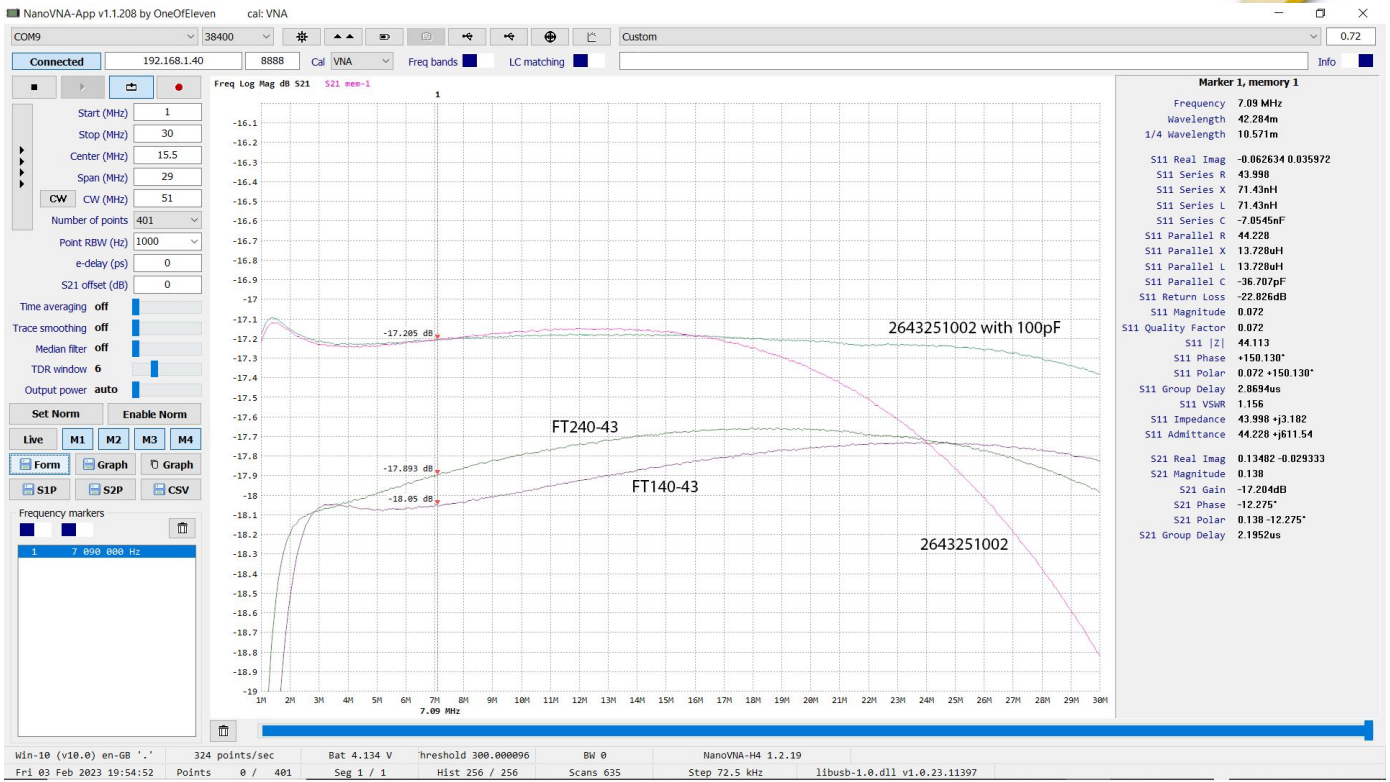
Resistive loss =

Mismatch Loss = $-10\log(1-\Gamma^2)$

Transformer loss = |S21| - 16.9 - mismatch loss

Transformer efficiency = 10^(-loss/10)

Testing the ununs

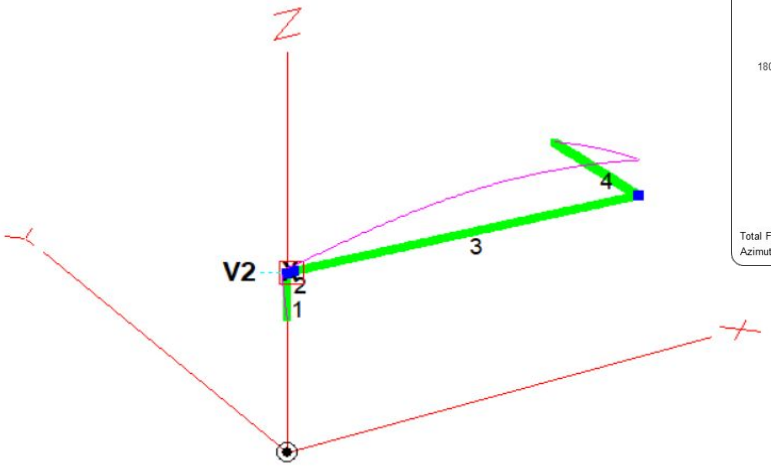


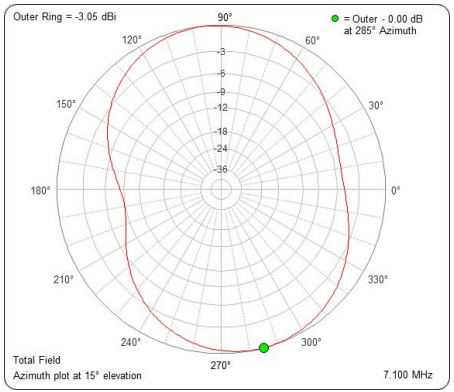
Comparing the cores

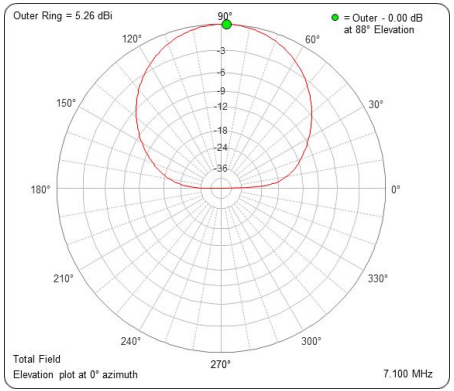
	7MHz		29MHz	
Core Type	**Loss dB**	**Efficiency %**	**Loss dB**	**Efficiency %**
FT140-43	1.42	72.1	0.84	82.4
FT240-43	1.26	74.7	0.77	83.7
2643251002	0.41	90.9	0.28	93.8

NOTE: Testing the FT240-43 core with a 3 turn primary gave efficiencies of 88.9% at 7MHz and 92.7% at 29MHz.

Making it fit the garden

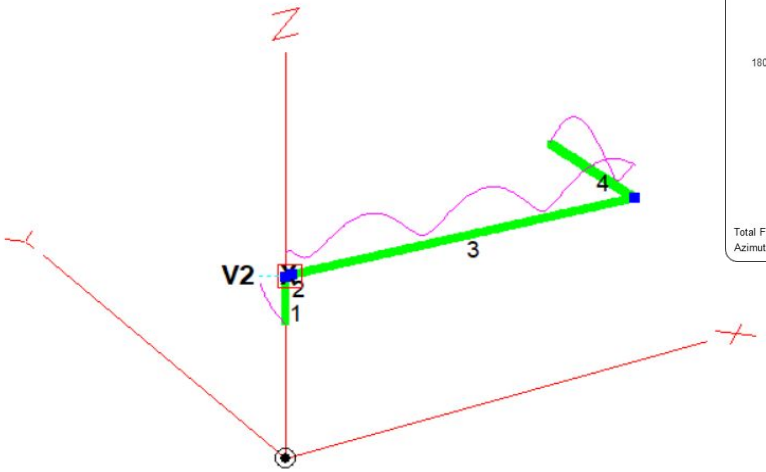




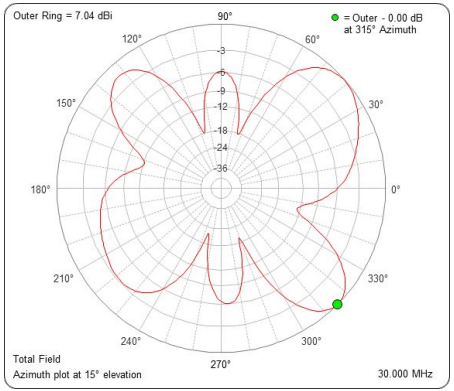


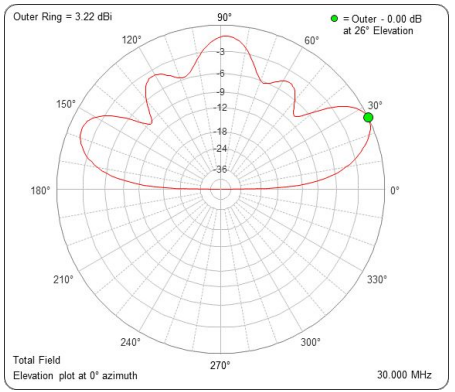
Current distribution at 7.1MHz

Making it fit the garden

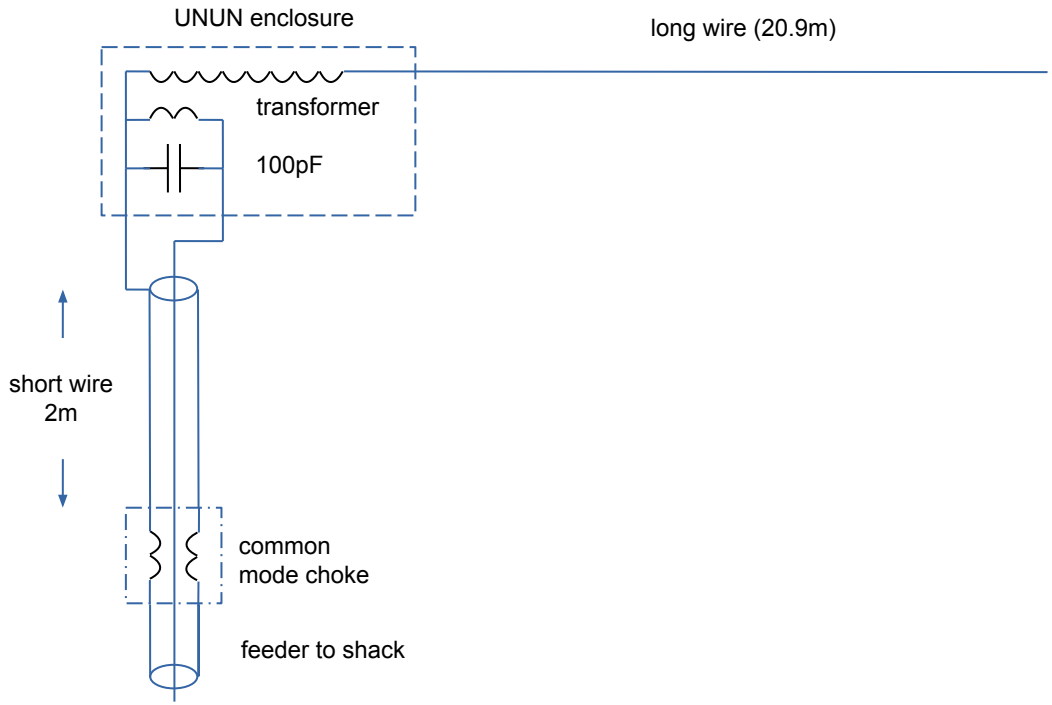


Current distribution at 30MHz

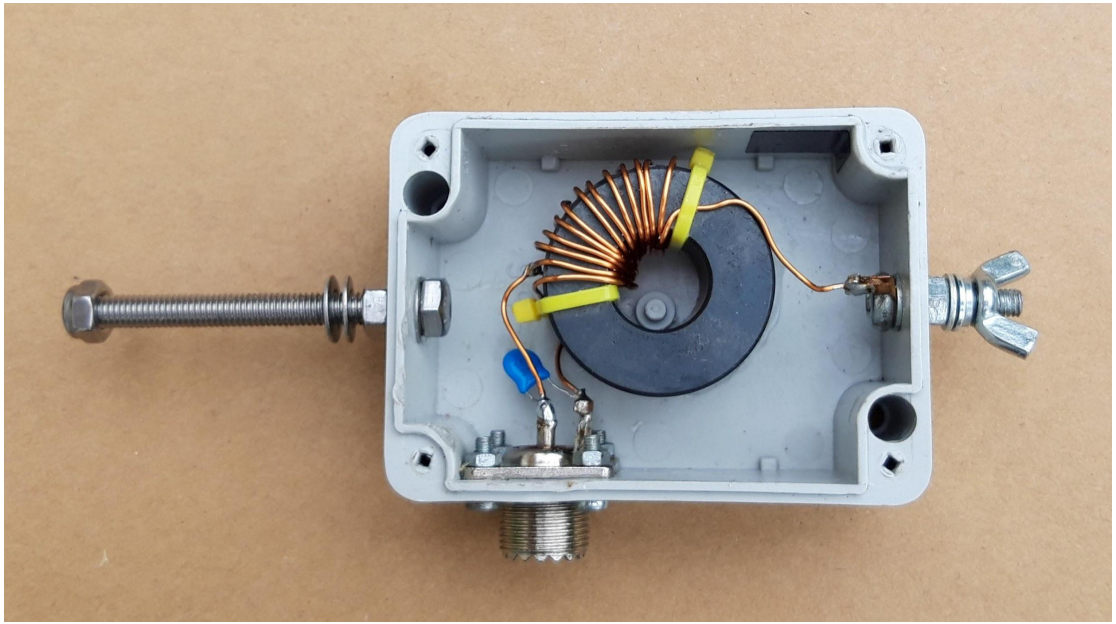




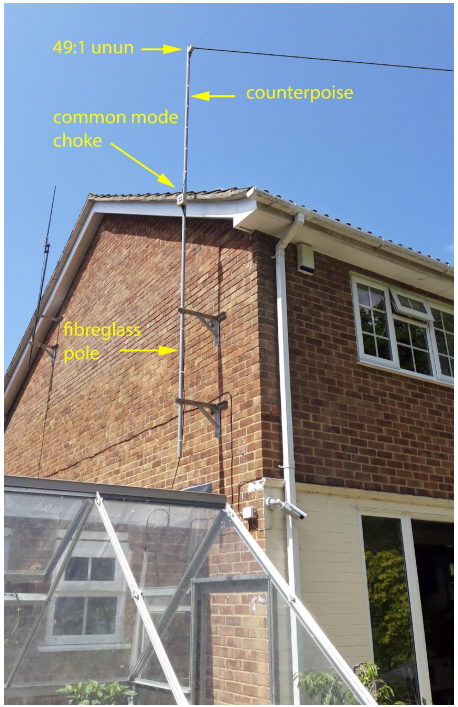
Building the antenna



Building the unun



Installing the antenna

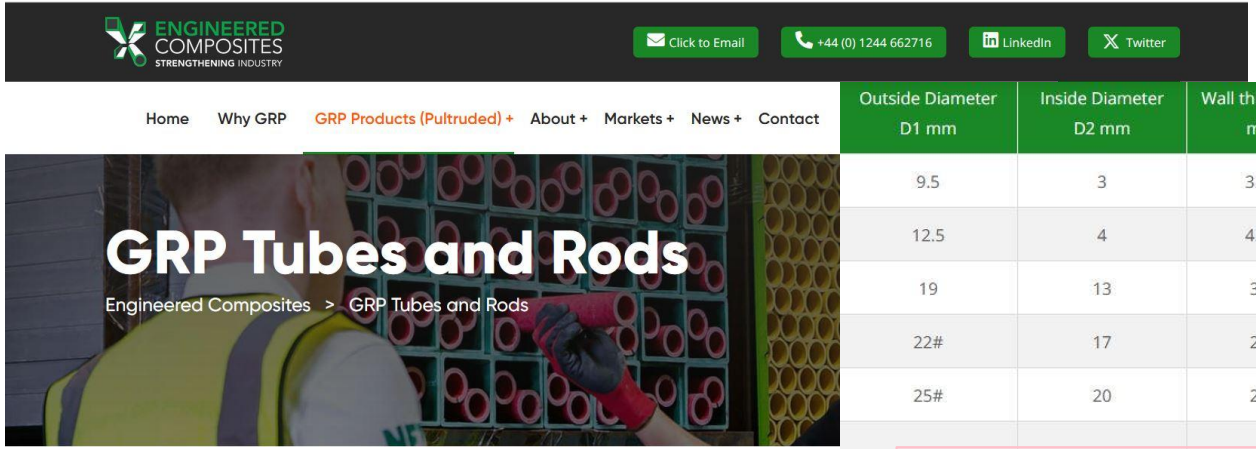




Installing the antenna



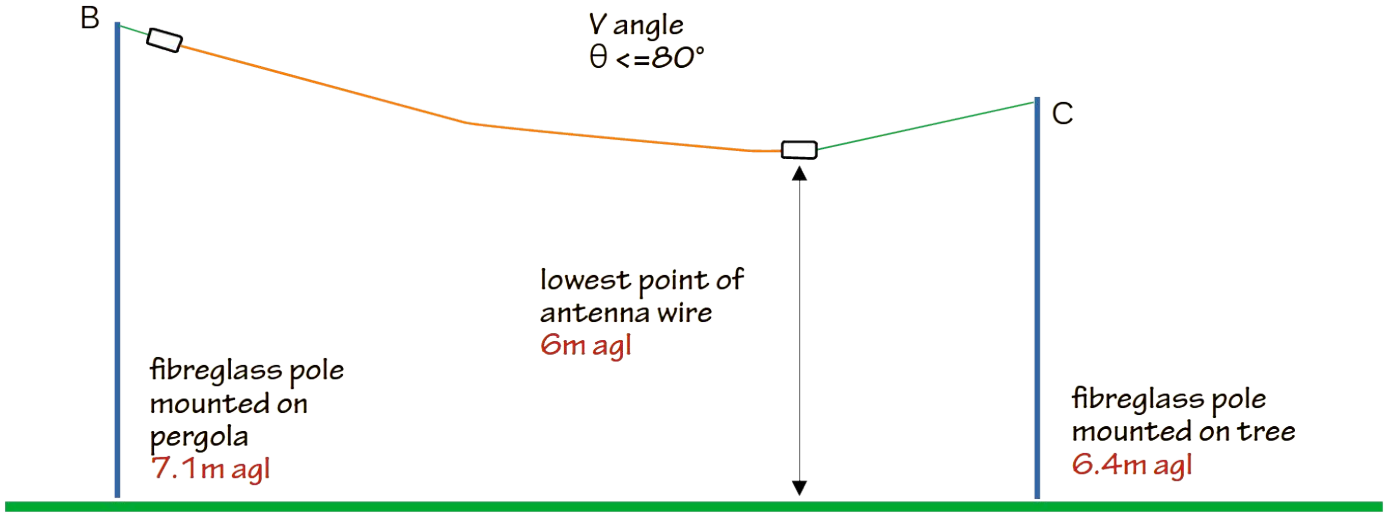
Fibreglass masts



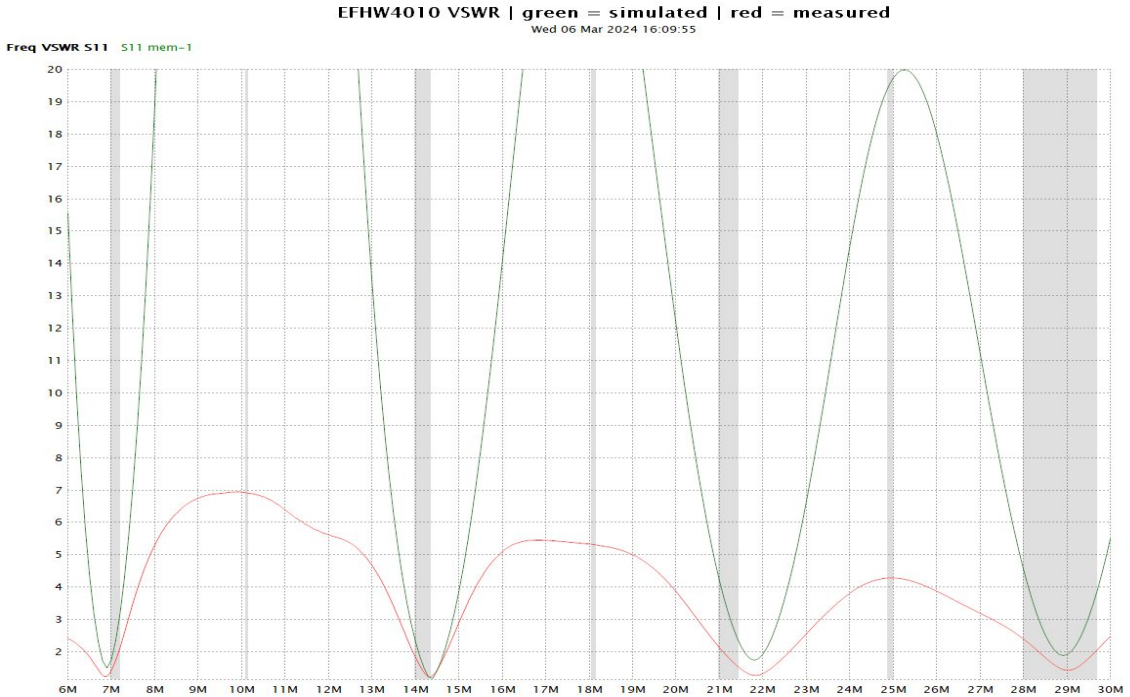
Outside Diameter D1 mm	Inside Diameter D2 mm	Wall thickness t mm	Weight gm/m	Stock length mm	Colour
9.5	3	3.25	100	6000	Black
12.5	4	4.35	200	6000	Black
19	13	3.2	290	6000	Grey
22#	17	2.5	280	6000	Grey
25#	20	2.5	330	6000	Grey
31	25	3.0	521	6000	Yellow & Grey
38	32	3.0	620	6000	Yellow & Grey
48.5	35	6.75	1600	6000	Red & Yellow
50	40	5	1300	5000	Yellow & Grey

EMF Assessment

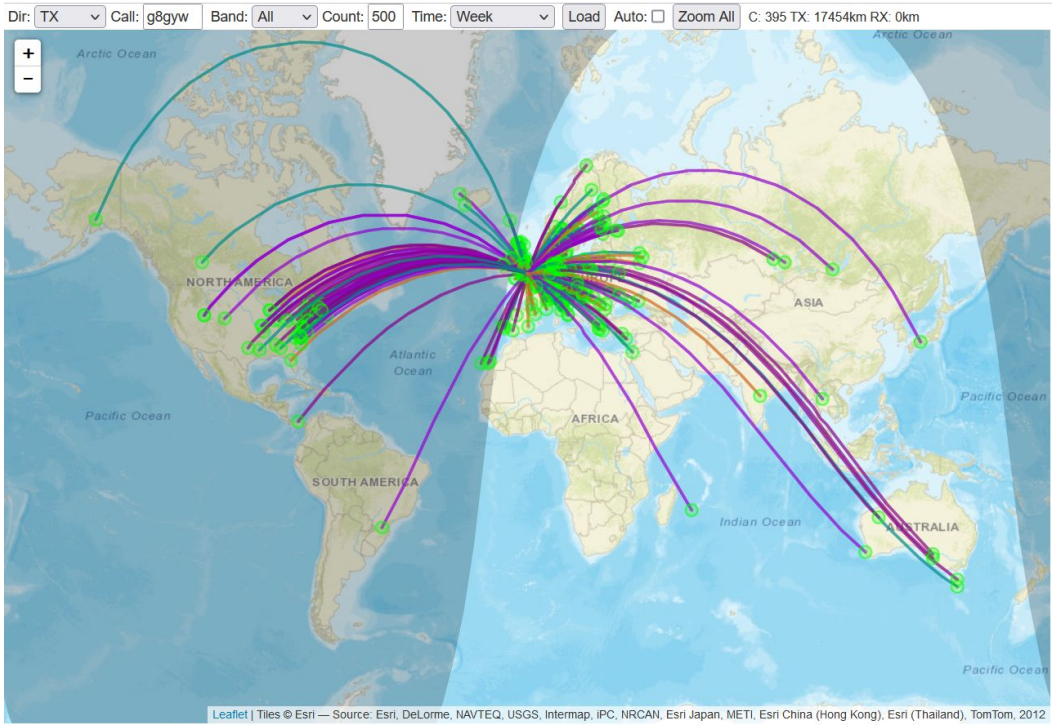
By reference to Tables 1 & 2 of RSGB document "EMF PAC-1, v1.0 2020-04-14" it can be seen that for 100W maximum PEP the antenna conforms with the Ofcom EMF licence condition (minimum horizontal clearance 1.1m, minimum height 2.7m)



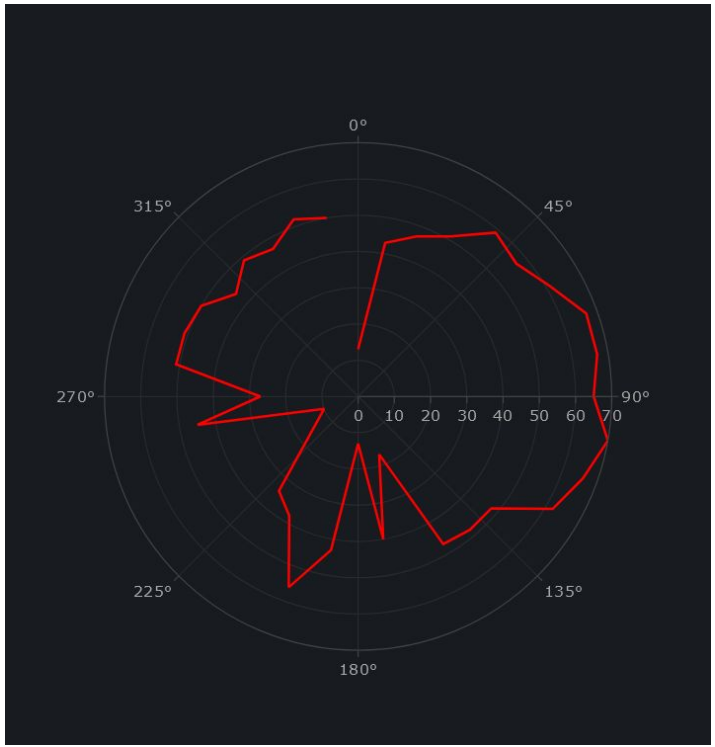
VSWR measured vs simulated



200mW WSPR Plot (All Bands)



40m radiation pattern from wspr.live





Some actual SSB QSOs!

Station	QTH	Band	Power	Distance (miles)
K5TR	Texas	40m	100W	4911
HZ1SM	Saudi Arabia	40m	100W	3096
OE2XAL	Salzburg	20m	3W	667
TK4TH	Corsica	20m	3W	812
YB0AR	Jakarta	20m	100W	7315
4X0A	Israel	15m	100W	2286
W1VE	New Hampshire	15m	100W	3260
TF2MSN	Iceland	15m	100W	1170
CU3IA	Azores	10m	100W	1549
UR5MKB	Ukraine	10m	100W	1426
RW4C	Russia	10m	3W	1980

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