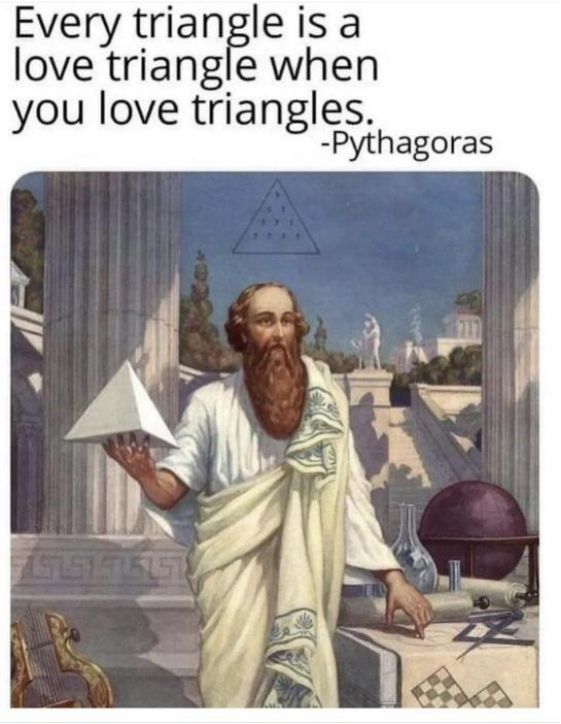
80-10 Meter Horizontal Delta Loop Antenna for Field Day

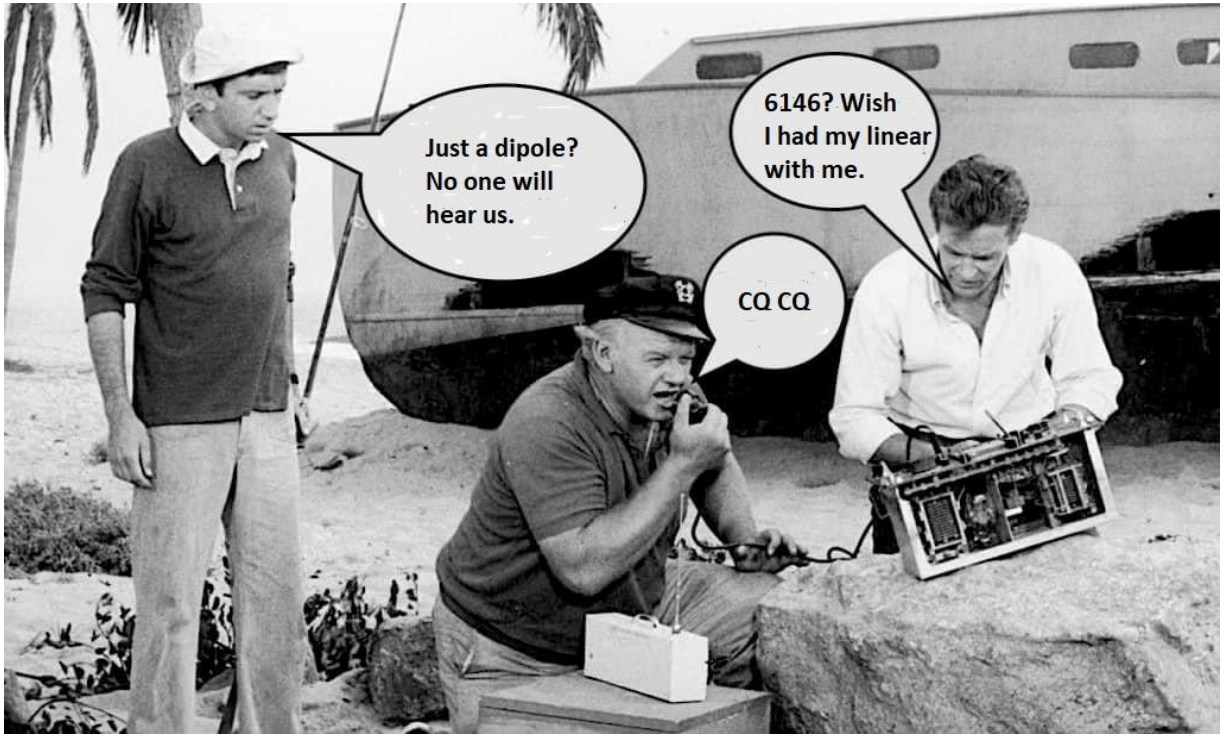


Greater Norwalk
Amateur Radio Club

April 10th, 2024

Steve Dick, K1RF

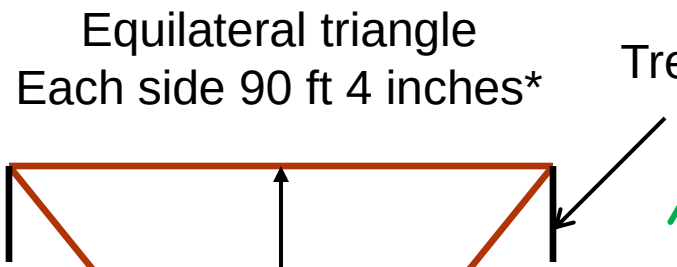
In search of the Holy Grail



A simple multiband wire antenna that is low cost, easy to build, and relatively easy to deploy, with great performance.

The 80-10 meter Horizontal Delta Loop Antenna for Field Day

Loop is close to resonance when total Length(feet) = 1032/f(MHz)
Sides (feet) = 344/f(Mhz)



Mount antenna 30 ft above ground level

Orient best radiation direction opposite the feed point

4 to 1 hybrid balun

50 ohm coax (RG-8X etc) length not critical

Rig → Antenna Tuner

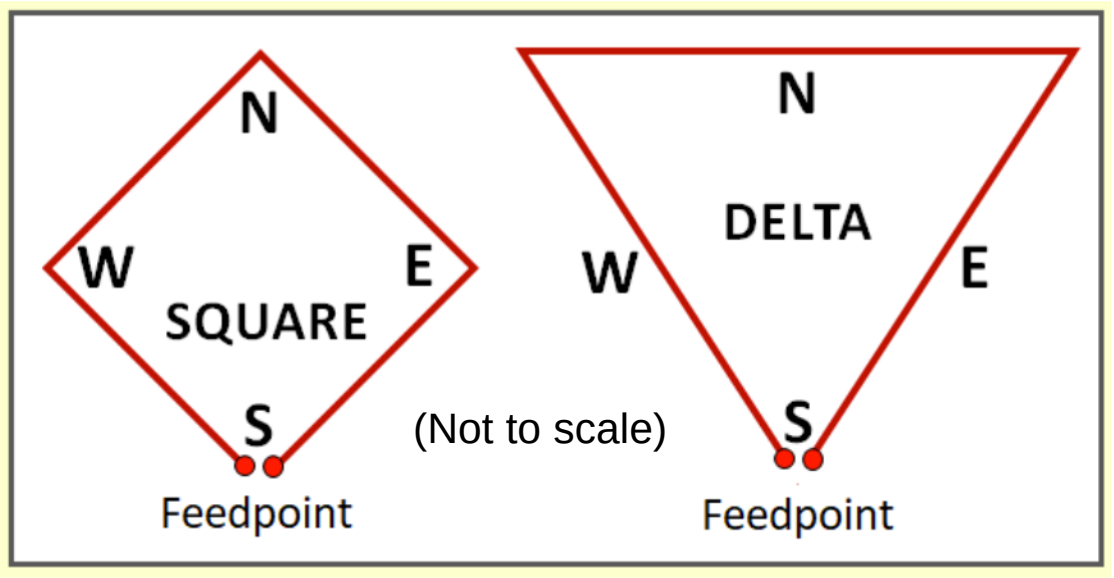
3:1 tuner adequate for part of 80 and 40/20/17/15/12 and lower half of 10 meters.

*for 40 -10m delta loop, 46 ft sides, about 40 ft depth. For 80m square loop 68’9” per side.

About horizontal loop feeding and shapes

- Fed on one corner (rather than at a middle), there is a tendency for the antenna to exhibit less lobes per band. Ground reflections tend to fill in any deep nulls.
- Ideally, a circular horizontal polarized is best from a theoretical perspective (maximum area for a given wire length), but regular polygons can work well. Square is next best, followed by rectangles or triangles. One wavelength long Triangles are the easiest to deploy in a Field Day environment with both triangles and squares having maximum radiation in the same direction for all bands and good VSWR performance with a 200 ohm impedance match via a 4 to 1 hybrid balun.

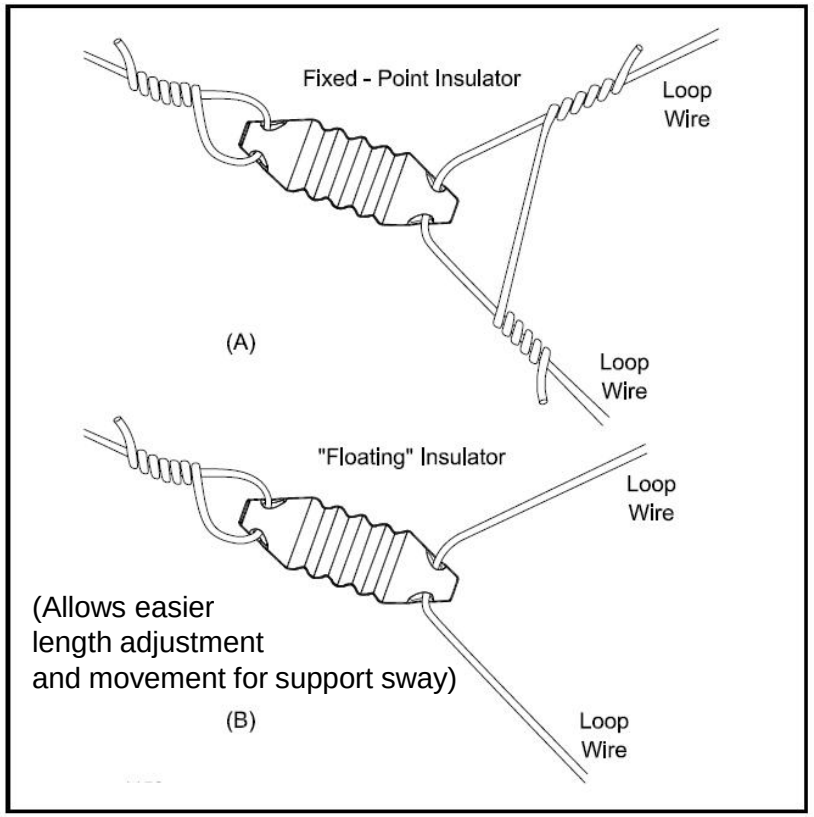
Feed Point Locations for Horizontal Delta or Square Loops



Direction Of Maximum radiation

Courtesy DJ0IP

Corner mounting options



Two methods of installing the insulators at the loop corners.

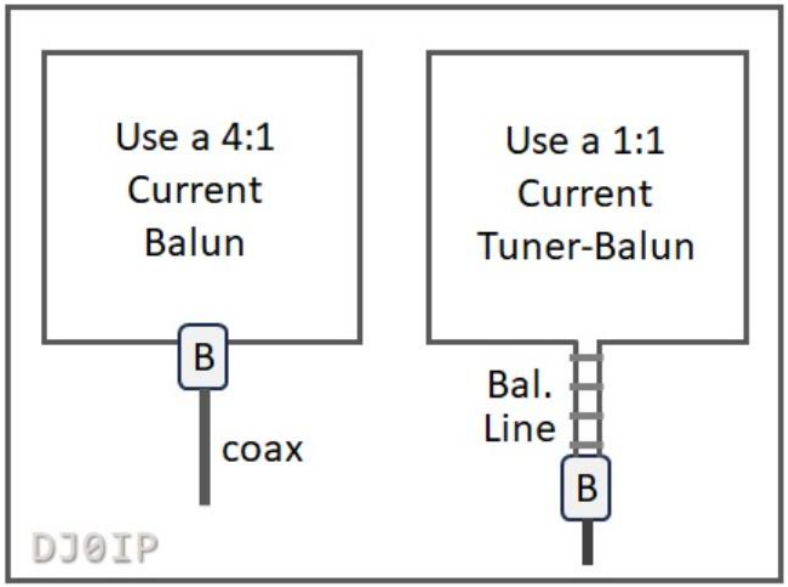
Insulators can also be made from inexpensive PVC pipe. At the top is a feed point insulator for parallel-conductor feed lines. The feed line is attached to the inner terminals and the loop to the output terminals which are jumpered together (jumpers not shown). At the bottom is a corner insulator. The support line is tied through the larger holes and the loop conductors attached to the eyes of the jumper.

Feedpoint balun should be fixed-mounted

Courtesy ARRL Antenna Book

Alternate feed methods

- 50 ohm coax plus 4 to 1 low cost 2-core current balun or 4 to 1 hybrid balun at feedpoint: **Eliminates need for ladderline. Any length coax.** Low VSWR provides relatively low losses on coax.
- 300 ohm ladderline (closest match for the multiband delta loop for ladderline and cheaper and less visible than 450 ohm) + single ended wide range antenna tuner +1 to 1 tuner balun or balanced antenna tuner. Antenna wire length
- Same as above but with 450 ohm ladderline or 600 ohm open wire line
- Note: 300 ohm or 450 ohm ladderline is subject to impedance changes in rain; Open wire line is not.

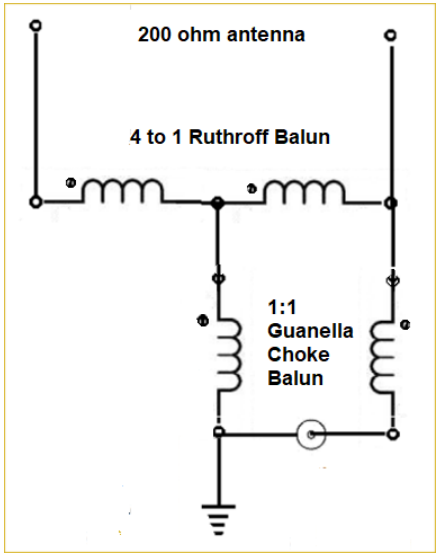


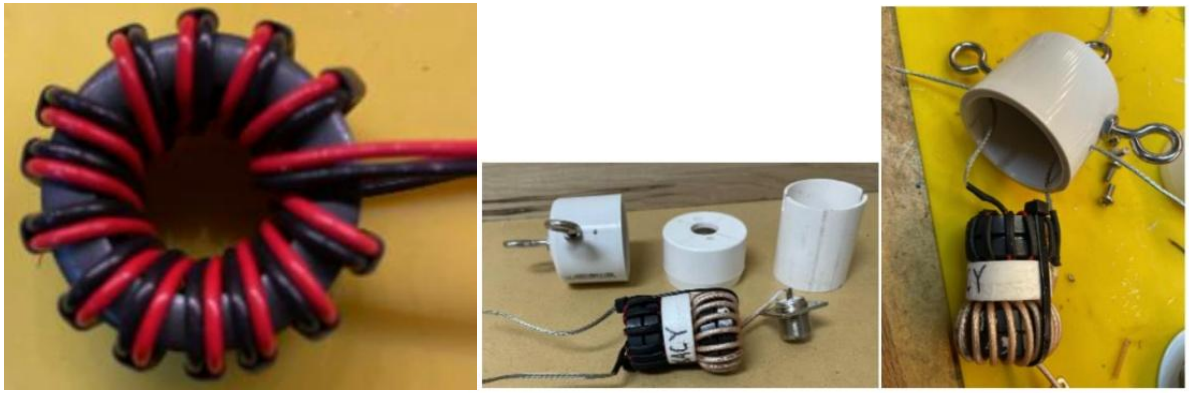
For delta loop or square loop

What are the advantages/disadvantages of a horizontally oriented loop antenna compared to other wire antennas?

- It typically has fewer bands with problematic impedances to match than multiband doublets.
- It has low noise pickup, especially compared to vertical
- It requires no ground radials like a vertical requires
- For all-band use, the horizontal loop is better than the vertically oriented loop. The Horizontal loop elevation angles are close to those of a single wire doublet, which places them lower and stronger than those for a Vertically oriented loop.
- Good gains on all bands for the horizontal loop in the same direction for most bands (opposite the feedpoint). Doublets, OCFDs, and EFHWs have lobing on higher bands not necessarily in the same direction
- It is somewhat omnidirectional. Useful in all directions but no rejection such as with a dipole off its ends.
- Required triangular loop depth might limit its use compared to a straight wire

4 to 1 Hybrid Balun (200 ohm output)





Low power Hybrid Balun Courtesy N4CY
Join groups.io OCFD group for details

- Cascade of a 4 to 1 Ruthroff Voltage Balun and a 1 to 1 Guanella Balun
- Low cost, efficient, and minimum complexity for a good performing 4 to 1 balun for impedance matching with good common mode choking suitable for 100 watt rigs. See next slide for details.

K1RF recommended low power hybrid balun components (mod of N4CY balun)

- Can take 100 watts continuous for digital modes:
- Ruthroff balun:
  - Fair Rite P/N 5961001201 (tall version of FT114-61) **($2.76 qty 1**, $2.38 qty 10 at 14 bifilar turns of #20 high build Magnet wire (About 14 cents/foot), .0331 inch diameter with a Red and Black Teflon Sleeve 28" long. Clear teflon tubing is available from McMaster-Carr, 0.034" ID for #20 AWG 30 cents per foot
- Guanella Balun
  - Fair Rite P/N 5943001201 (Tall version of FT114-43) **($1.78 qty 1**, $1.19 qty 10) 36" length of RG-316, 17 turns ($4.25/ft Pasternack)

- Toroids can dissipate ~3.4 watts, each >97% efficient or 113 watts continuous input power to the antenna.

  The tall versions of the toroids can be replaced by two standard single height FT114's which must be glued together (N4CY version).

  FT114-61 Fair Rite P/N 5961001001
  FT114-43 Fair Rite P/N 5943001001

Alternate build approach for 4 to 1 Hybrid Balun

Alternate mounting method of
4:1 Ruthroff and 1:1 Guanella

RUTHROFF:

- 1 Fair Rite P/N 5961991201 ("Tall" FT114-61)
- 14 turns of twisted pair wire (Teflon insulated)
- #20 AWG

GUANELLA:

- 1 Fair Rite P/N 5943001201 ("Tall" version of FT114-43)
- 17 turns of RG-316 Teflon insulated coax

Or use two standard FT114-61 for Ruthroff and two standard FT114-43 for Guanella

Mount on a piece of epoxy board by itself with sealant or inside a box

Mounting method courtesy
Rick Westewrman, DJ0IP
from his "B10 small hybrid balun"

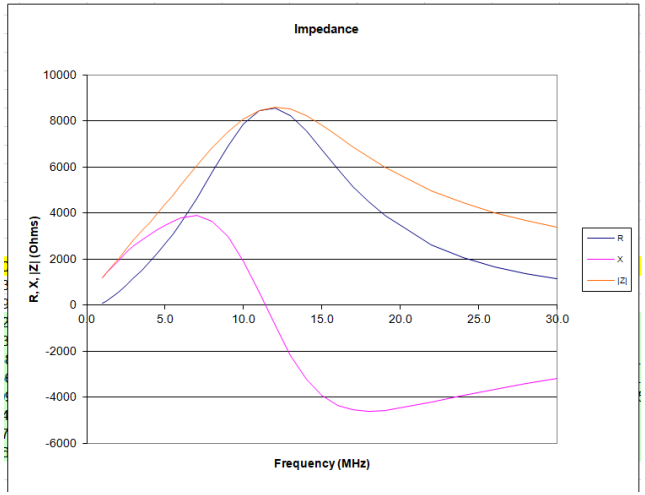
Hybrid Balun Performance

VSWR

1: 3.5MHz	53.87ohm	1.20
2: 7.3MHz	54.92ohm	1.13
3: 14.3MHz	55.83ohm	1.12
4: 18.1MHz	55.96ohm	1.12
5: 21.3MHz	55.80ohm	1.12
6: 28.5MHz	54.38ohm	1.11

VSWR Data courtesy N4CY in his writeup “Hybrid Balun 50Ω/200Ω for Field Day OCF Dipole” in the groups.io OCFD group

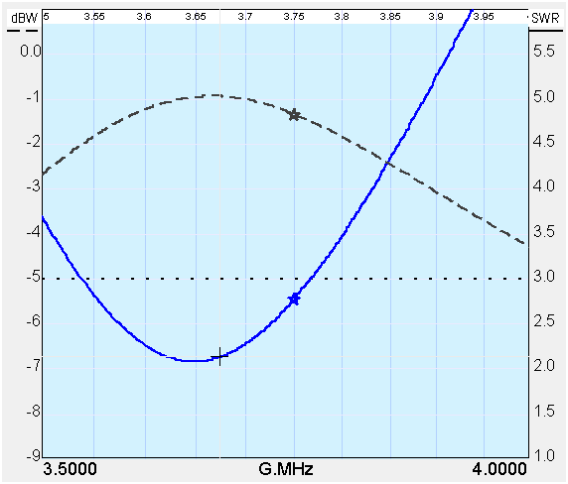
Guanella
Common Mode Impedance



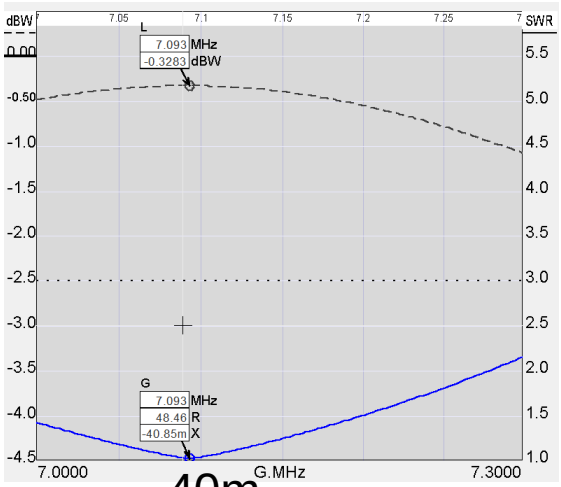
F(MHz)	3.5	7	14	22	30
R	1519	4634	7582	2626	1157
X	2843	3897	-3223	-4222	-3166
Z	3223	6054	8239	4972	3371

Simulated with Owen Duffy’s Common Mode Choke Design Tool

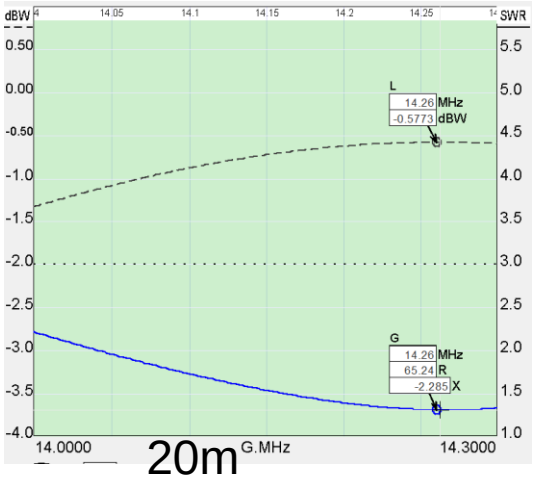
VSWRs 80M Delta Loop simulated in EZNEC and Simnec



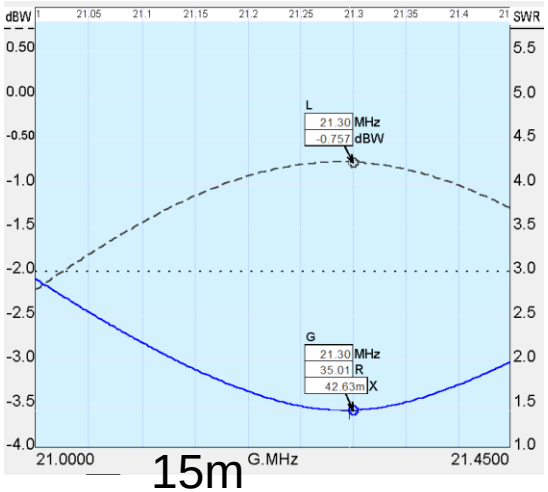
80m



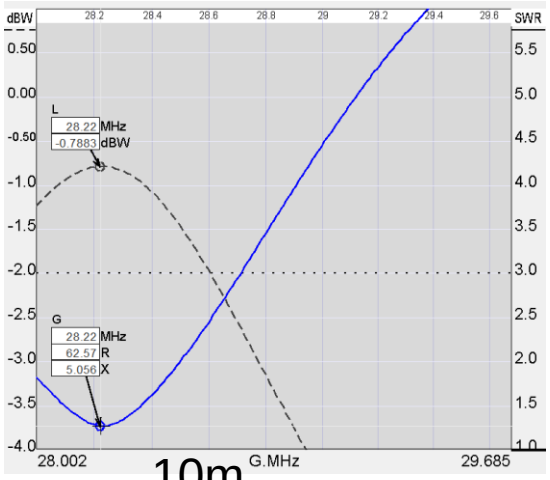
40m



20m



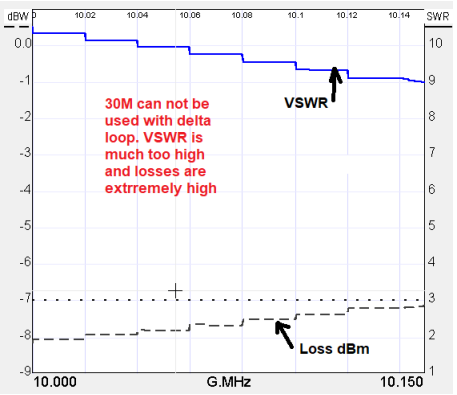
15m



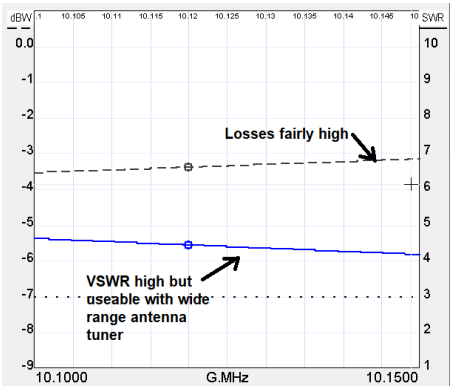
10m

VSWRs include simulation of hybrid balun and 50 ft of RG-8X coax simulated in Simnec

VSWRs 80m Delta Loop - WARC bands

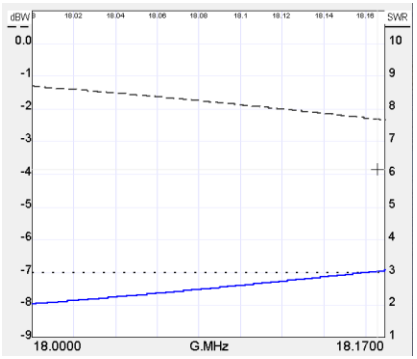


30m Delta Loop

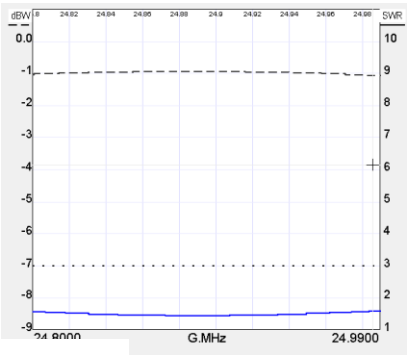


30m Square Loop

30m cannot be used with delta loop but can be used with square loop with wide range antenna tuner.



17m



12m

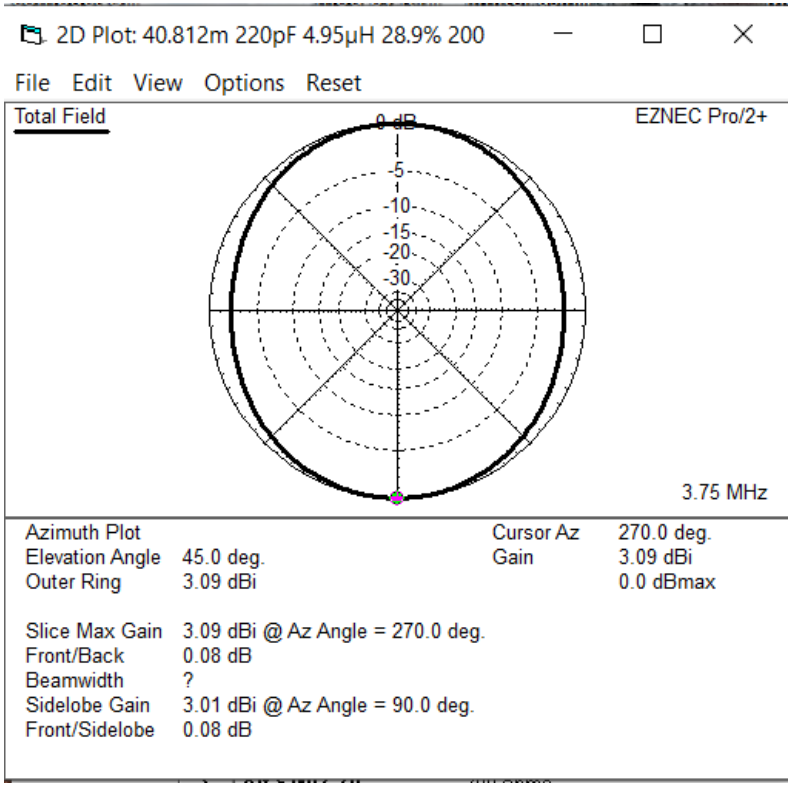
80m Delta Loop works well on 17m and 12m!

Antenna Pattern Summary
80 meter horizontal delta loop

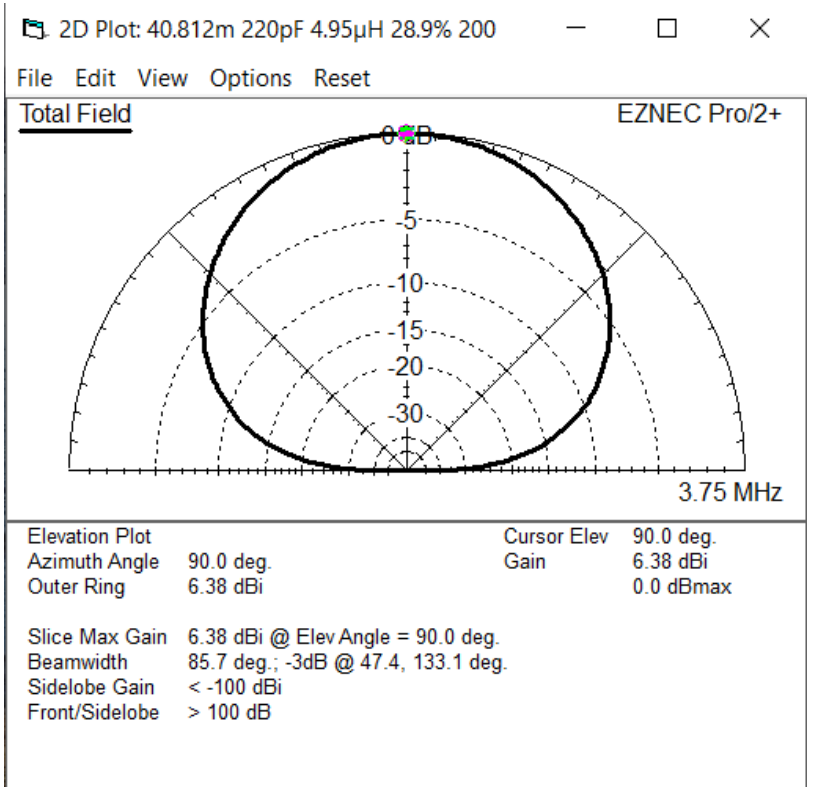
Band	TO angle Degrees	Max Gain dBi	Az Pattern notes
80m	90	3.09 at 45 deg TO angle	6.38 at 90 deg TO angle and 90 deg Az. NVIS
40m	51	6.71	Oval, max gain at 90 deg. Az, slightly better than a 40m dipole at 30 ft agl
20m	31	9.4	6 lobes, max gain at 90 degrees Az
15m	18	10.86	6 lobes, max gain at 90 degrees Az
10m	14	12.73	Many lobes. Max gain at 90 degrees Az

Compare these to a dipole mounted half-wave above average ground: 7.9dBi, 28 degrees take-off angle. The loop has higher gain on 20, 15, 10 and lower take-off angles on 15 and 10.

80m Delta Loop
Antenna Patterns 80m

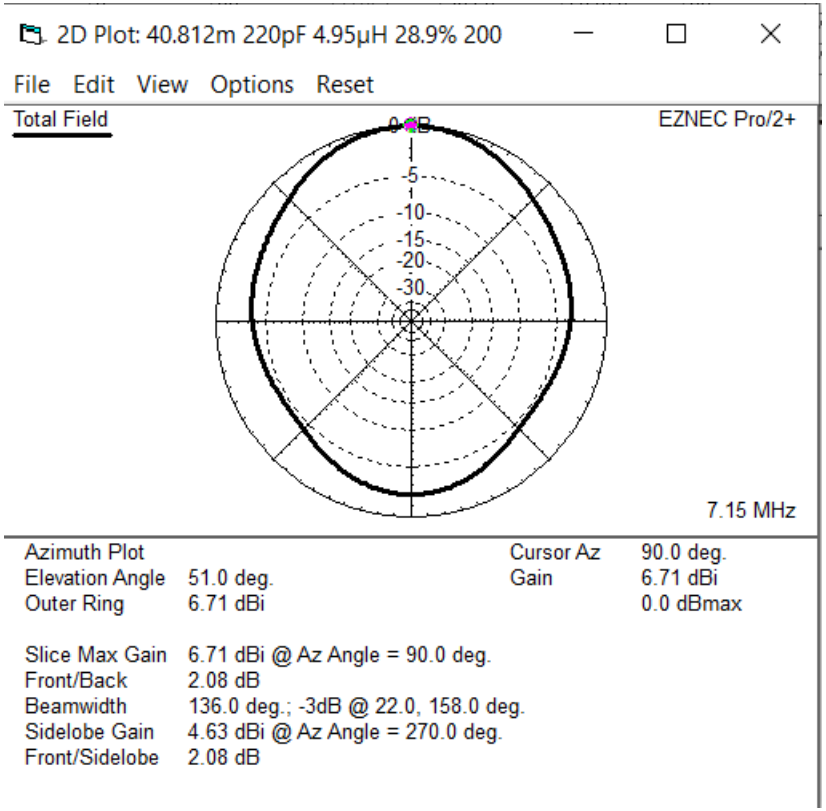


Az with 45 degrees El

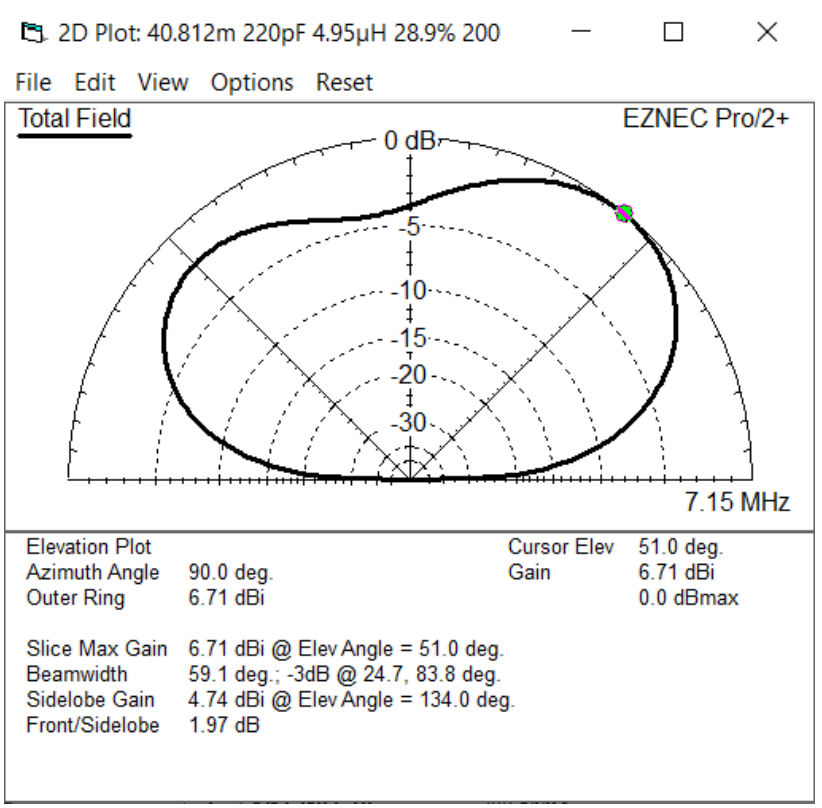


El with 90 degrees Az

80m Delta Loop
Antenna Patterns – 40m

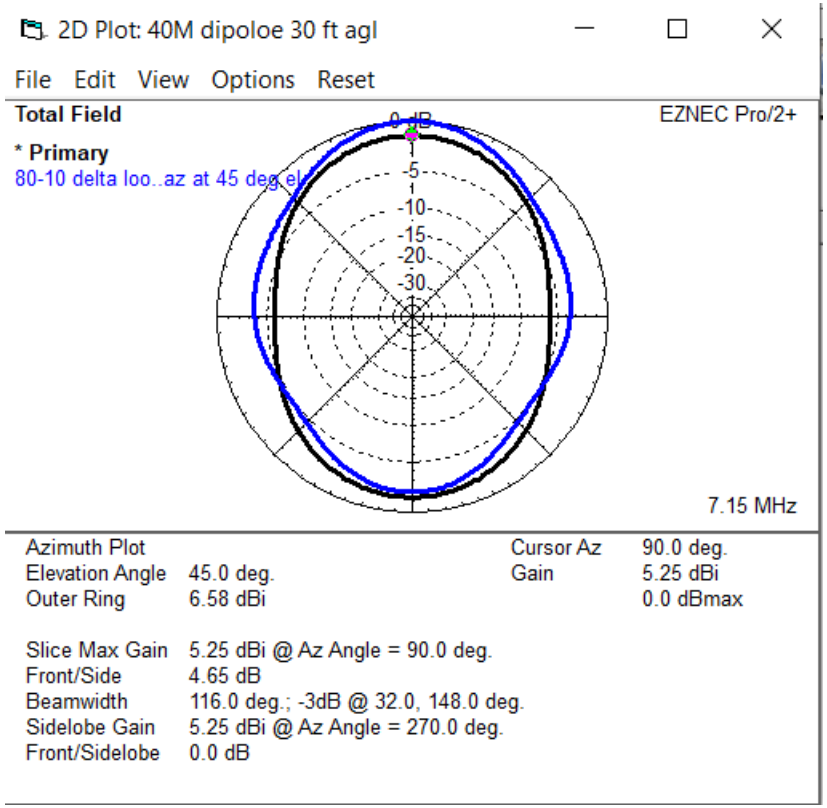


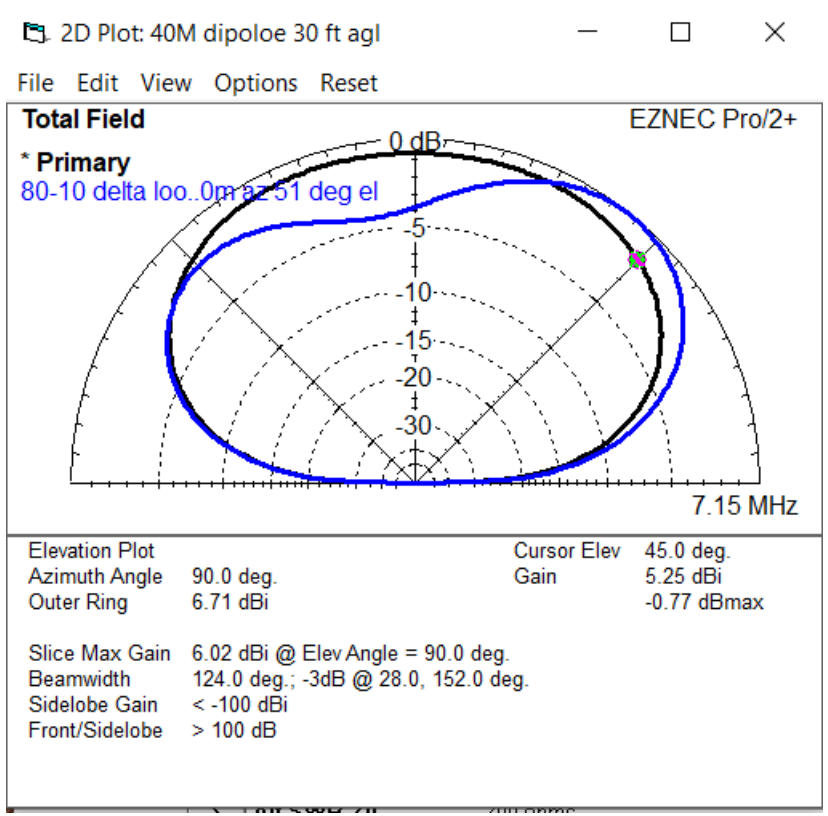
Az with 51 degrees El.
Max Gain = 6.71dBi



El with 90 degrees az
max gain = 6.71dBi

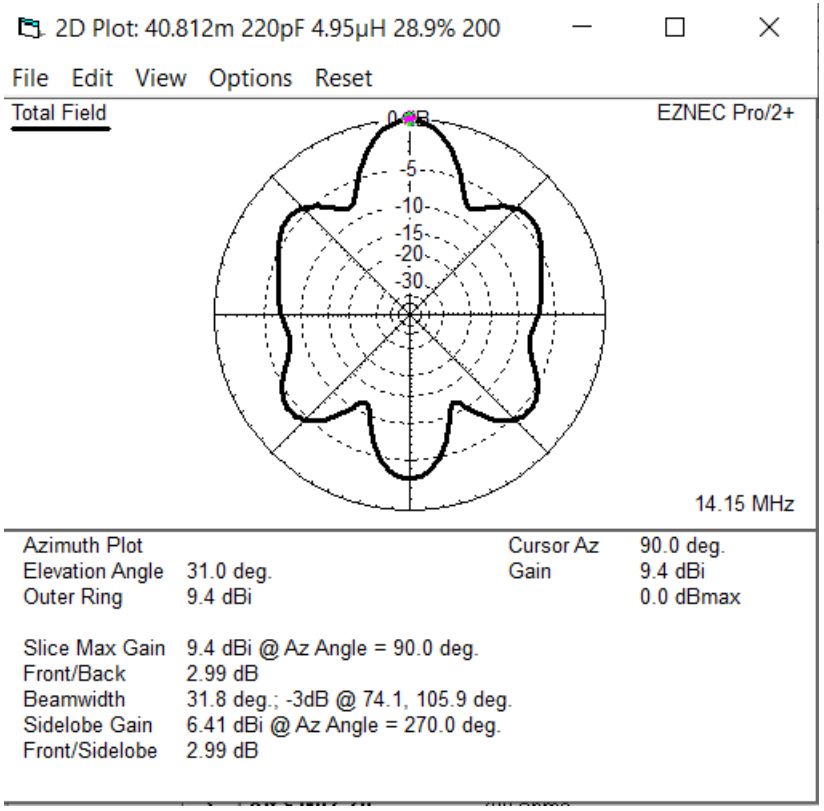
80m Delta Loop Antenna patterns 40m compared to dipole at 30 ft above ground level, 45 degrees elevation angle



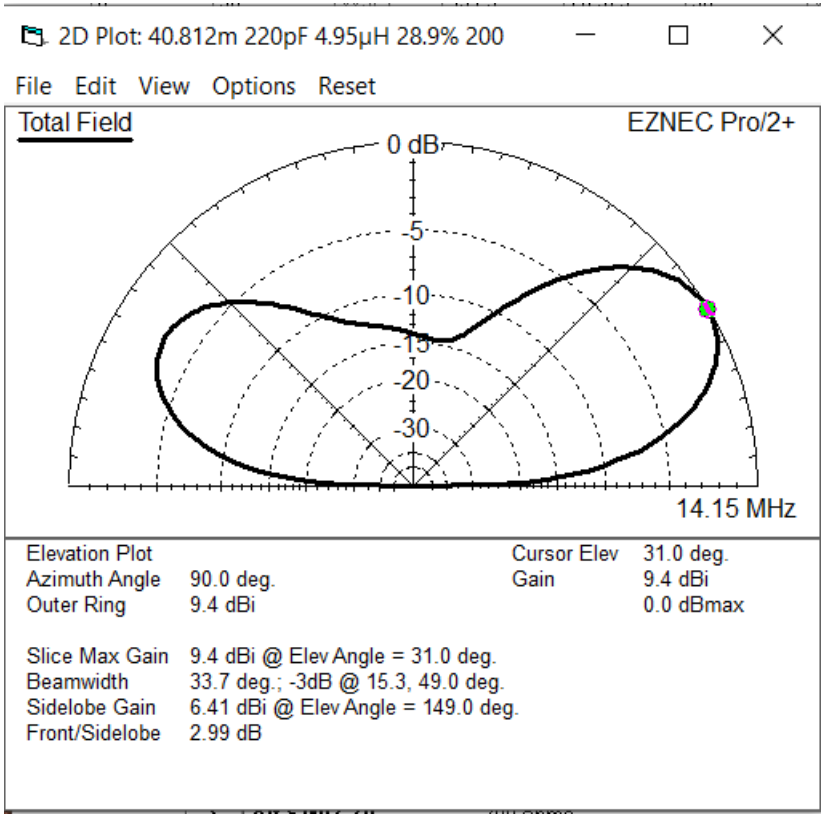


Delta loop: 6.58dBi gain, Dipole: 5.25dBi gain
Delta loop is 1.33dB better than a dipole at 45 degree el at 30 ft agl

80m Delta Loop
Antenna Patterns 20m

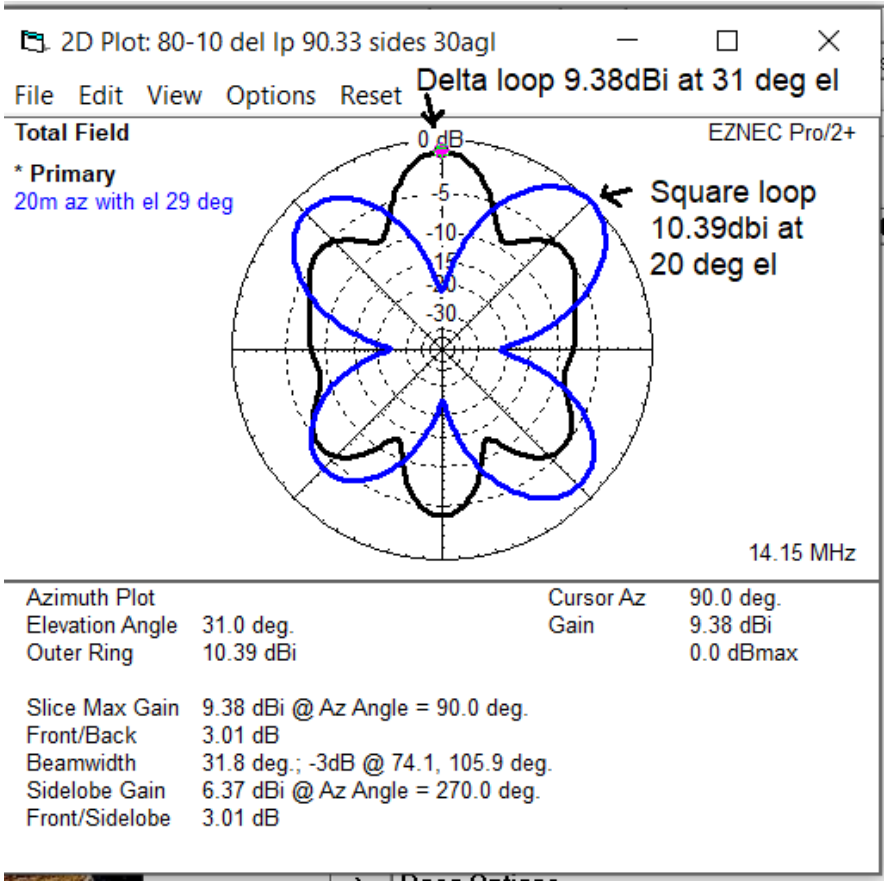


Az with 31 degree El



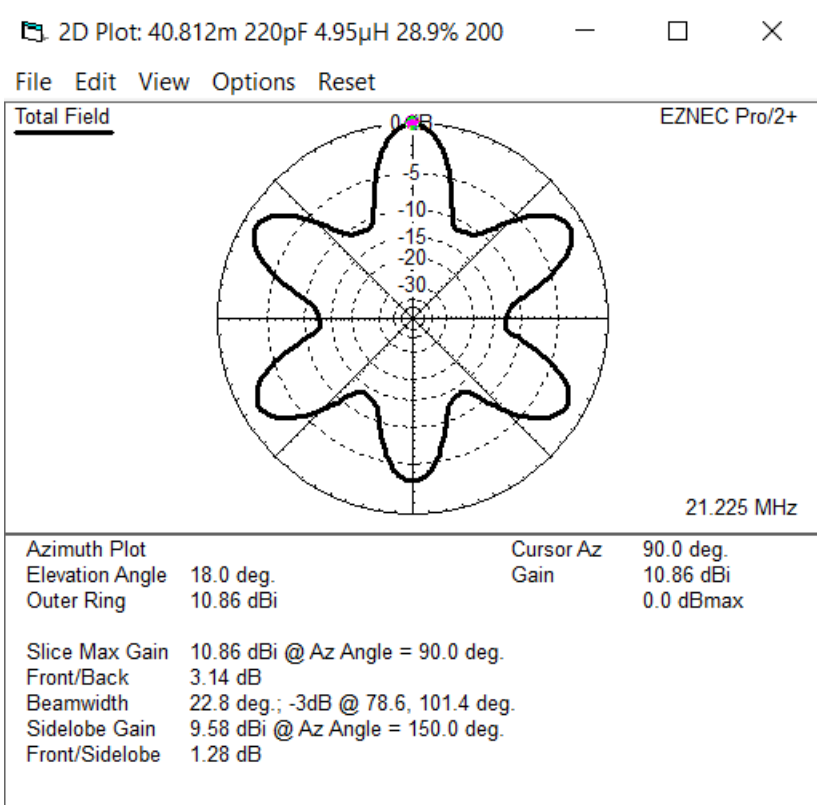
El with 90 degree Az

Compare 20m delta loop vs. 20m square loop azimuth patterns

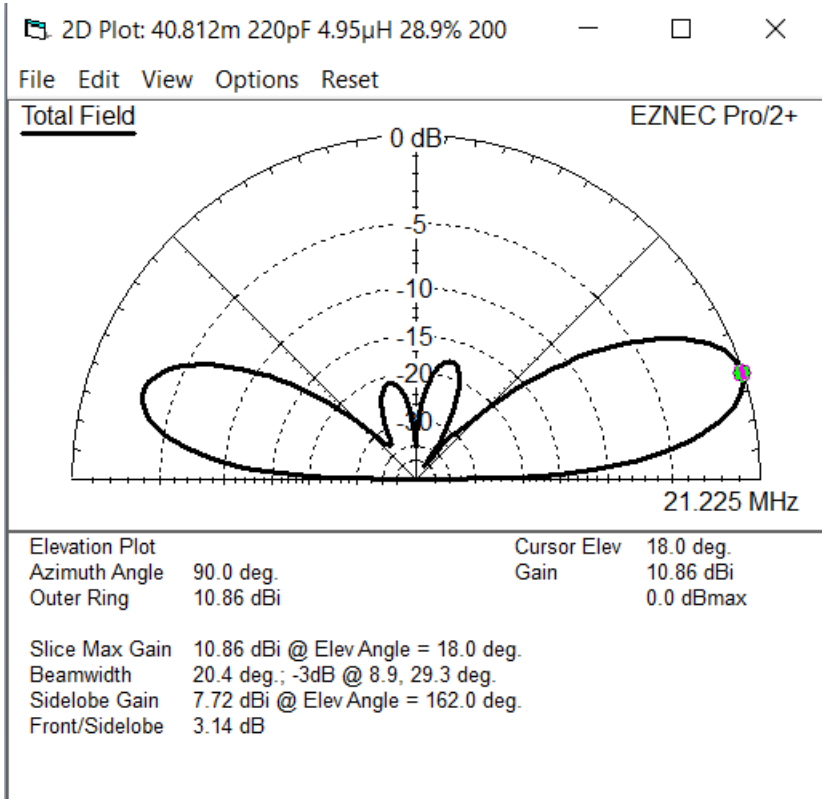


The delta loop is more omnidirectional. The square loop has 4 higher gain major lobes which might be useful if those directions can be taken advantage of.

80m Delta Loop
Antenna Patterns 15m

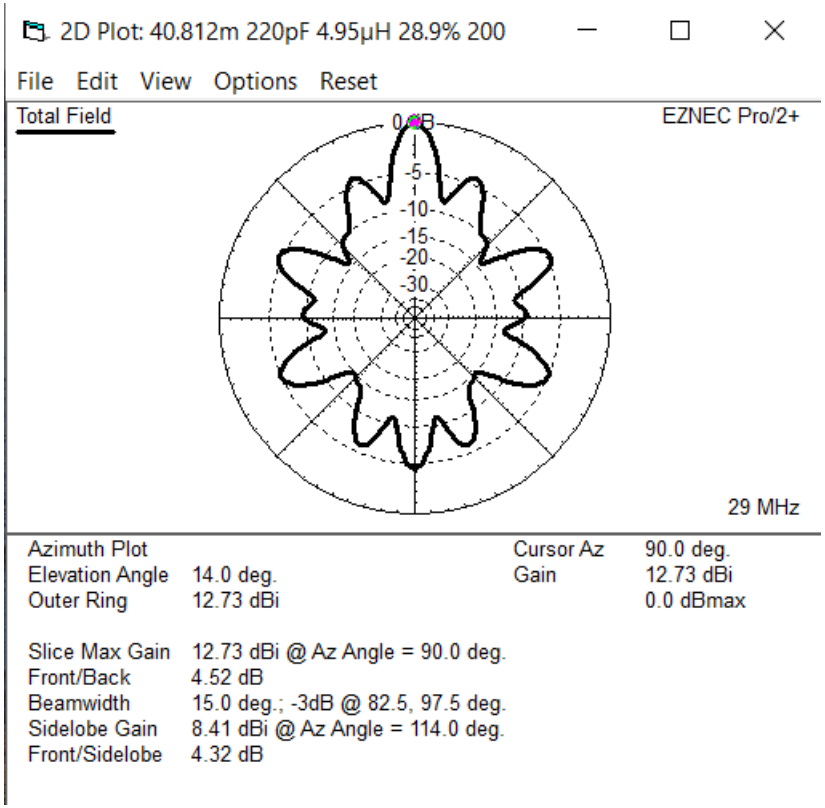


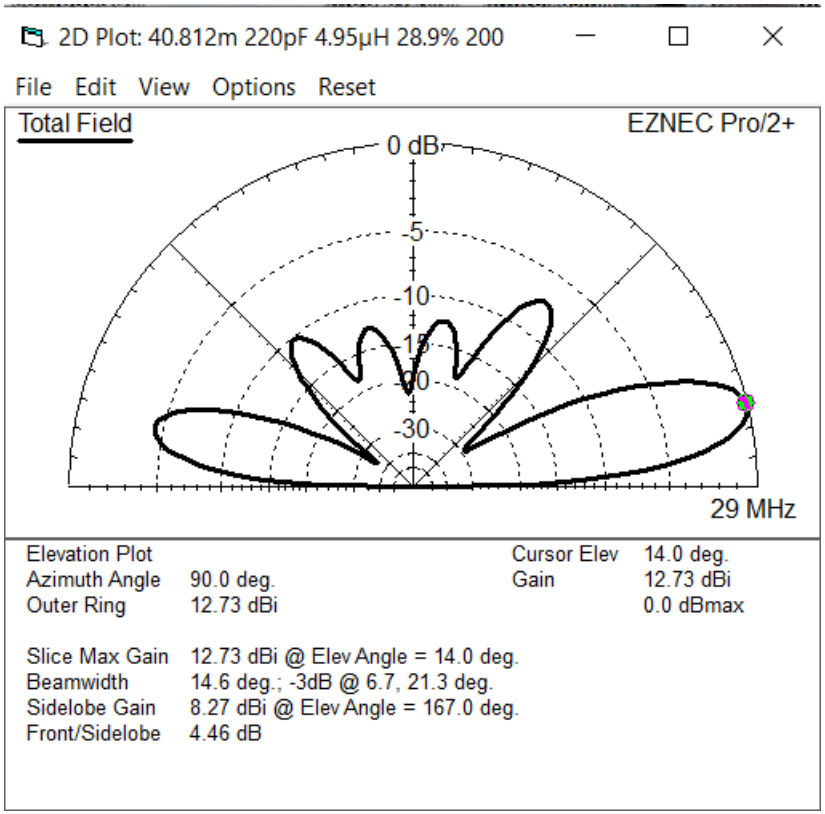
Az with 18 deg El



El with 90 degree Az

80m Delta Loop
Antenna Patterns 10m





Az with 14 deg El

El with 90 degree Az

40-10 meter Horizontal Delta Loop antenna

- About half the physical dimensions of the 80 meter horizontal triangular loop antenna ~ 46 ft per side
- Suitable for lots not having the space for an 80 meter version.
- Similar construction with 30 foot height above ground level (AGL)

80m vs. 40m delta loop performance

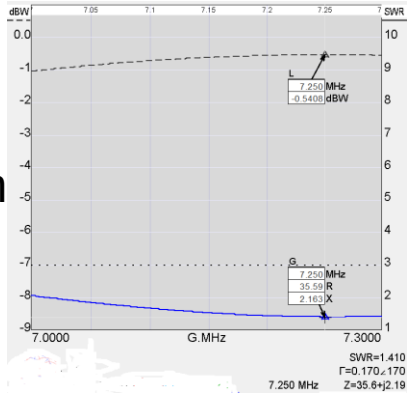
Band	80m Delta Loop		40m Delta Loop	
	TO angle Degrees	Max Gain dBi	TO angle Degrees	Max Gain dBi
80m	90	3.09 at 45 deg TO angle		
40m	51	4.54 at 45 deg TO angle	90	6.71 at 90 deg TO angle
20m	31	9.4	33	7.48
15m	18	10.86	20	8.22
10m	14	12.73	16	11.04

Compare these to a dipole mounted half-wave above average ground: 7.9dBi, 28 degrees take-off angle.

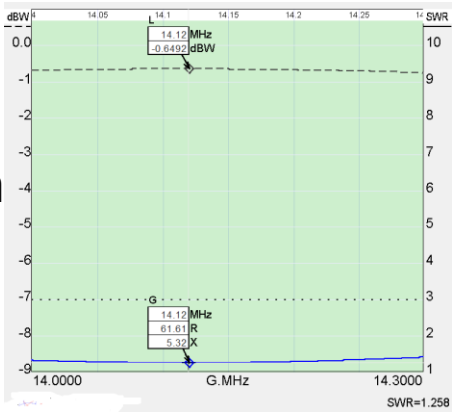
If you have the room, the 80m delta loop is preferred. It has higher gain and lower take-off angle

VSWRs 40M Delta Loop simulated in EZNEC and Simnec

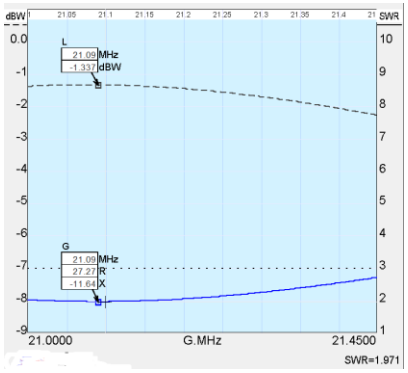
40m



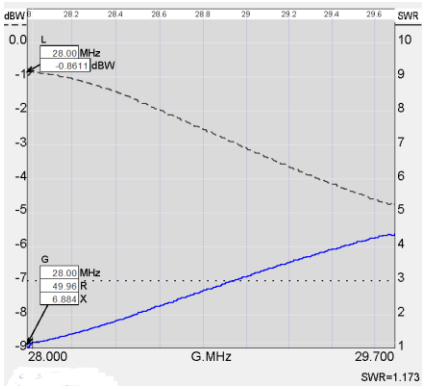
20m



15m



10m



Less than 3:1 VSWR for lower half of 10m

VSWRs include simulation of hybrid balun and 50 ft of RG-8X coax simulated in EZNEC and Simnec

Commercially available horizontal loop antennas

- Palomar Engineers 80-10 Meter Loop Antenna System with 4:1 Balun and Choke Combo, 3-30 MHz, 500/1500/5000 PEP Option
  - $199.95 500W PEP
  - +$60.00 1500W PEP
  - +120.00 5000 wattsPEP
- Chamelion Skyloop II antenna sold by Dx Engineering
  - $299 250W CW or 500W SSB

What about the Vertical Delta Loop as a multiband antenna?

- Advantage: much easier to mount with a single vertical pole and quicker to deploy.

- Disadvantage as a multiband antenna:
  “The delta loop when set up vertically, can be used on all bands, just as can almost any wire antenna that is at least 3/8 wavelength long at the lowest frequency to be used. However, whatever the configuration (apex up or down) and whatever the feedpoint (corner, apex, mid-horizontal, SCV, mid-side), it is unlikely to outperform even a simple center fed wire at the same height as the top of the delta.” – L. B. Cebik (SK)

  See Notes on All-band use of Vertical Plane Deltas – L.B. Cebik W4RNL (SK) for more information

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Resource Links

- L.B. Cebik, W4RNL “Antennas made of Wires” Vol. 3 Page 553, Chapter 70: “All-Band Horizontal-Plane Loops”
- L. B. Cebik, W4RNL “Horizontal Wire Loops “How Big? How High? What Shape?” (2 wavelength long loops)
- Tilted delta loop: “The Full Wave Delta Loop at Low Height”. QST Magazine, Oct. 1984, Doug DeMaw, W1FB and Lee Aurick, W1SE
- The ARRL Antenna Book 24th edition
  - 5.1.4, “Horizontal Loops”
  - 10.1.10 “Horizontal Skywire”
- 8-band Horizontal Loops – Rick Westerman DJ0IP (see lower half of web page)
- 80 meter Sky Loop Antenna – OH8STN
- Square loop and Delta loop VSWR measurements – Rick Westerman DJ0IP
- Square loop and Delta loop antenna pattern comparison with comments - Rick Westerman DJ0IP
- Notes on All-band use of Vertical Plane Deltas – L.B. Cebik W4RNL (SK)

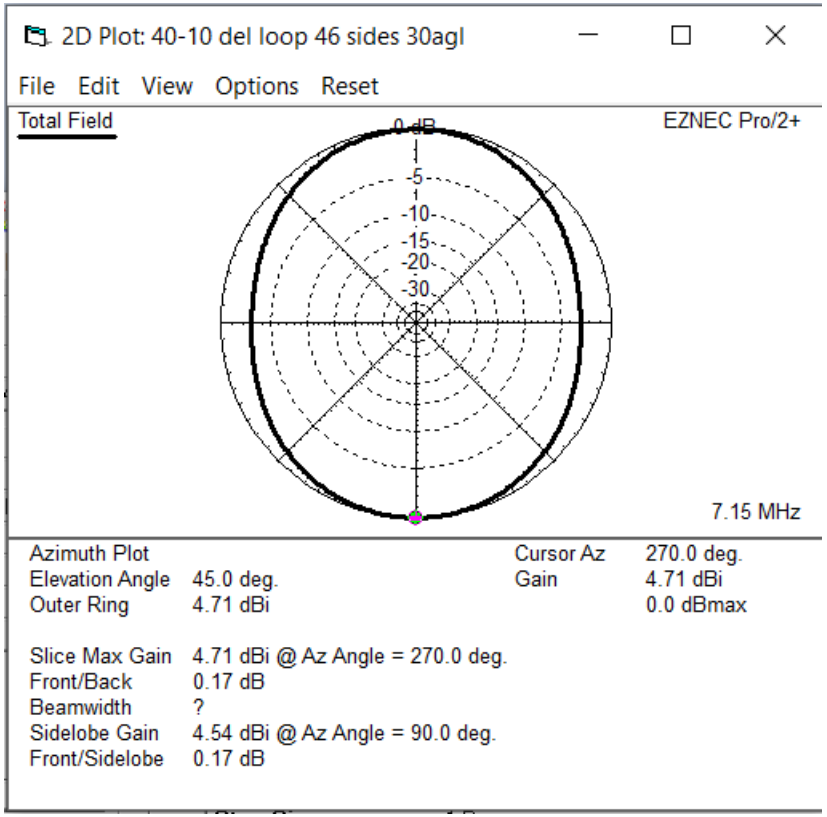
Appendix 1

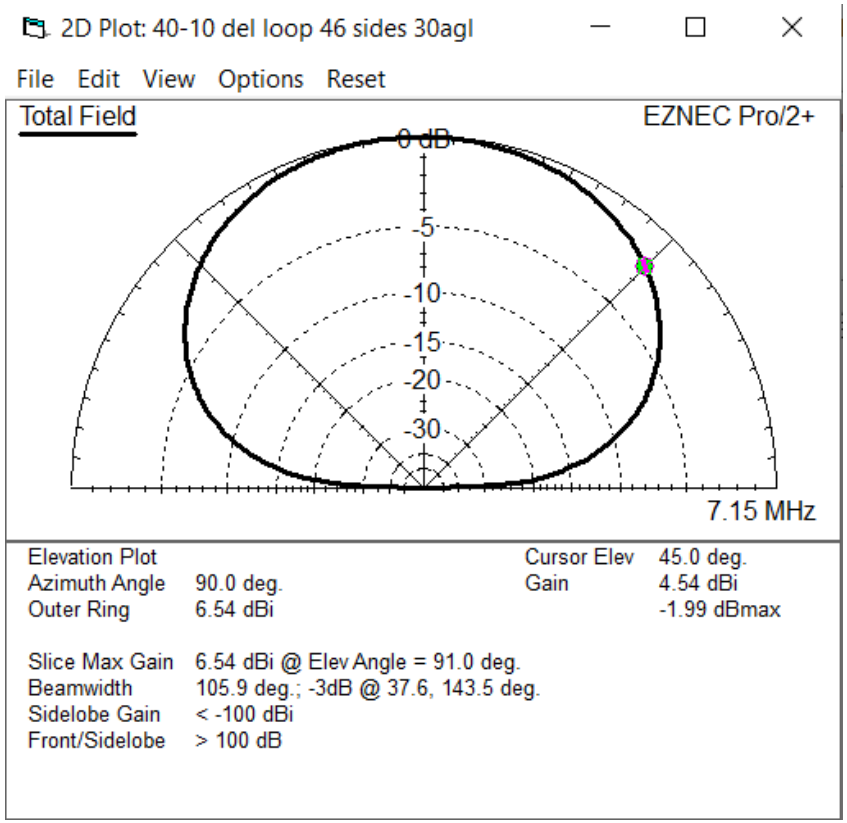
40 meter horizontal Delta Loop Antenna Patterns

and

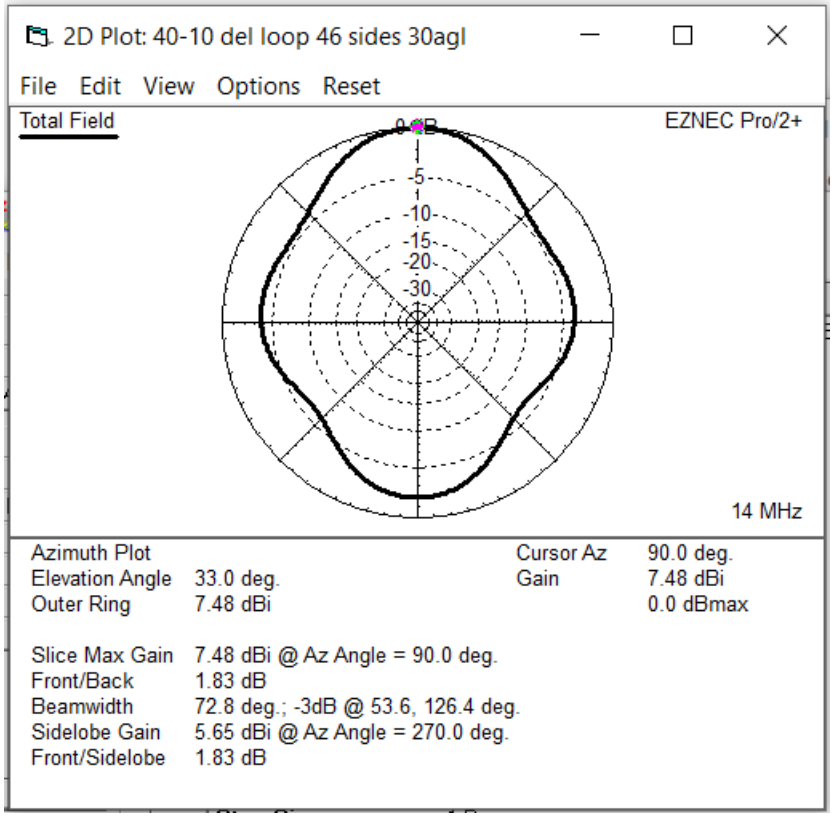
Comparison of 80-10 meter Delta Loop to Square loop antenna patterns

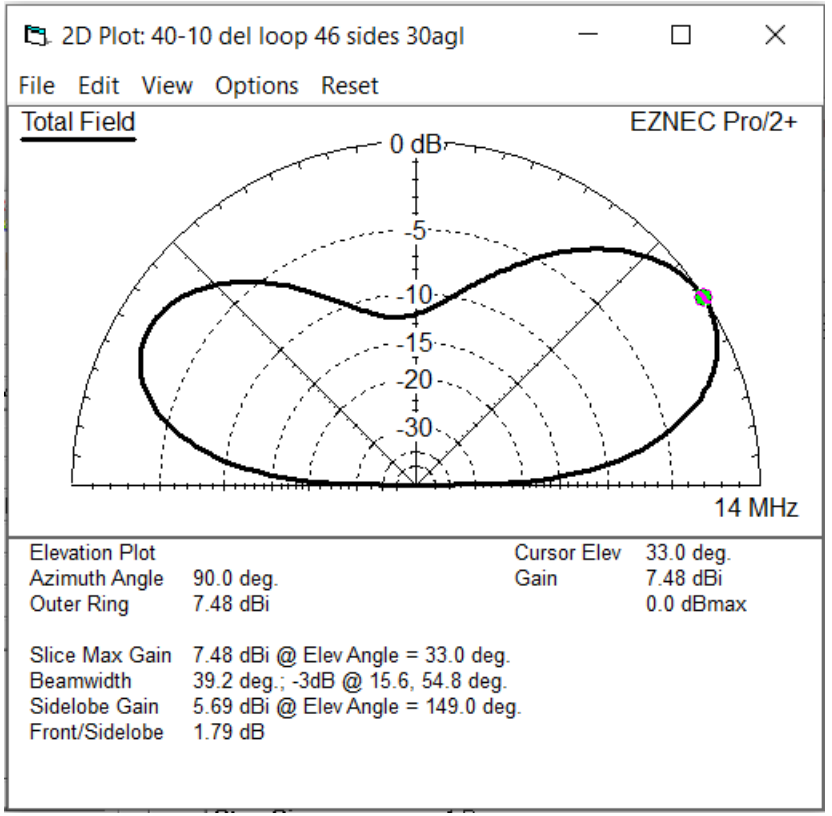
40m Delta Loop
Antenna Patterns 40m



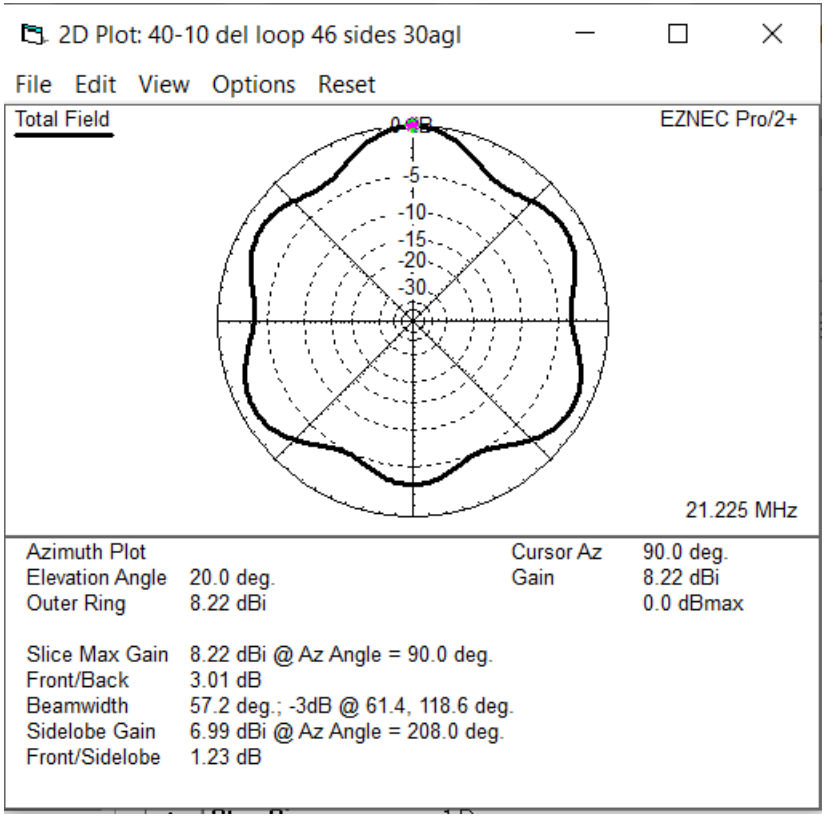


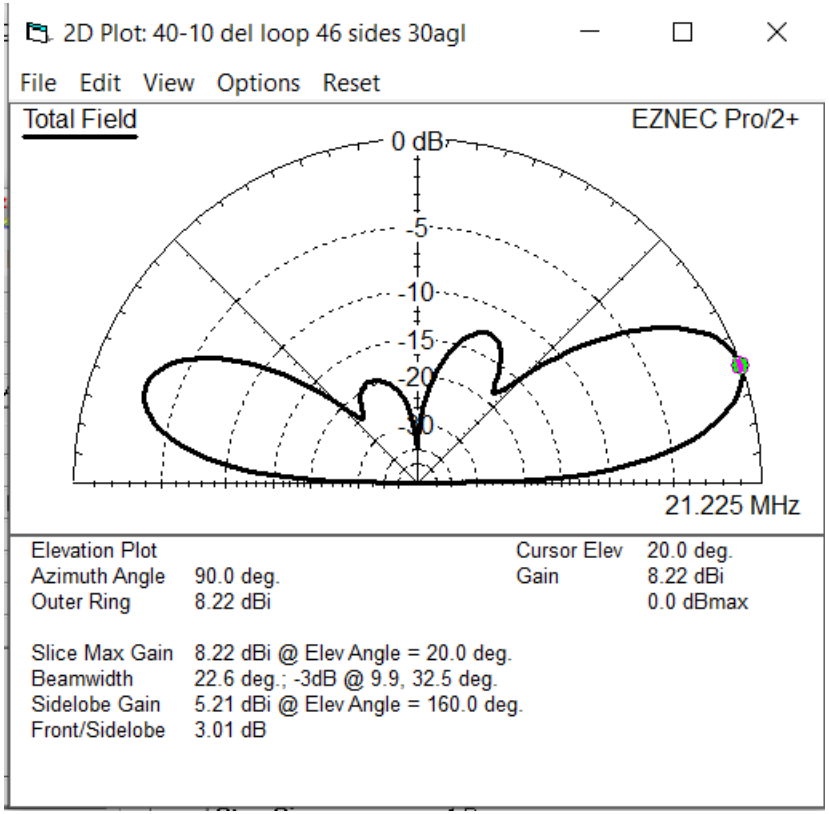
40m Delta Loop
Antenna Patterns 20m



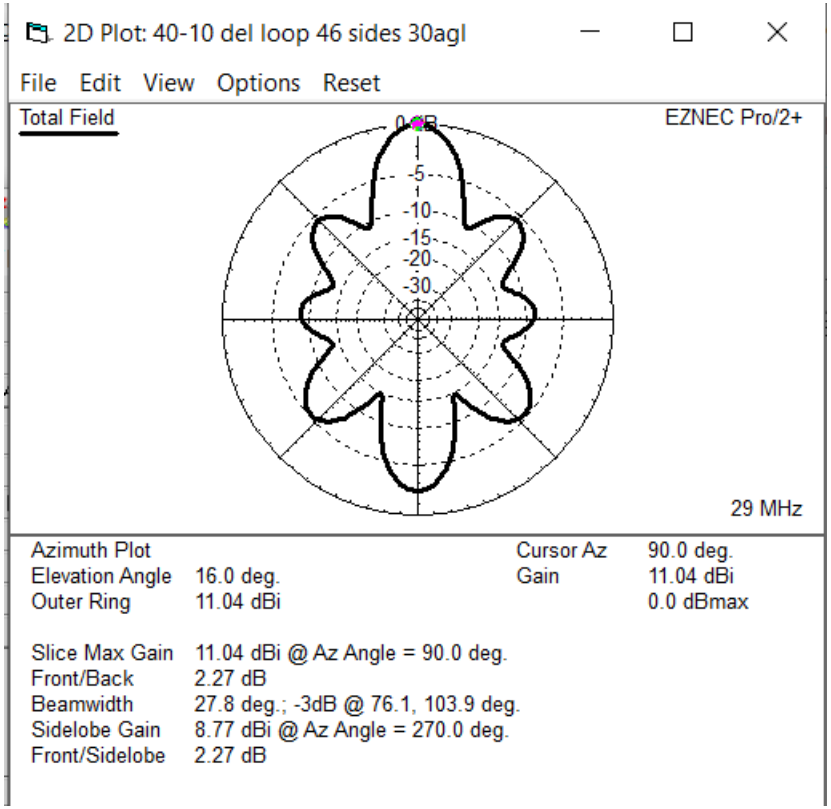


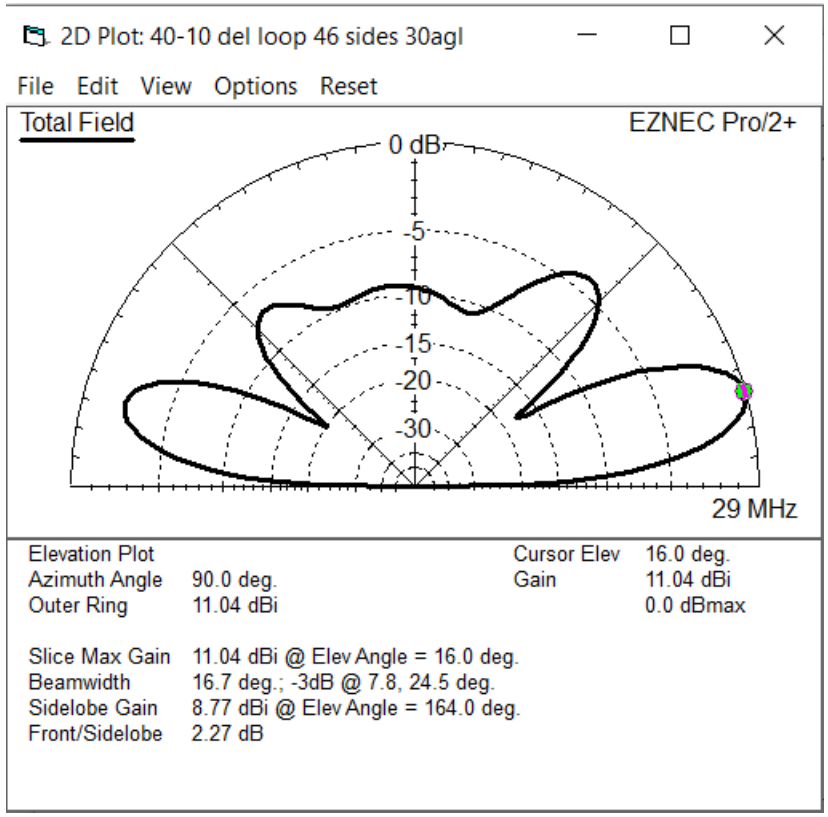
40m Delta Loop
Antenna Patterns 15m





40m Delta Loop
Antenna Patterns 10m





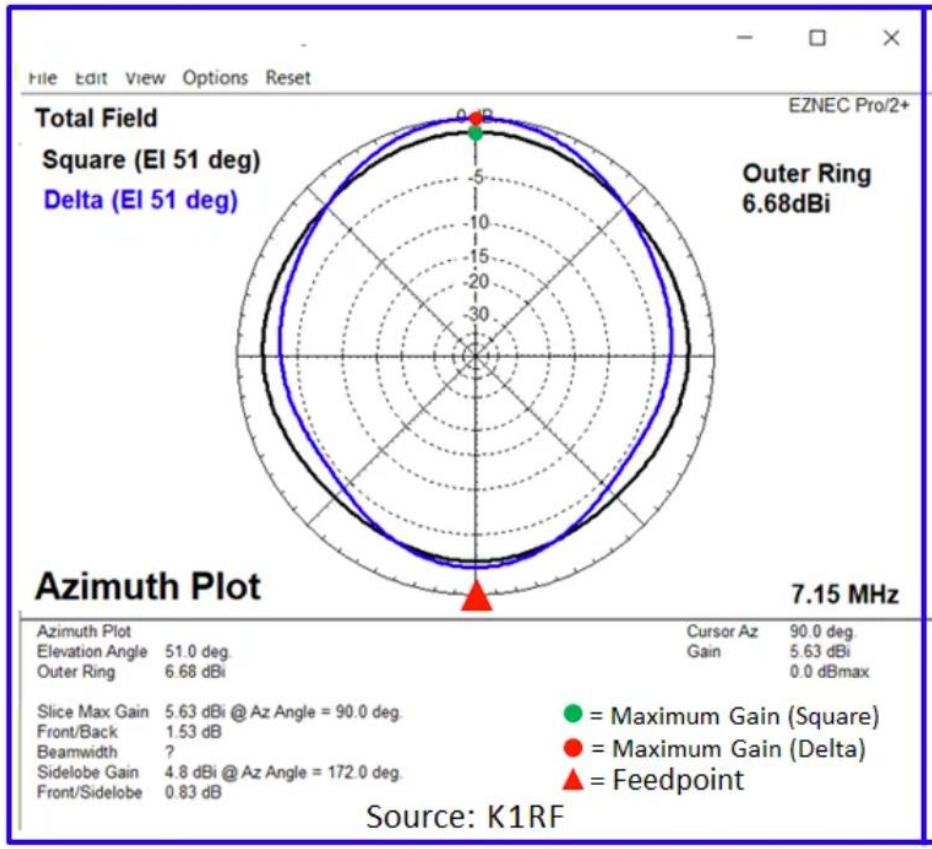
Compare 80 meter Delta to Square antenna patterns

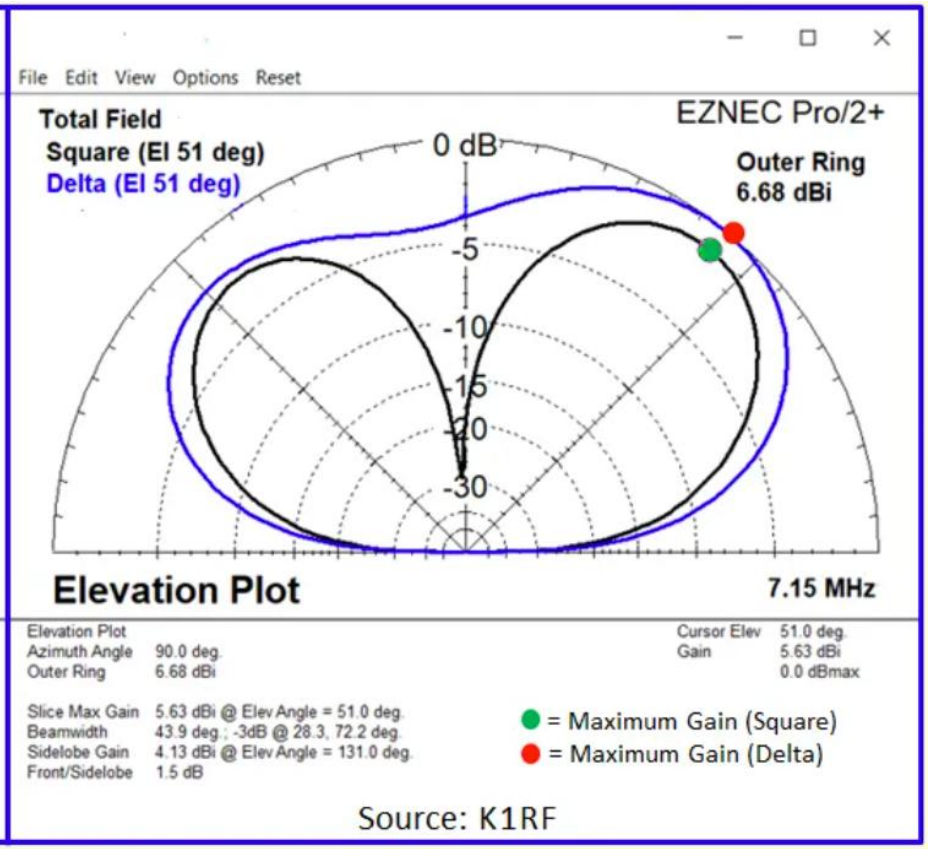
80 meters

Basically The same

Compare 80 meter Delta to Square antenna patterns

40 meters

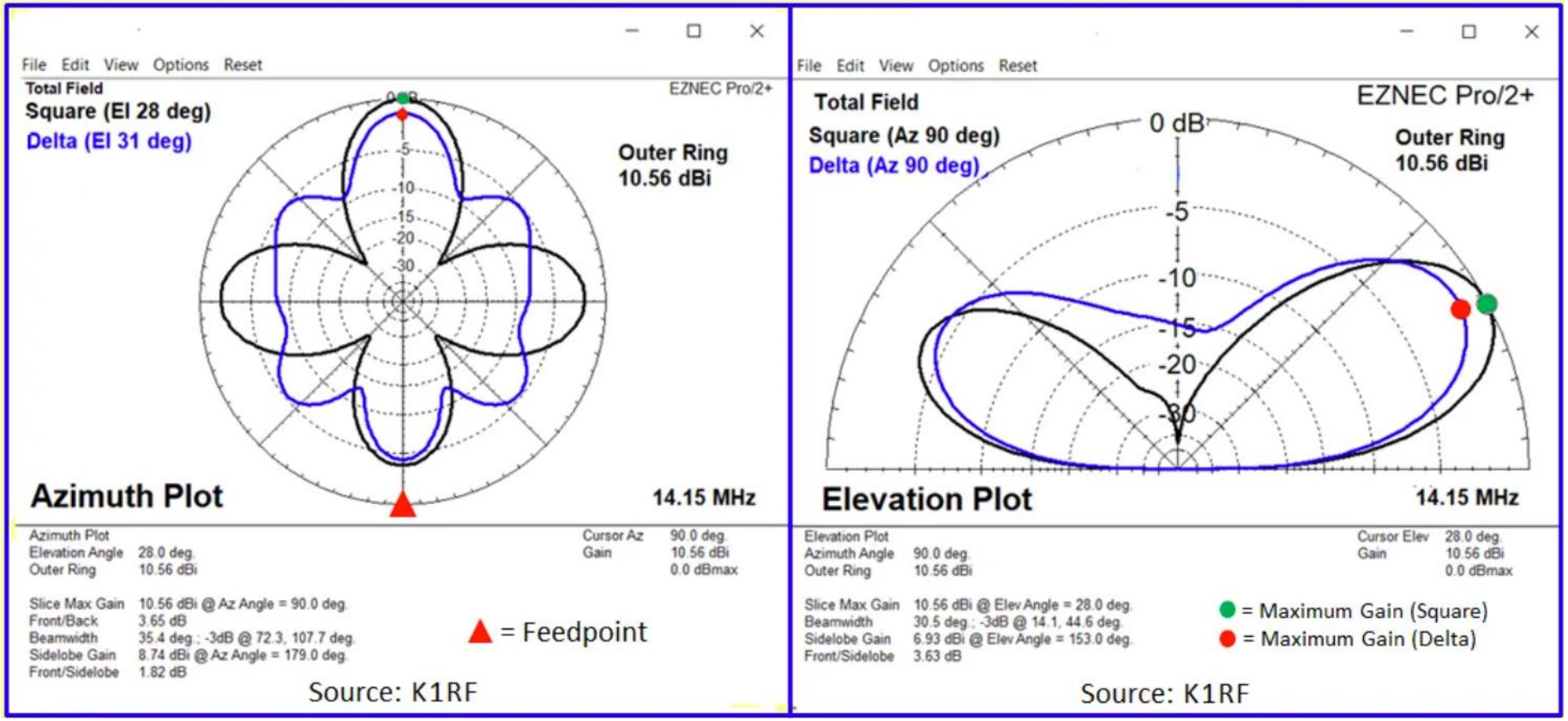




Similar in azimuth – Delta Loop slightly narrower pattern with slightly more gain

Compare 80 meter Delta to Square antenna patterns

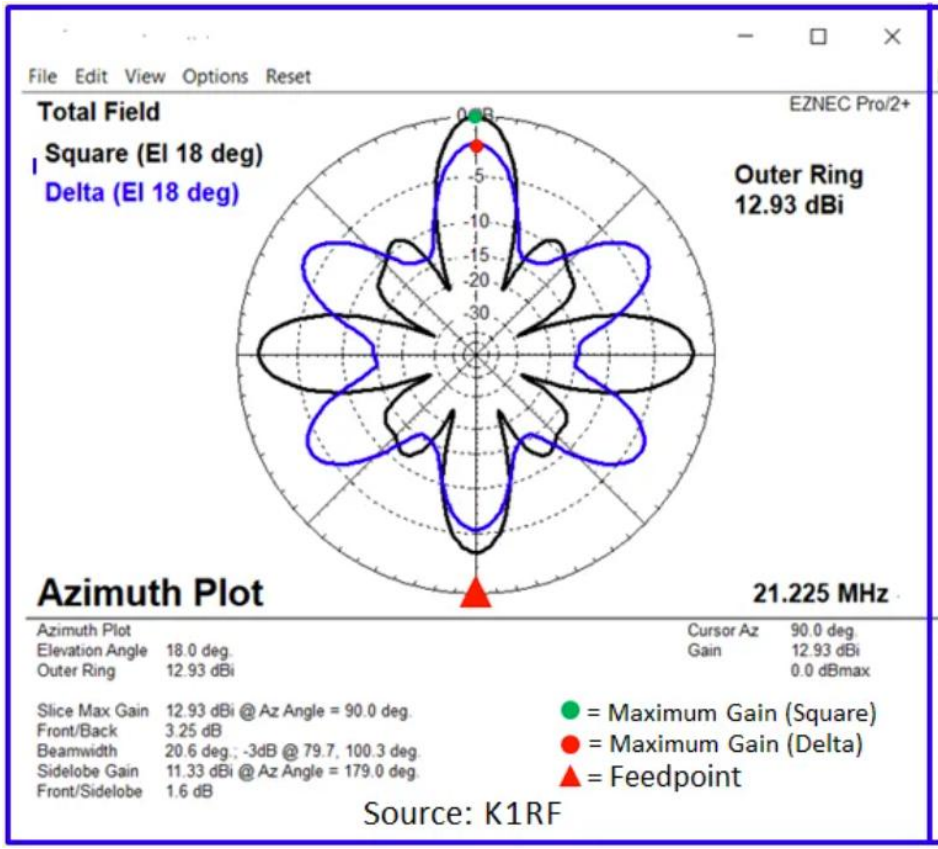
20 meters

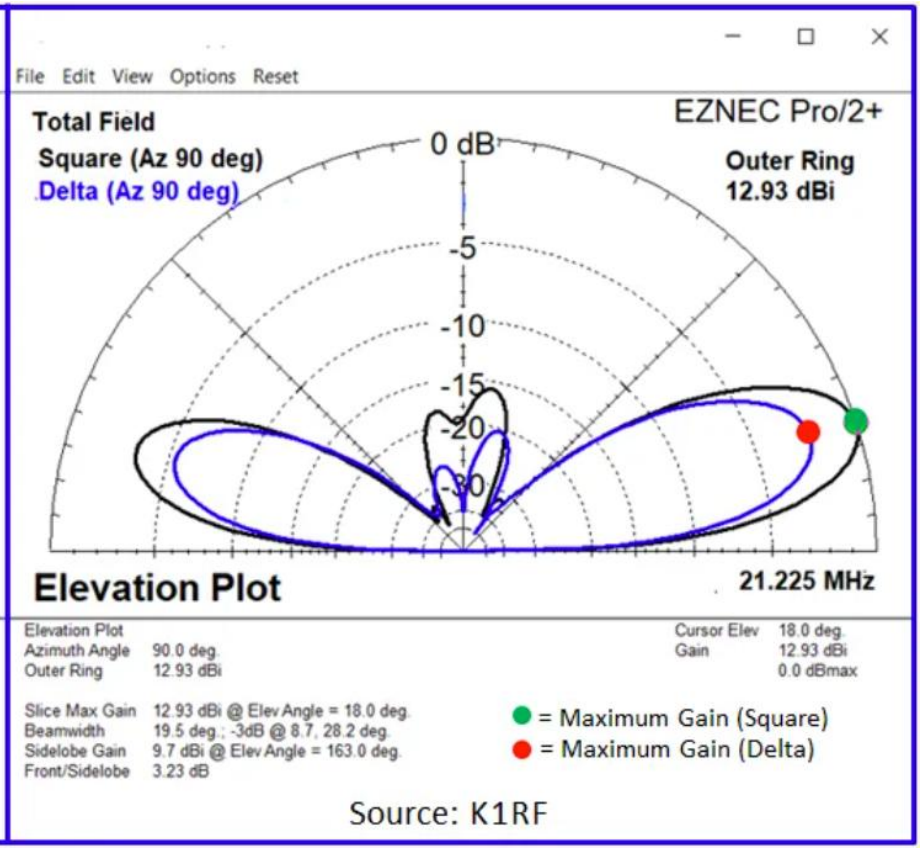


Marked difference in azimuth patterns. Square has higher gain lobes but deeper nulls. Which configuration is better will depend on the QTH and preferences.

Compare 80 meter Delta to Square antenna patterns

15 meters

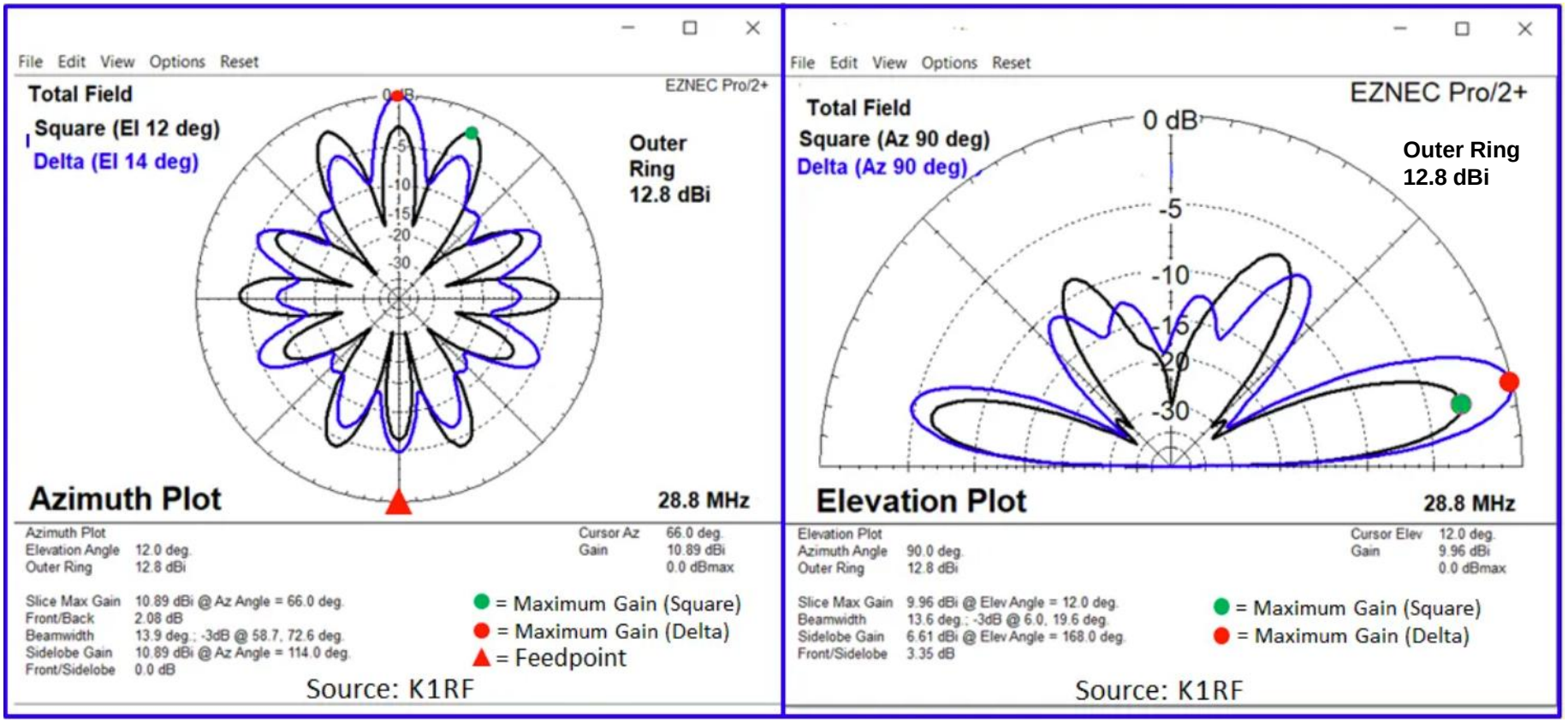




Complex lobe pattern. Delta-Loop has 6 horizontal lobes, the Square Loop has 8.

Compare 80 meter Delta to Square antenna patterns

10 meters



Complex lobe patterns. Many lobes and nulls. Square has higher gain lobes.