40m OVF at OH1MA

Two phased elements

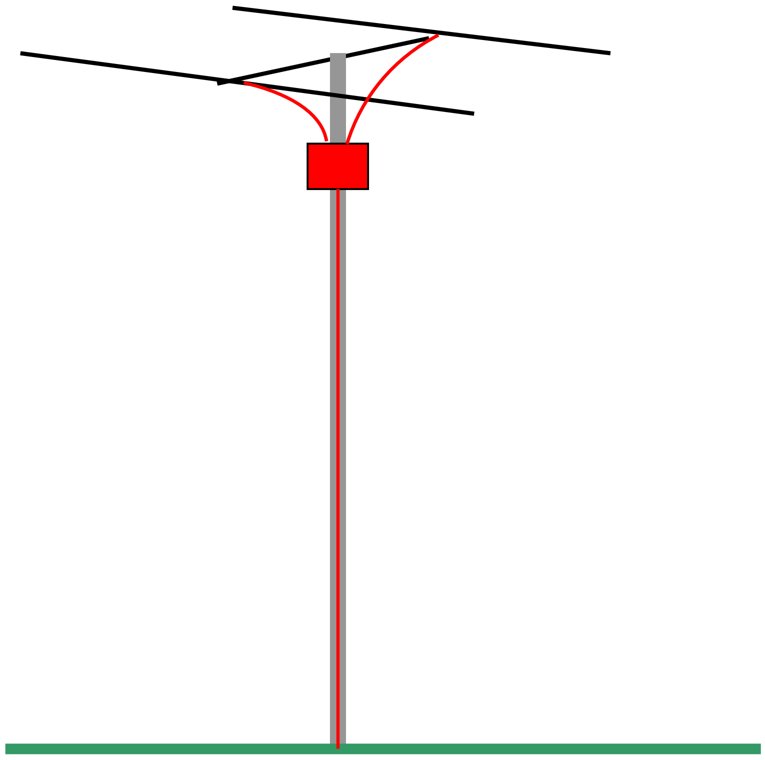
Two bands on 40m

F/B 20dB over whole 7000-7200kHz band

Gain 6.5dBi

Instant direction reversal

2-el phased array for 40m at OH1MA



- Antenna up 40m
  - coil loaded elements, 81% of full size
  - coils 1.9m from the element center
- Opposite-voltage feed system
  - both elements are tuned to 7100kHz
  - ½ wavelength cables from both element to the phasing box
  - opposite cable polarities in front and rear elements
  - current balun on both cables
  - equal current amplitudes in both elements
- Band divided into two sub-bands
  - 7000-7100 and 7100-7200kHz
  - This way better performance is achieved with shortened element
- Instant 180 degree direction switching

What is Opposite Voltage Feed?

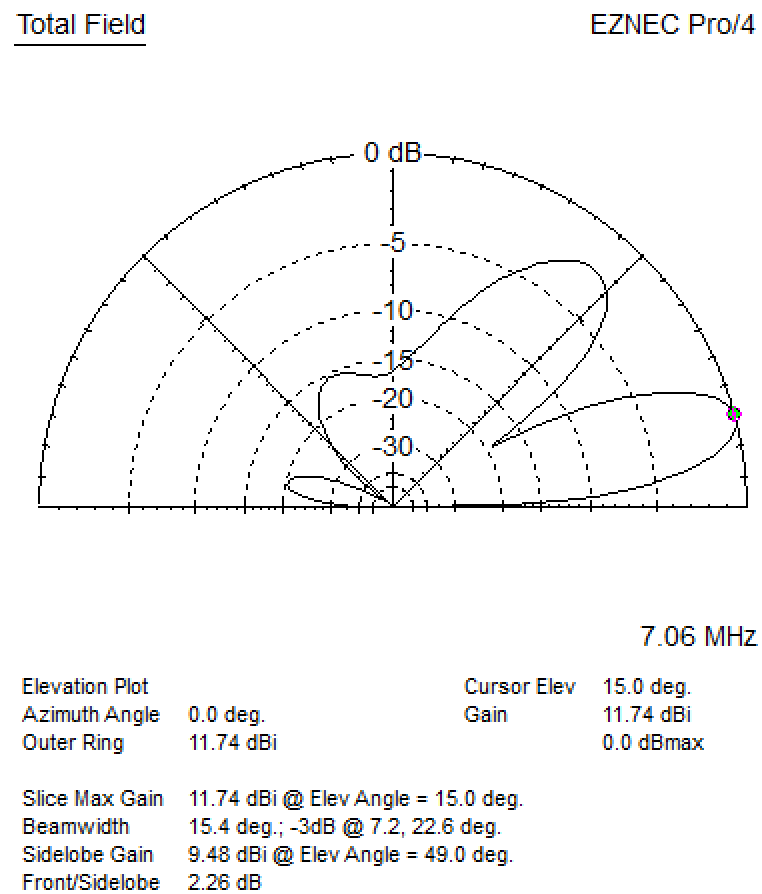
OVF is a method to feed 2-element antennas. It makes possible to adjust current amplitudes and phases so that good radiation pattern can be achieved. The main advantage is insensitivity of radiation pattern to frequency change. The concept is that equal amplitude but opposite phase voltages are brought to the element feedpoints. By selecting proper detuning of the elements and taking into account their mutual impedance, it is possible to reach equal currents and wanted phase difference of the currents. When frequency is changed, both current phases move to the same direction and their difference remains almost constant, making the radiation pattern wideband.

Opposite phase normally is generated with half wavelength cable. It can be achieved also with cable polarity inversion and two cables, each half wavelength long. This method is used in this case.

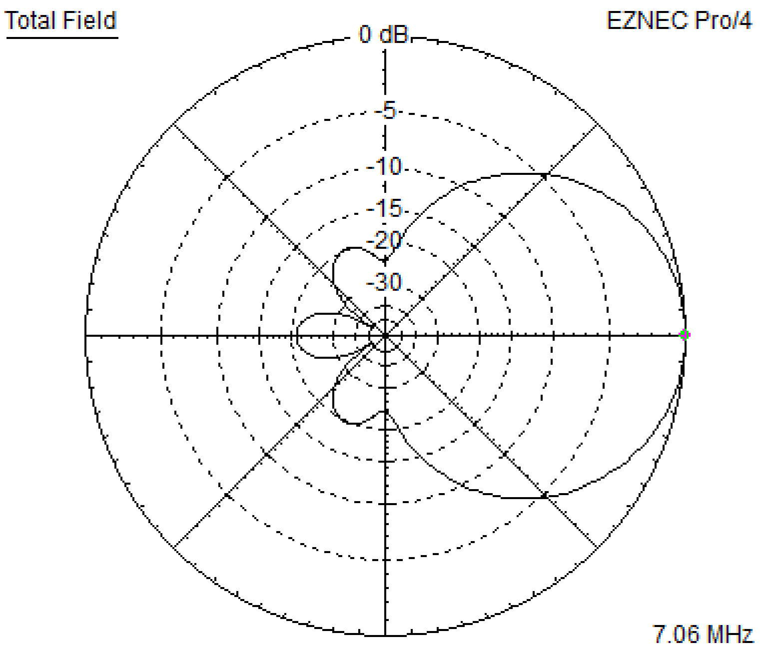
An approximation of phase reversal can be made using very short equal length cables and cable polarity inversion. This method is not perfectly accurate but in most cases adequate. Short cable method is not used in this case.

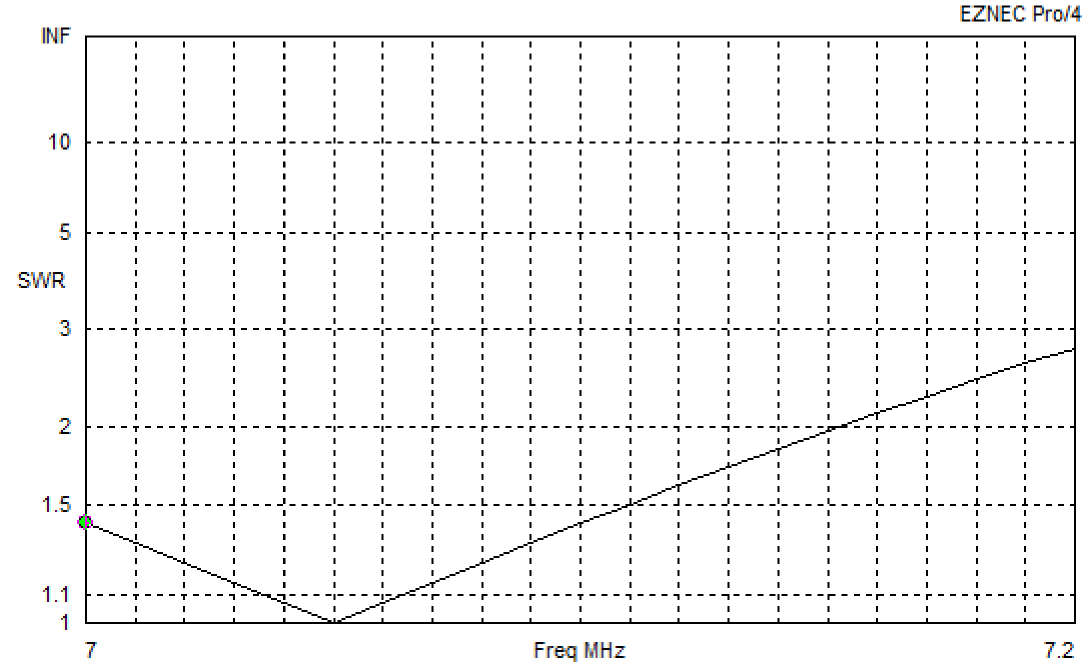
Modeled performance

7000-7100kHz, band center



7000-7100kHz, band center



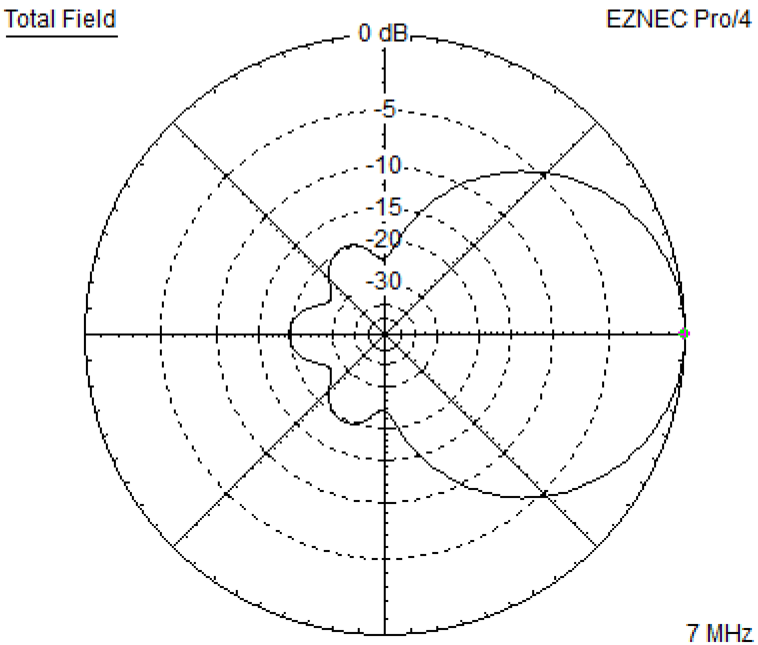


Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	11.74 dBi
Outer Ring	11.74 dBi		0.0 dBmax

Slice Max Gain	11.74 dBi @ Az Angle = 0.0 deg.
Front/Back	20.85 dB
Beamwidth	72.6 deg.; -3dB @ 323.7, 36.3 deg.
Sidelobe Gain	-8.0 dBi @ Az Angle = 114.0 deg.
Front/Sidelobe	19.74 dB

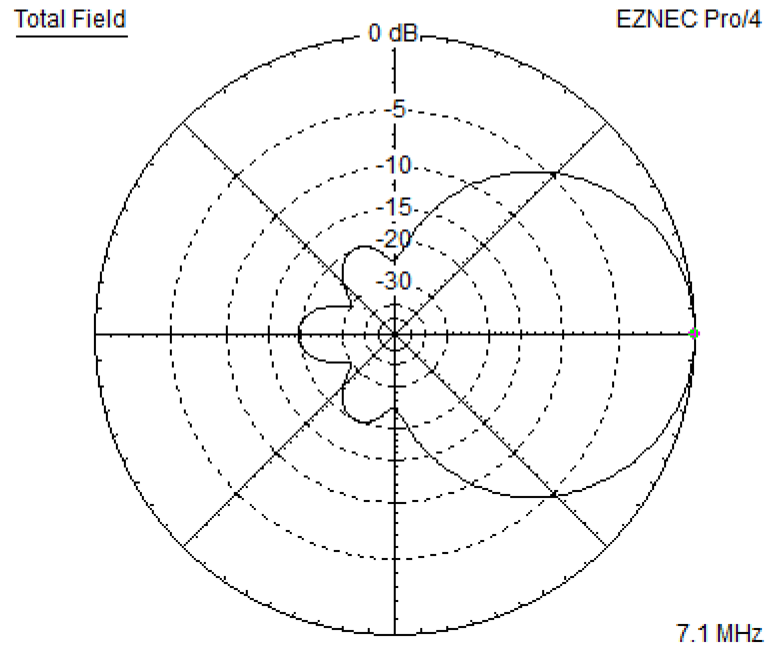
Freq	7 MHz	Source #	1
SWR	**1.41**	Z0	50 ohms
Z	36.75 at 8.45 deg.		
	= 36.35 + j 5.397 ohms		
Refl Coeff	0.1696 at 154.85 deg.		
	= -0.1536 + j 0.0721		
Ret Loss	15.4 dB		

7000-7100kHz, band ends



Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	11.69 dBi
Outer Ring	11.69 dBi		0.0 dBmax

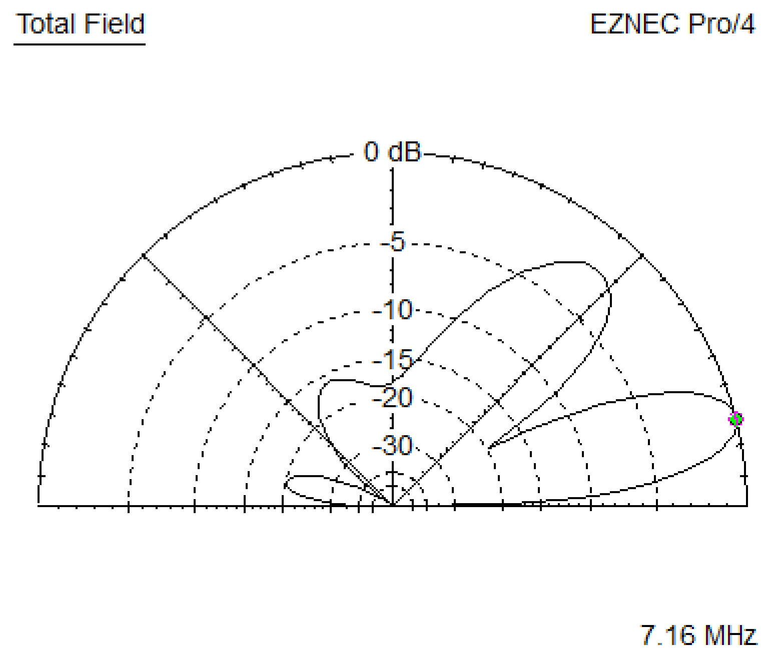
Slice Max Gain	11.69 dBi @ Az Angle = 0.0 deg.
Front/Back	19.57 dB
Beamwidth	72.8 deg.; -3dB @ 323.6, 36.4 deg.
Sidelobe Gain	-7.8 dBi @ Az Angle = 115.0 deg.
Front/Sidelobe	19.49 dB



Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	11.77 dBi
Outer Ring	11.77 dBi		0.0 dBmax

Slice Max Gain	11.77 dBi @ Az Angle = 0.0 deg.
Front/Back	19.4 dB
Beamwidth	72.6 deg.; -3dB @ 323.7, 36.3 deg.
Sidelobe Gain	-7.63 dBi @ Az Angle = 180.0 deg.
Front/Sidelobe	19.4 dB

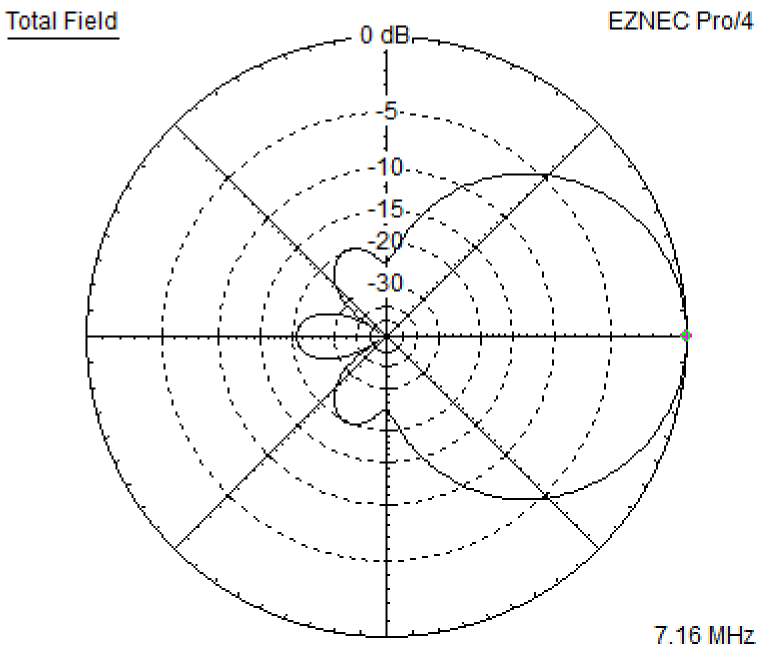
7100-7200kHz, band center

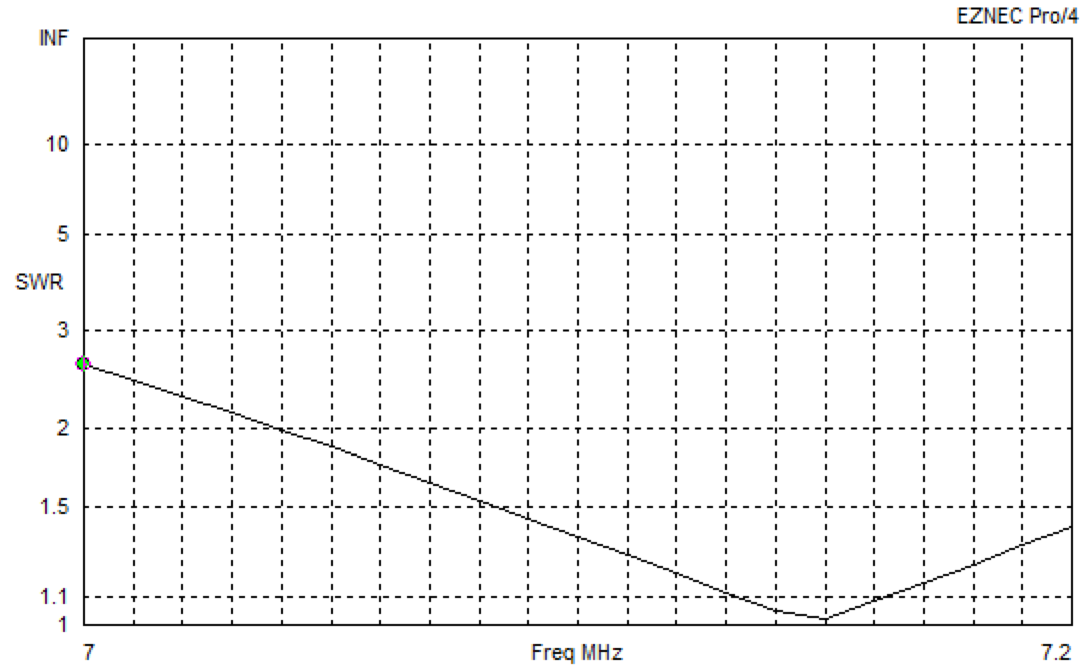


Elevation Plot		Cursor Elev	14.0 deg.
Azimuth Angle	0.0 deg.	Gain	11.79 dBi
Outer Ring	11.79 dBi		0.0 dBmax

Slice Max Gain	11.79 dBi @ Elev Angle = 14.0 deg.
Beamwidth	15.2 deg.; -3dB @ 7.1, 22.3 deg.
Sidelobe Gain	9.6 dBi @ Elev Angle = 49.0 deg.
Front/Sidelobe	2.19 dB

7100-7200kHz, band center



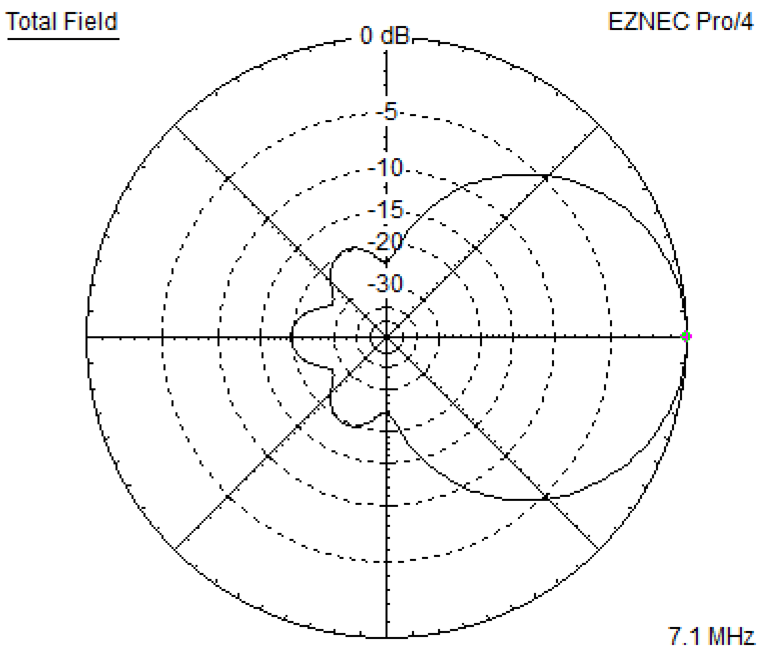


Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	11.79 dBi
Outer Ring	11.79 dBi		0.0 dBmax

Slice Max Gain	11.79 dBi @ Az Angle = 0.0 deg.
Front/Back	20.68 dB
Beamwidth	72.4 deg.; -3dB @ 323.8, 36.2 deg.
Sidelobe Gain	-8.0 dBi @ Az Angle = 114.0 deg.
Front/Sidelobe	19.79 dB

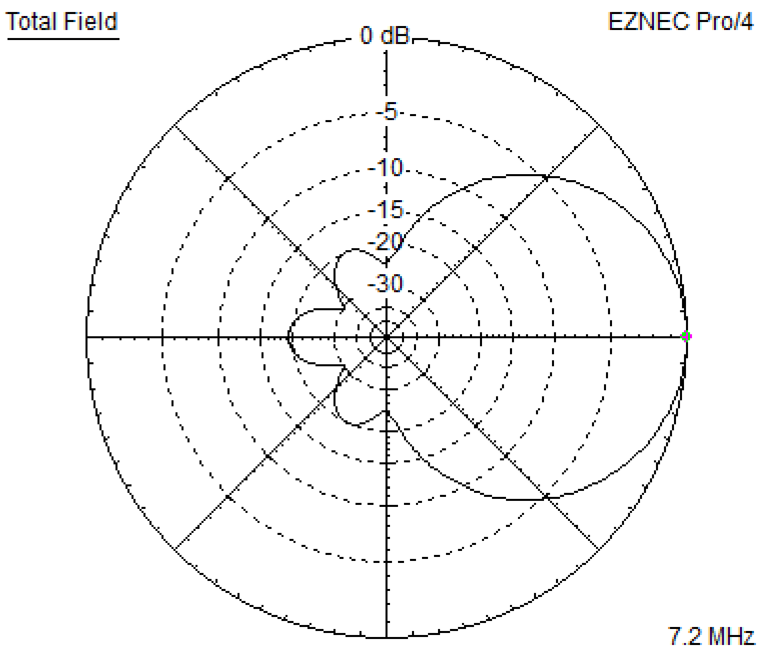
Freq	7 MHz	Source #	1
SWR	**2.59**	Z0	50 ohms
Z	19.64 at 9.0 deg.		
	= 19.39 + j 3.073 ohms		
Refl Coeff	0.4428 at 171.73 deg.		
	= -0.4382 + j 0.06369		
Ret Loss	7.1 dB		

7100-7200kHz, band ends



Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	11.73 dBi
Outer Ring	11.73 dBi		0.0 dBmax

Slice Max Gain 11.73 dBi @ Az Angle = 0.0 deg.
Front/Back 19.6 dB
Beamwidth 72.6 deg.; -3dB @ 323.7, 36.3 deg.
Sidelobe Gain -7.77 dBi @ Az Angle = 115.0 deg.
Front/Sidelobe 19.5 dB



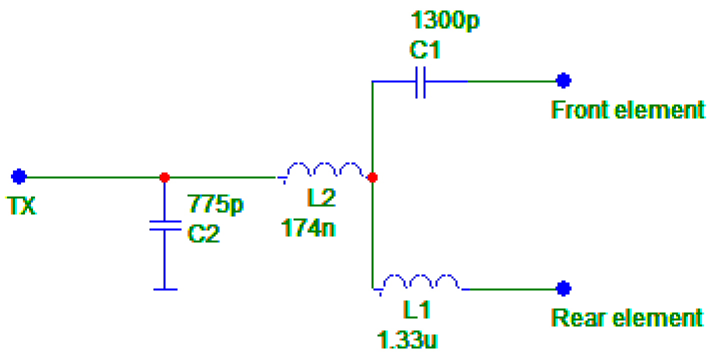
Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	11.82 dBi
Outer Ring	11.82 dBi		0.0 dBmax

Slice Max Gain 11.82 dBi @ Az Angle = 0.0 deg.
Front/Back 19.23 dB
Beamwidth 72.4 deg.; -3dB @ 323.8, 36.2 deg.
Sidelobe Gain -7.41 dBi @ Az Angle = 180.0 deg.
Front/Sidelobe 19.23 dB

Structure

L-match and phasing for 7000-7100kHz-band

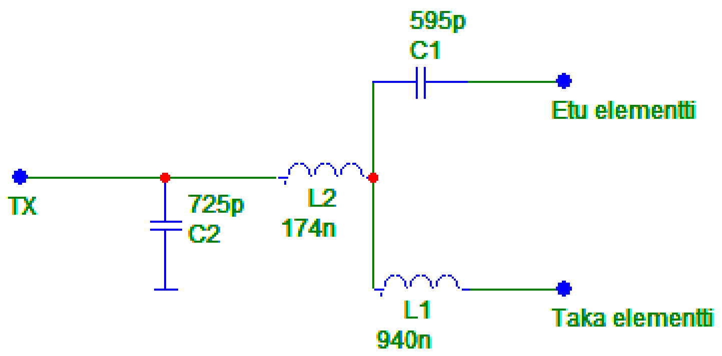
40m OVF array at OH1MA
Antenna height 40m, shortened elements 17.27m long (81%)
Elements tuned to 7100kHz
Electrical length of feed cables is 21.1m
Element spacing 6.5m
Center frequency 7060kHz
Phasing box for band 7000-7100kHz



21.9.2016
OH1TV

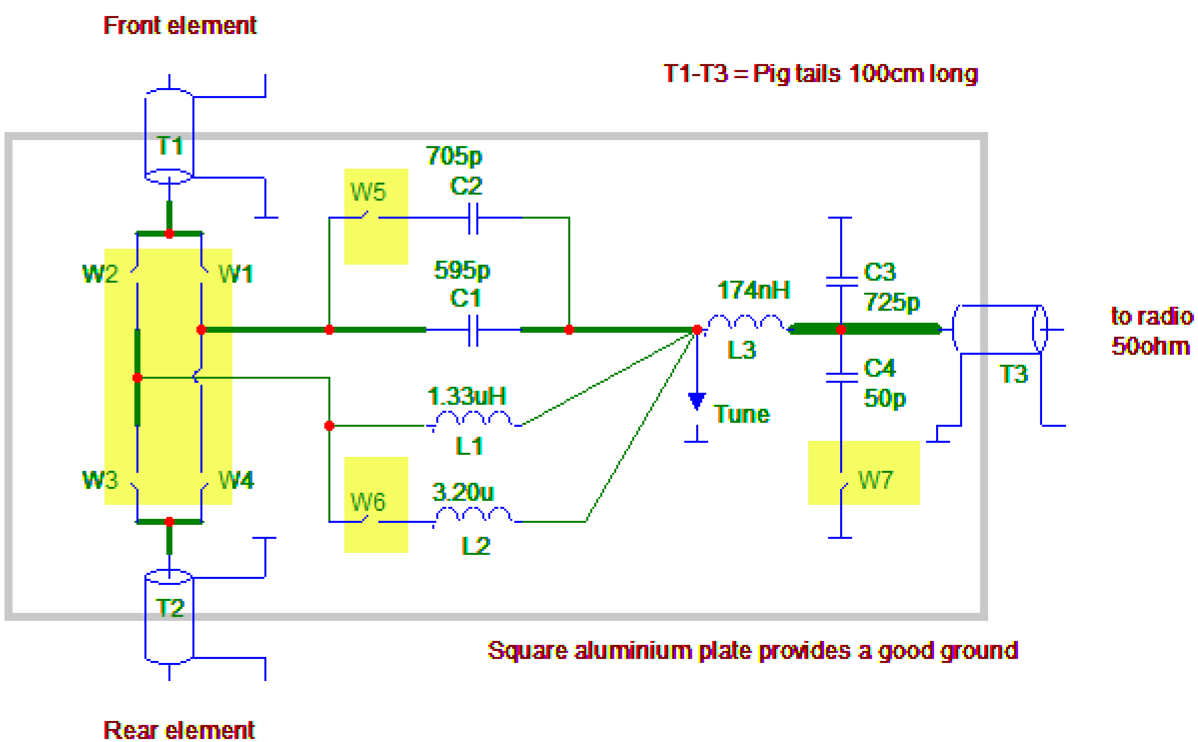
L-match and phasing for 7100-7200kHz-band

40m OVF array at OH1MA
Antenna height 40m, shortened elements 17.27m long (81%)
Elements tuned to 7100kHz
Electrical length of feed cables is 21.1m
Element spacing 6.5m
Center frequency 7160kHz
Phasing box for band 7100-7200kHz



21.9.2016
OH1TV

Phasing box for 2el 40m OVF array at OH1MA



Forwards / Backwards switching

Forward: W1, W3 are on
Backwards : W2, W4 are on

7060 / 7160kHz switching

7060kHz relay W5 is on, W6 off
7160kHz relay W5 is off, W6 on

L-match, SWR tuning

7060kHz W7 is on
7160kHz W7 is off

21.9.2016
OH1TV

How it was aligned

- Both elements were tuned to 7100kHz +/- 5kHz
  - Measurements were made at 40m, which is the installation height
  - Abt 40m long measurement cable was eliminated with calibration
  - Impedance at element terminals was measured: zero reactance on 7100kHz
- All components for the phasing box were measured before installation
  - Capacitors and coils were selected based on measurements on 7100kHz
  - Also inductance of relays and wiring were measured on 7100kHz
- Lay-out of wiring is critical as we play with small inductances
  - All stray inductances from wiring were taken into account
- Final alignment was based on serial reactance in each leg when the summing point **Tune** was grounded (left end of L3).
  - The target values were from Eznec model
- After this lab alignment no in-situ tuning was made. The box was just connected and the system was ready to go

Going up in September 2016

Participants in the project

• Antenna electrical design	OH1TV
• Phasing box builder	OH1MA
• Final tuning	OH1MA, OH1ND, OH1TV
• Elements and boom	UA2FZ
• Tuning	OH1MA
• Antenna assembly	OH1MA
• Installation to the tower	OH1ND, OH1MA
• Basket crane	Jalo & Jalo, Turku

-> The antenna works as expected.