Antennas 101

Part 1

Dipoles, Doublets and Verticals

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NV5E

Including:

- Dipoles
- Doublets
- Loops
- Windoms
- G5RV
- End Fed Half Wave (EFHW)
- Beverage

Definitions

- Isotropic Radiator – A theoretical antenna in free space that radiates equally well in all directions.
- Gain – Increase in amplitude of a signal, measured in dB
- Decibel (dB) – Logarithmic measurement of gain.
- dBi – Gain measured in relation to an isotropic radiator

Definitions

- dBd – Gain measured in relation to a dipole, dBd = dBi + 2.15.
- Azimuth Pattern – Radiation pattern of the antenna when viewed from above. Directional or omni directional.
- Elevation Pattern – Angle of maximum radiation in relation to the ground. Lower is better for DX.
- Balun – Short for BALanced/UNbalanced. A device to force equal currents in coax.

How Much Gain is a dB?

- 0 dB = 1
- 1 dB = 1.26
- 2 dB = 1.58
- 3 dB = 1.99
- 4 dB = 2.51
- 5 dB = 3.16
- 6 dB = 3.98 = 1 S unit
- 7 dB = 5.01
- 8 dB = 6.31
- 9 dB = 7.94
- 10 dB = 10

Dipole

- 2.15 dB gain over an Isotropic Radiator
- Balanced design
- Resonant on one band
- Traps can be added to make it multiband
- Fan Dipole
- Nominal 50 ohm impedance
- Gain increases with height (true for all antennas)
- Formula for calculating dipole length 468/F (MHz)

29-MHz Dipole at Various Heights above Average Ground						Table 3
Height wl	Len feet	Feed R	Feed X	Gain dBi	Gain dBd	El Angle
0.0625	16.14	59	0.2	0.49	-1.66	90
0.125	16.01	55.2	0	4.64	2.49	88
0.1875	15.94	65.8	-0.3	5.78	3.63	87
0.25	16.02	77.9	0.3	5.73	3.58	62
0.3125	16.17	85	0.1	5.75	3.6	46
0.375	16.32	84.7	0	6.07	3.92	37
0.4375	16.4	78.4	0.3	6.62	4.47	32
0.5	16.38	70.2	0.2	7.23	5.08	28
0.5625	16.29	64.5	-0.1	7.66	5.51	25
0.625	16.18	63.8	-0.2	7.75	5.6	22
0.6875	16.13	67.4	0.3	7.56	5.41	20
0.75	16.13	72.8	0.1	7.28	5.13	18
0.8125	16.18	77.1	0	7.12	4.97	17
0.875	16.26	78.1	0.1	7.15	5	16
0.9375	16.31	75.7	-0.1	7.34	5.19	15
1	16.31	71.6	-0.2	7.63	5.48	14
1.0625	16.27	68.2	0.2	7.85	5.7	13
1.125	16.21	67.2	0	7.9	5.75	12
1.1875	16.17	69	0.1	7.81	5.66	12
1.25	16.17	72.3	0.3	7.63	5.48	11
See text for explanation of column labels.						

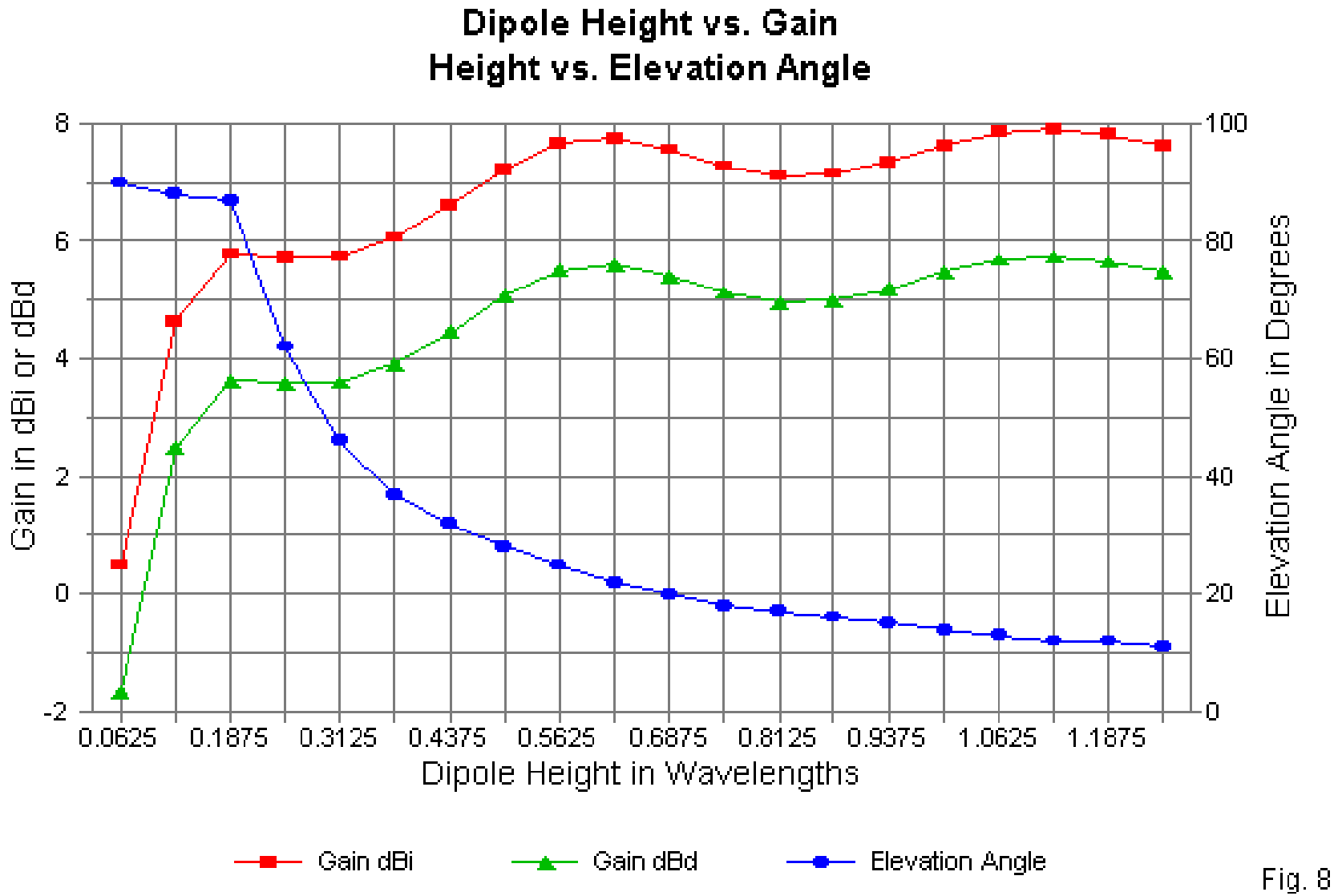
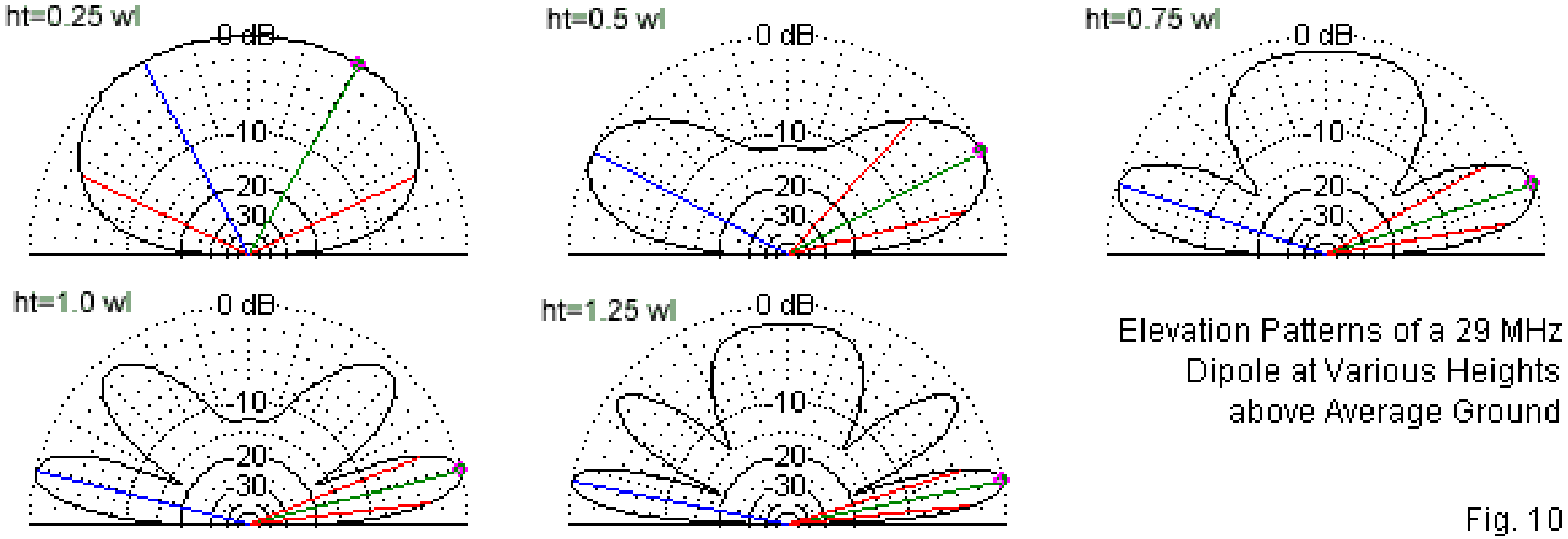

Dipole Height vs. Gain
Height vs. Elevation Angle
Gain in dBi or dBd
Elevation Angle in Degrees
Dipole Height in Wavelengths
8
6
4
2
0
-2
100
80
60
40
20
0
0.0625
0.1875
0.3125
0.4375
0.5625
0.6875
0.8125
0.9375
1.0625
1.1875
Gain dBi
Gain dBd
Elevation Angle

Fig. 8

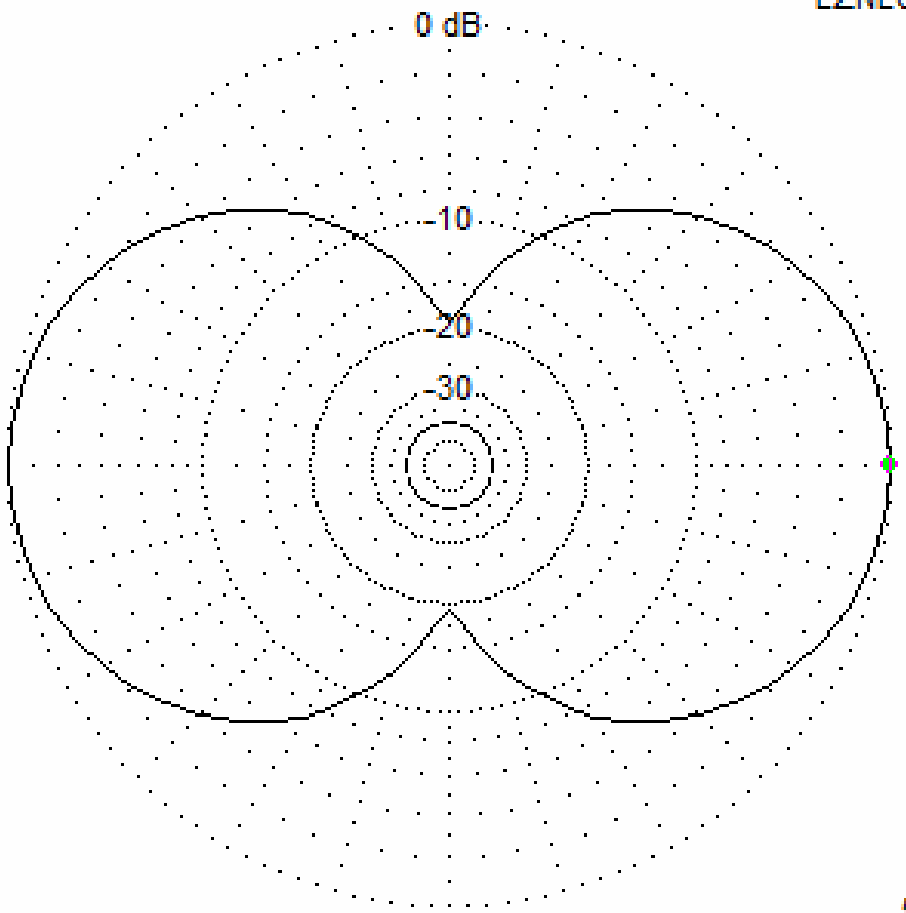


Elevation Patterns of a 29 MHz Dipole at Various Heights above Average Ground

Fig. 10

Diagrams from www.cebik.com

EZNEC ARRL



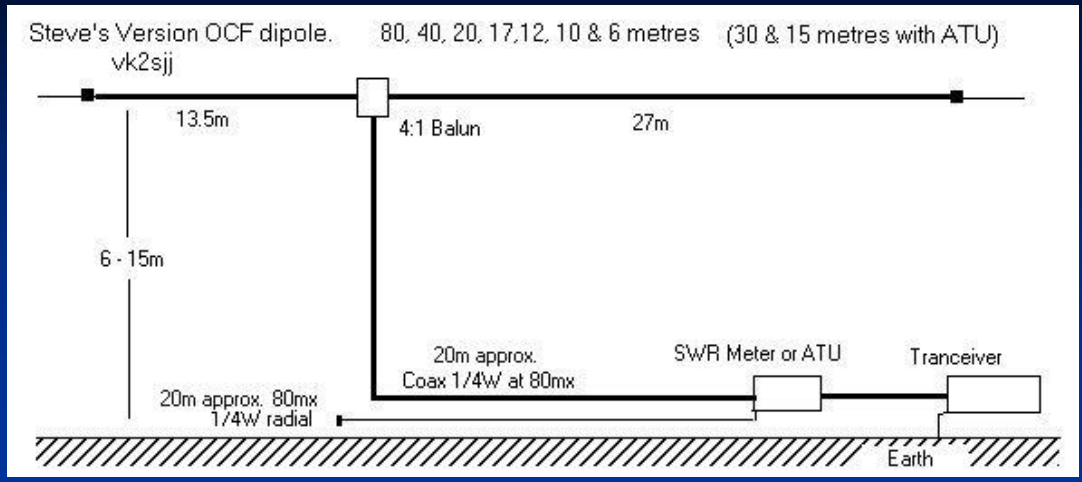
52 MHz

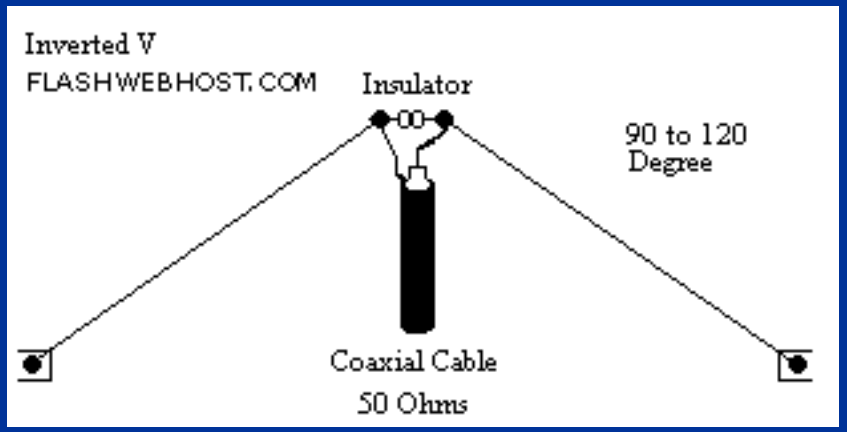
Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	15.0 deg.	Gain	7.67 dBi
Outer Ring	7.67 dBi		0.0 dBmax

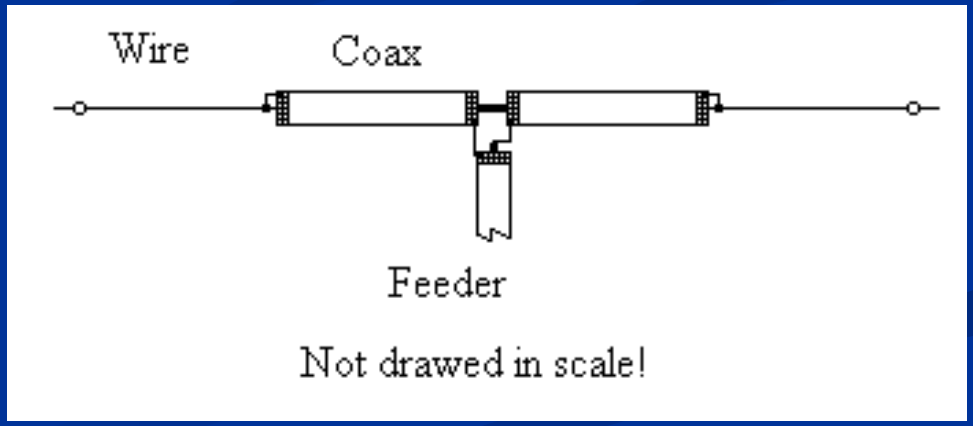
3D Max Gain	7.67 dBi
Slice Max Gain	7.67 dBi @ Az Angle = 0.0 deg.
Front/Side	19.13 dB
Beamwidth	79.6 deg.; -3dB @ 320.2, 39.8 deg.
Sidelobe Gain	7.67 dBi @ Az Angle = 180.0 deg.
Front/Sidelobe	0.0 dB

Dipole Cousins

- Inverted V – Only needs one support. 5% shorter than a dipole. Takes up less space.
- Off Center Fed Dipole – Feed point is 20-33% from one end. Feed point impedance is high and requires a 4-1 balun.
- Windom – Similar to the OCFD. Fed at 34% from the end, it uses a single feed wire and can be resonant on more than one band.
- Double Bazooka – Broad banded dipole made out of coax.

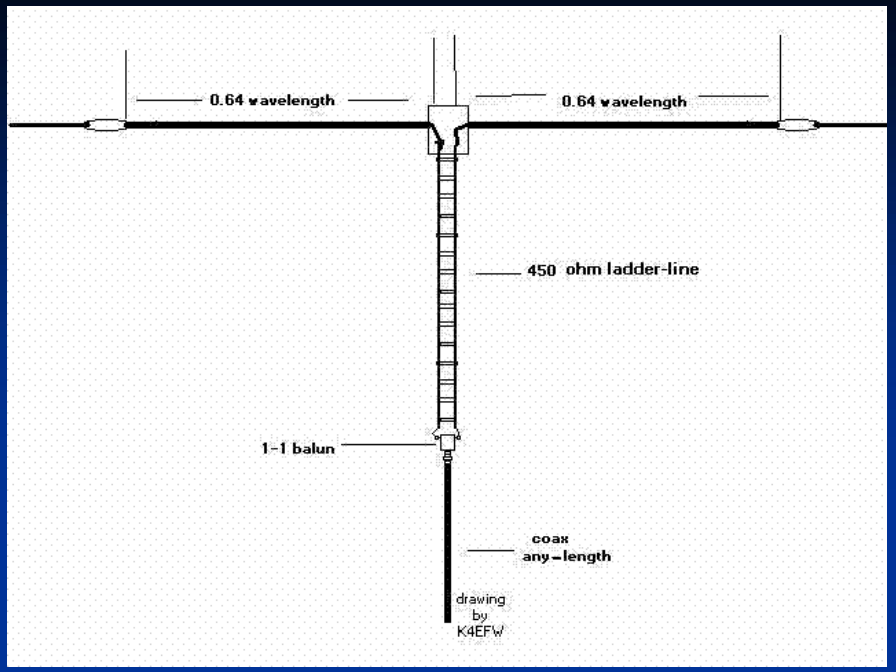

Steve's Version OCF dipole.
vk2sjj
80, 40, 20, 17,12, 10 & 6 metres
(30 & 15 metres with ATU)
13.5m
4:1 Balun
27m
6 - 15m
20m approx.
Coax 1/4W at 80mx
SWR Meter or ATU
Tranceiver
20m approx. 80mx
1/4W radial
Earth

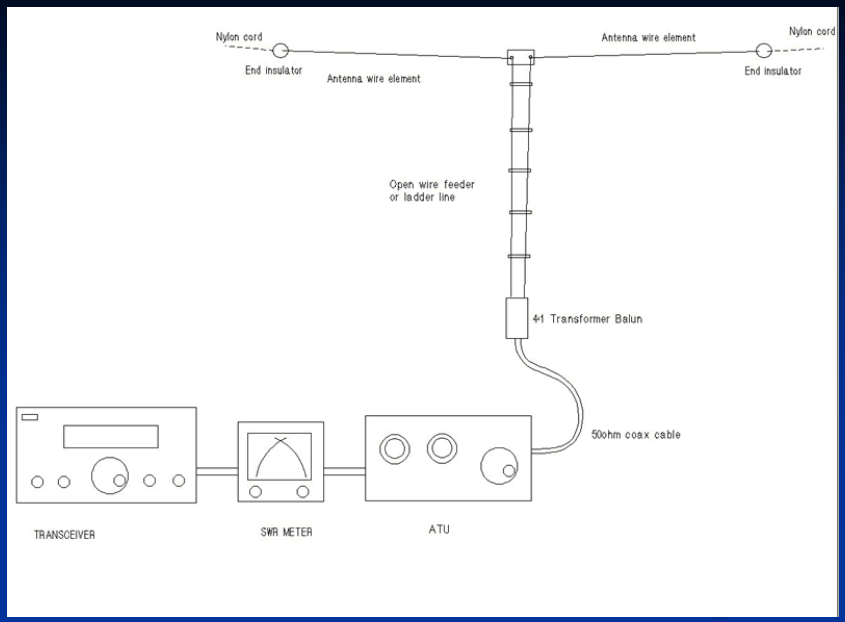

Inverted V
FLASHWEBHOST.COM
Insulator
90 to 120
Degree
Coaxial Cable
50 Ohms

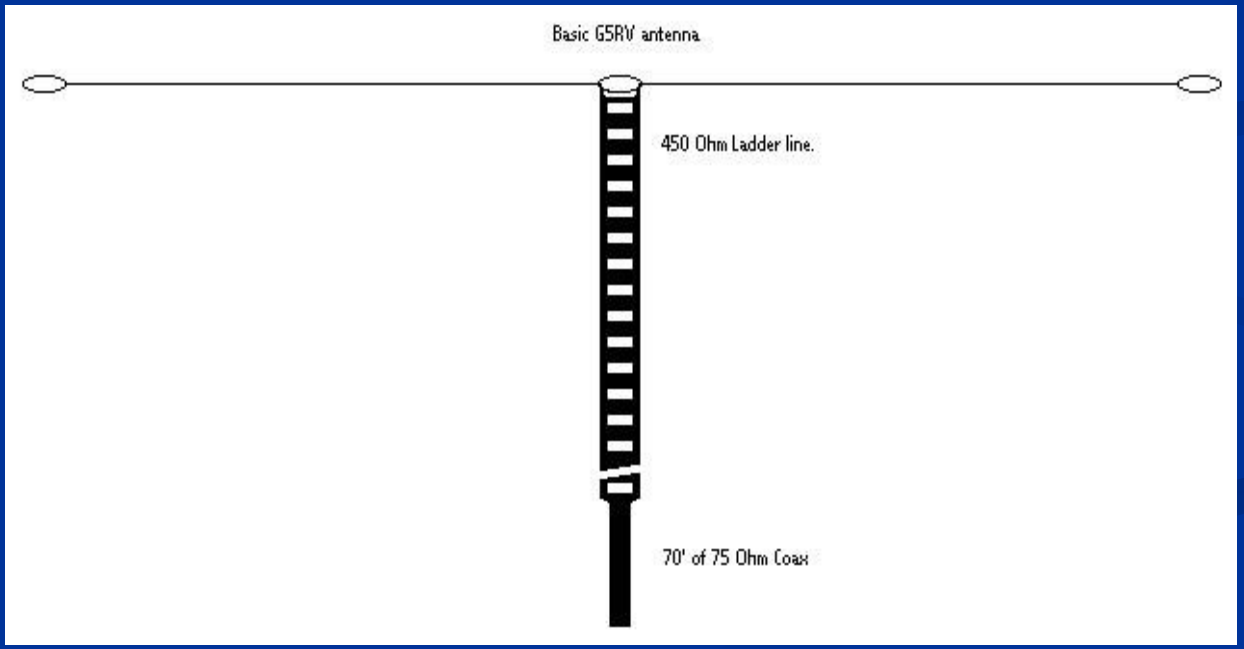

Wire
Coax
Feeder
Not drawed in scale!

Doublets

- Doublet – Multi-band antenna that is not resonant on a particular band. 88 ft and 44 ft are popular lengths. Requires antenna tuner.
- G5RV – 102 ft. (3/2 λ) doublet with 31 (1/4 λ) ft of ladder line, then fed with coax. Designed as a 20m antenna. Multi-band with antenna tuner.
- Extended Double Zepp – Longer than a dipole (5/8 wave or longer). 3 dB gain over a dipole. Fed by ¼ λ ladder line into a balanced tuner.


0.64 wavelength
0.64 wavelength
450 ohm ladder-line
1-1 balun
coax
any-length
drawing
by
K4EFW


Nylon cord
End insulator
Antenna wire element
Antenna wire element
Nylon cord
End insulator
Open wire feeder
or ladder line
4:1 Transformer Balun
50ohm coax cable
TRANSCEIVER
SWR METER
ATU


Basic G5RV antenna
450 Ohm Ladder line.
70' of 75 Ohm Coax

Loops

- A horizontal or vertical full wave continuous wire. One end connected to each lead of the feed line.
- Horizontal should be a square
- Vertical can be a square, circle, triangle (delta loop) or rectangle.
- Can be fed on anywhere along the loop.
- Mount triangles point down and feed at bottom.
- Impedance 80 – 150 ohms, use 2 – 1 or 4 – 1 Balun

Rhombics

- Four long wires forming two V's connected with a terminating resistor, making a large rhombic shape.
- Very large, each leg at least 1 – 2 wavelengths long.
- Very directional
- High gain
- Broad banded – consistent gain and impedance over a 2 - 1 bandwidth.

Vertical Antennas

- Mono band ¼ wavelength with ¼ wave counter poise or radials or
- Vertical Dipole that does not require radials.
- Can be multiband with traps. Requires ¼ wave radials for each band or many (60+) short radials.
- Noisier than horizontal antennas
- Easier to hide in antenna restricted areas (can be disguised as flagpole or be a single wire in a tree)
- Gain is less than a dipole but the low angle of radiation is good for DX

End Fed Half Wave

- A dipole antenna that's fed at one end instead of the middle
- Very high impedance, 1800 - 5000 Ω.
- Requires a balun
- Single wire feed line
- Very light, popular for QRP and backpacking
- Par Electronics End Fedz

Transmission Lines

- RG-58
- RG-8/U
- RG-8/x (Mini 8)
- RG-213
- LMR400
- RG-59
- RG-6
- Ladder Line

Coax Connectors

- SMA
- BNC
- UHF
- N

Questions?

- Sources:
- Arrl Antenna Handbook – buy a used copy
- www.cebik.com – Website of L.B. Cebik, W4RNL (SK). Must register, but it's free. There more good information here than anywhere!
- www.google.com is your friend.

Antennas 101

Part 2

Directional And Gain Antennas aka “Beams”

Rob May

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Types of Beams

- Yagi – Uda
- Moxon
- Log Periodic
- Quad
- Hex (Spider) Beam

Yagi Antennas

- Multi Elements – Driven element, reflector and director(s)
- Two to Ten or more elements
- About 70Ω nominal impedance
- Mono or Multiband
- Three element tri-bander (20 - 15 - 10m) is the most common

Long, Medium, and
Short Boom Yagi
Free Space
Azimuth Patterns

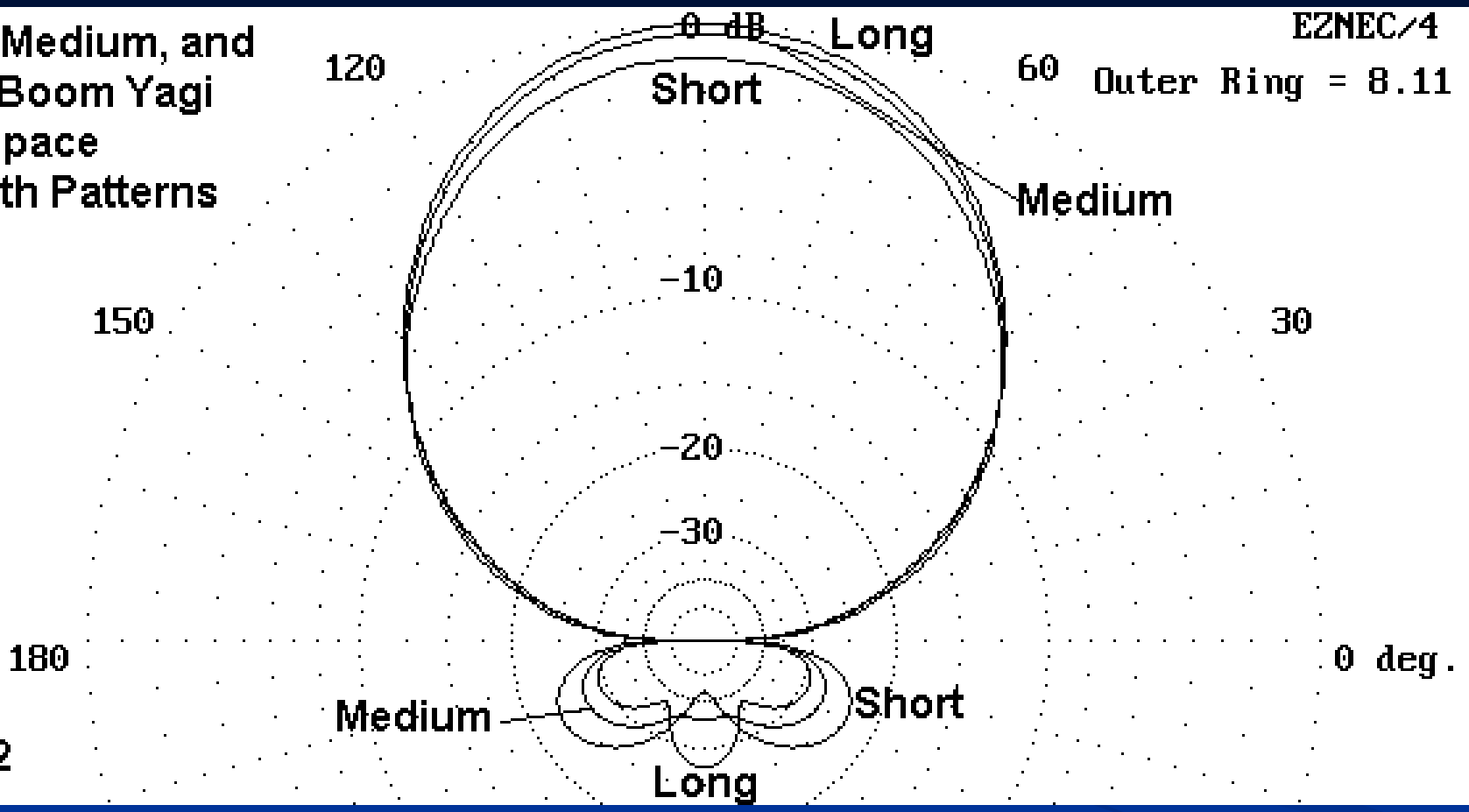
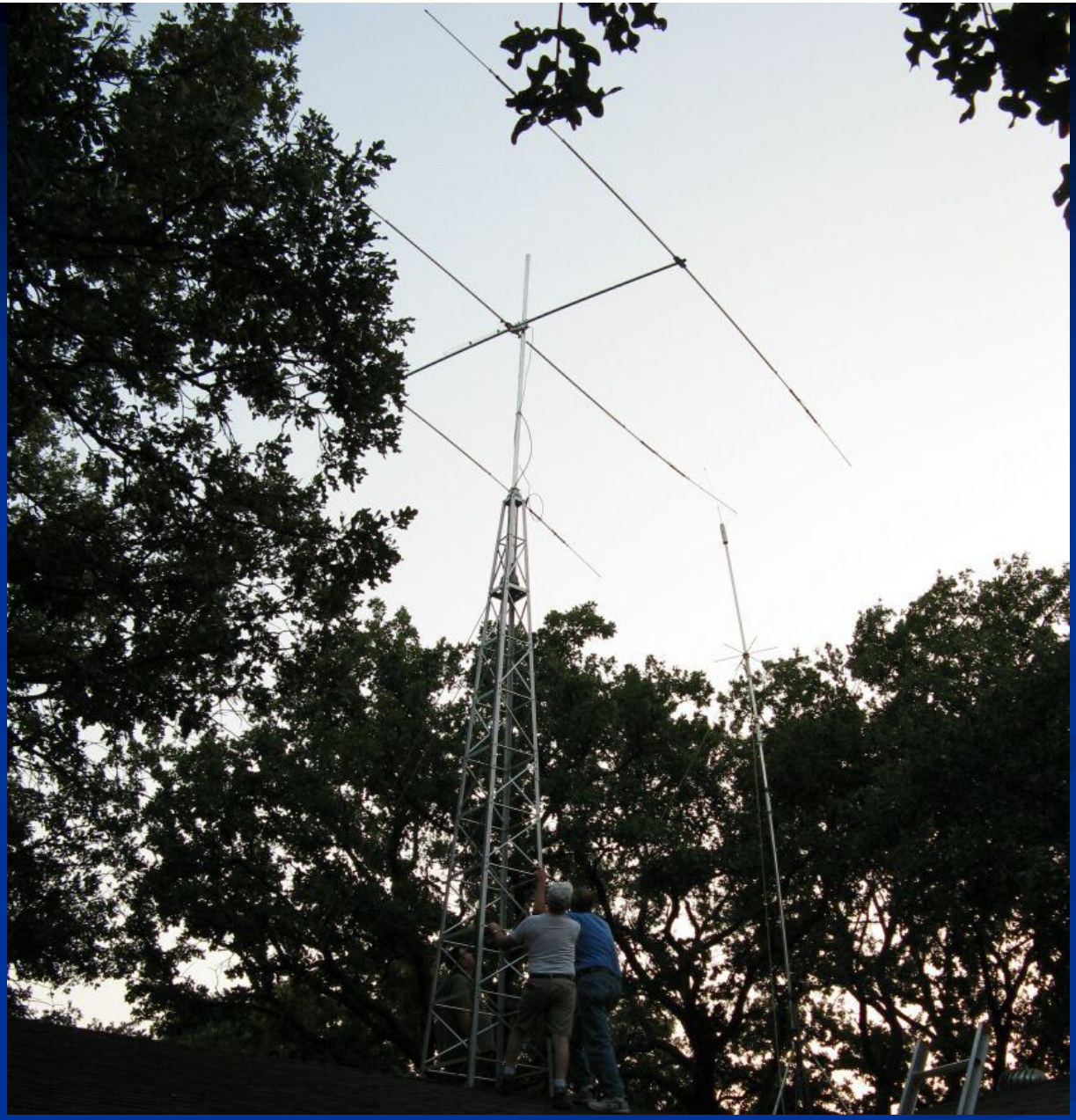


Fig. 2

Yagi azimuth pattern.



Hy-Gain TH-3JRS

Moxon

- Invented by Les Moxon, G6XN
- Variation of the Yagi – Uda
- More compact than Yagi, slightly less gain (0.2 dB)
- Popular for Field Day and Portable use
- Very high F/B ratio

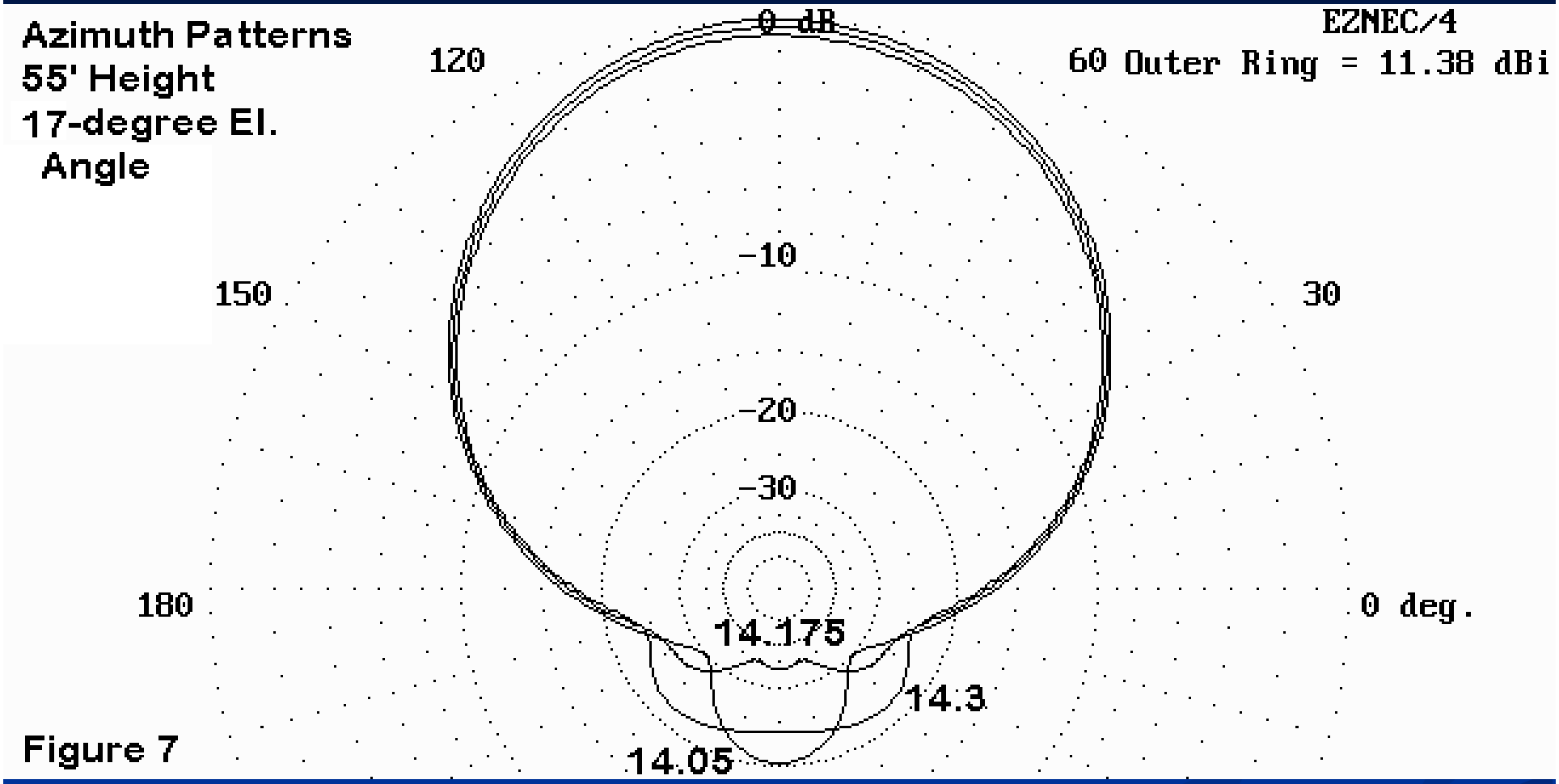


Figure 7

Moxon Azimuth Pattern

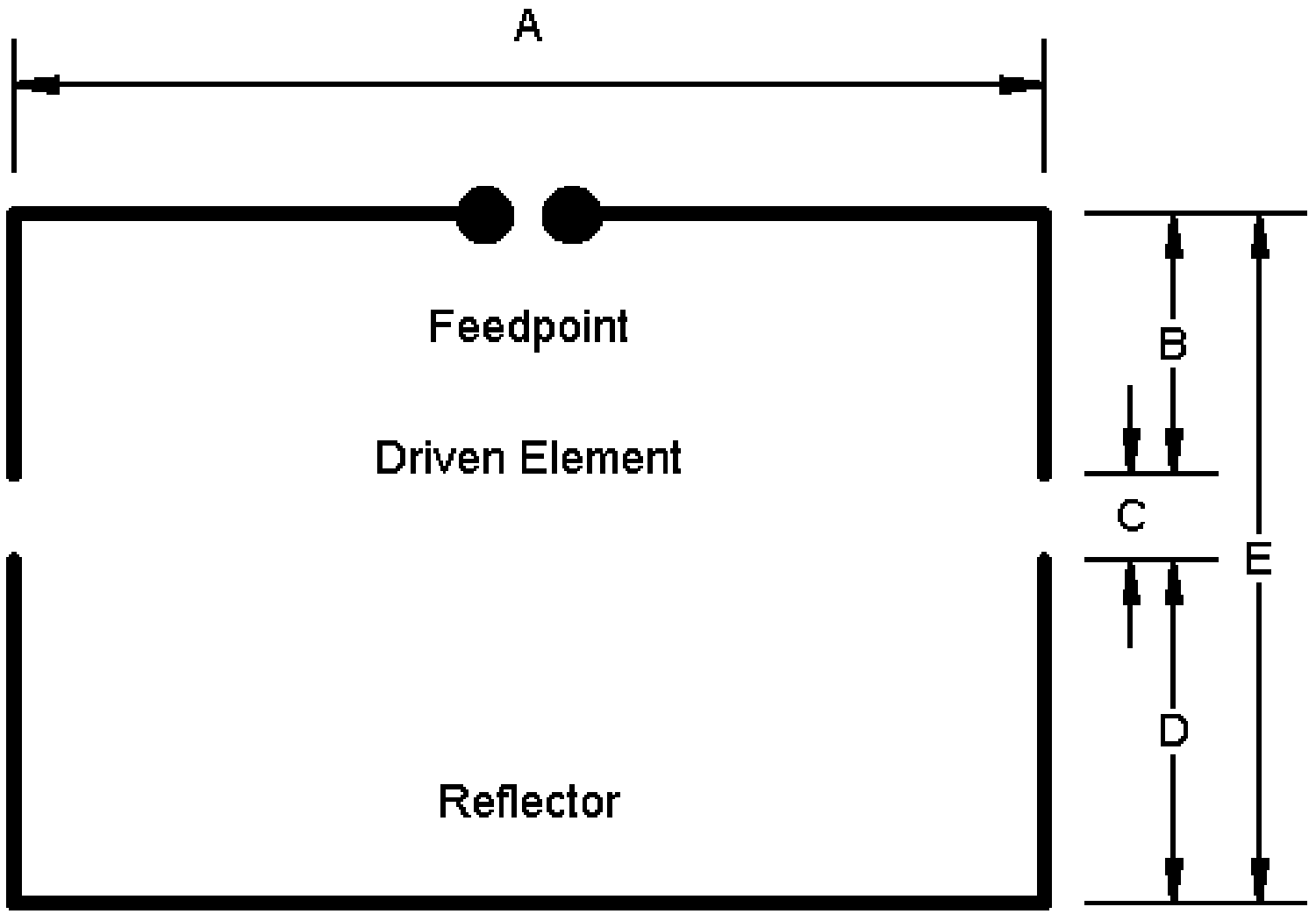
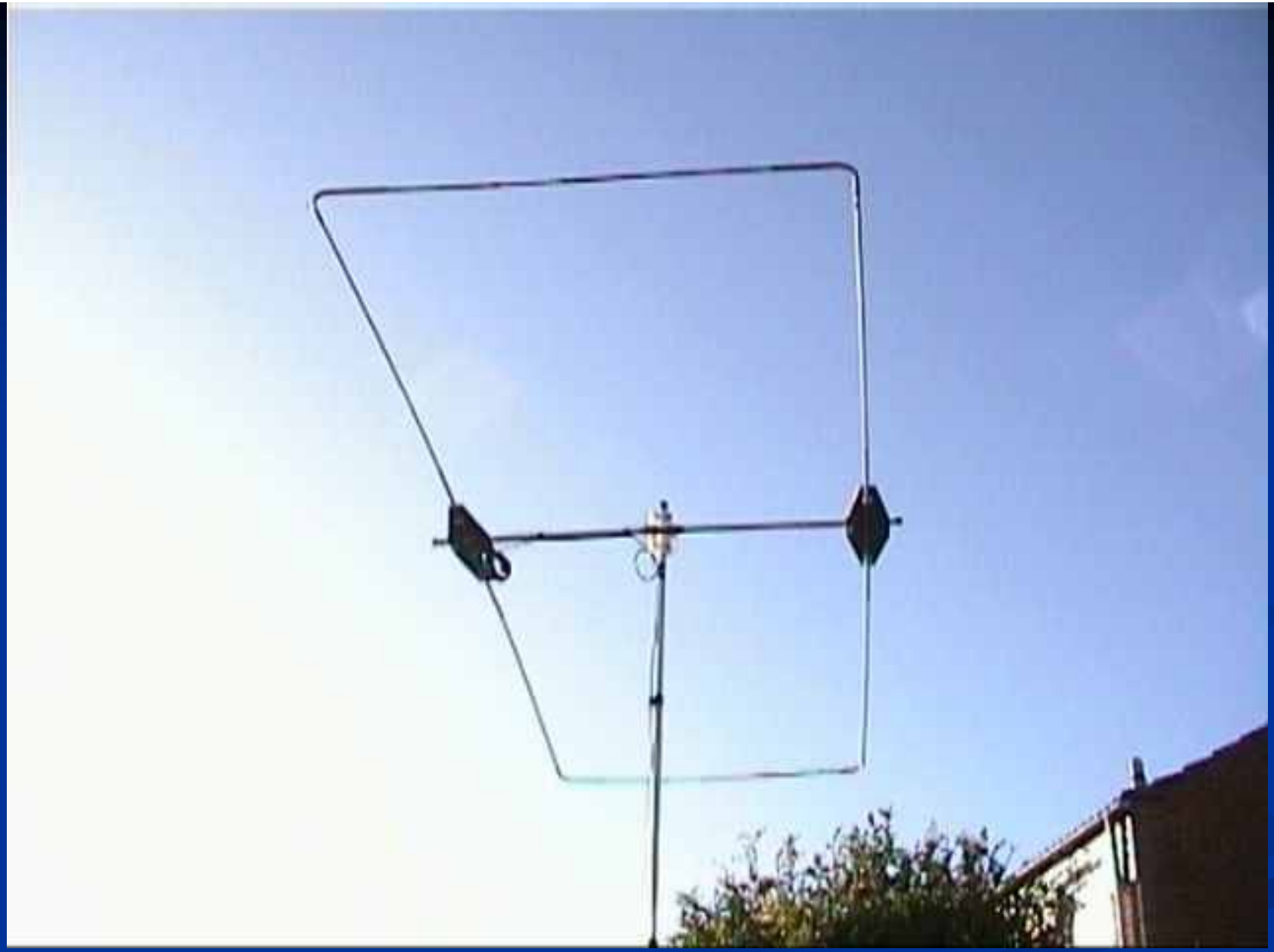


Figure 5 Moxon Rectangle Outlines

Moxon Diagram



Homebrew Moxon

Moxon End Detail

Log Periodic

- LDPA – Log Periodic Dipole Array
- Very broadband, an octave or more
- Bigger and heavier than a Yagi
- Multiple band with a single feedpoint
- Alternating elements are phased 180° apart
- Uses stubs for impedance matching
- Example: Typical outdoor TV antenna

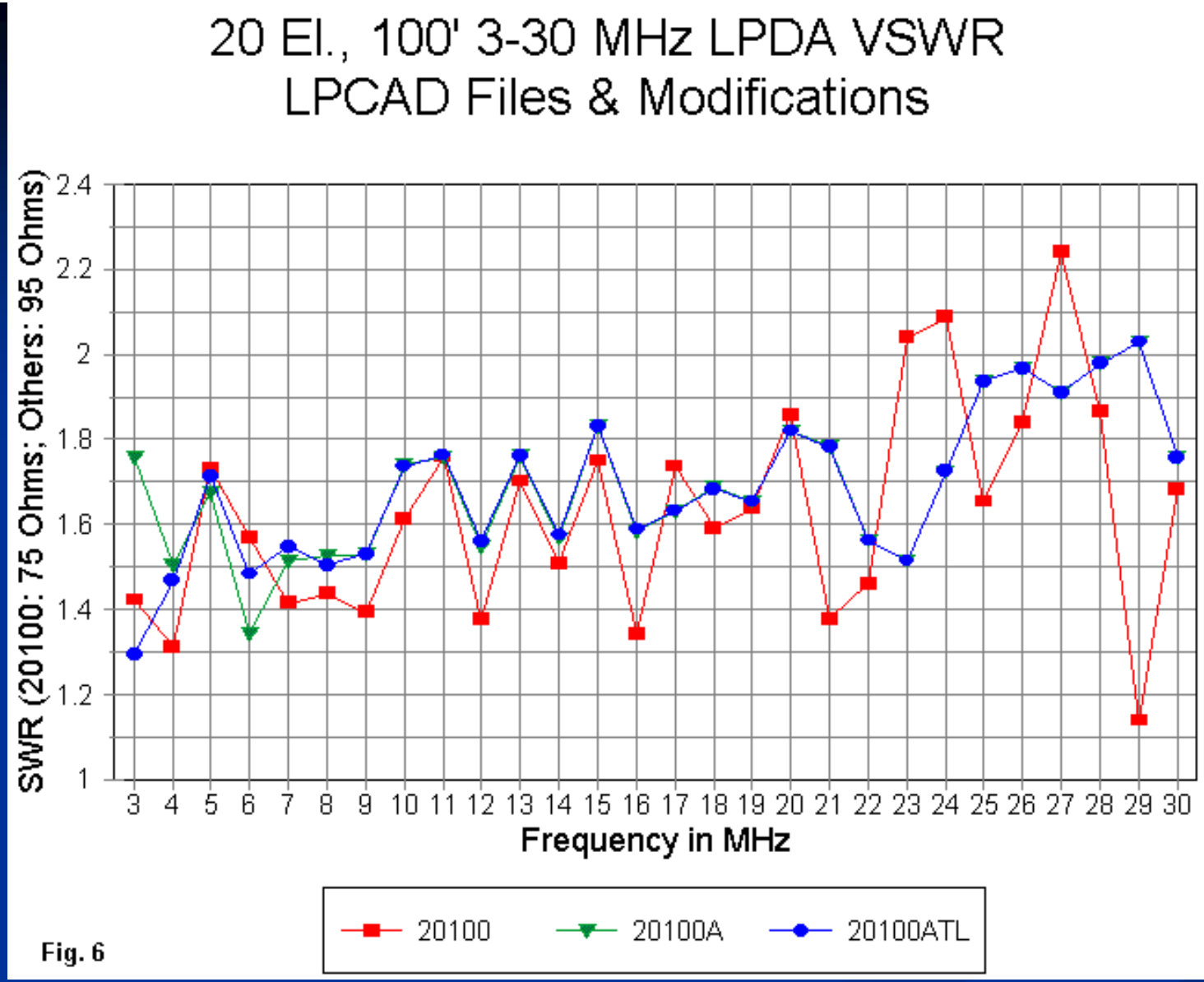
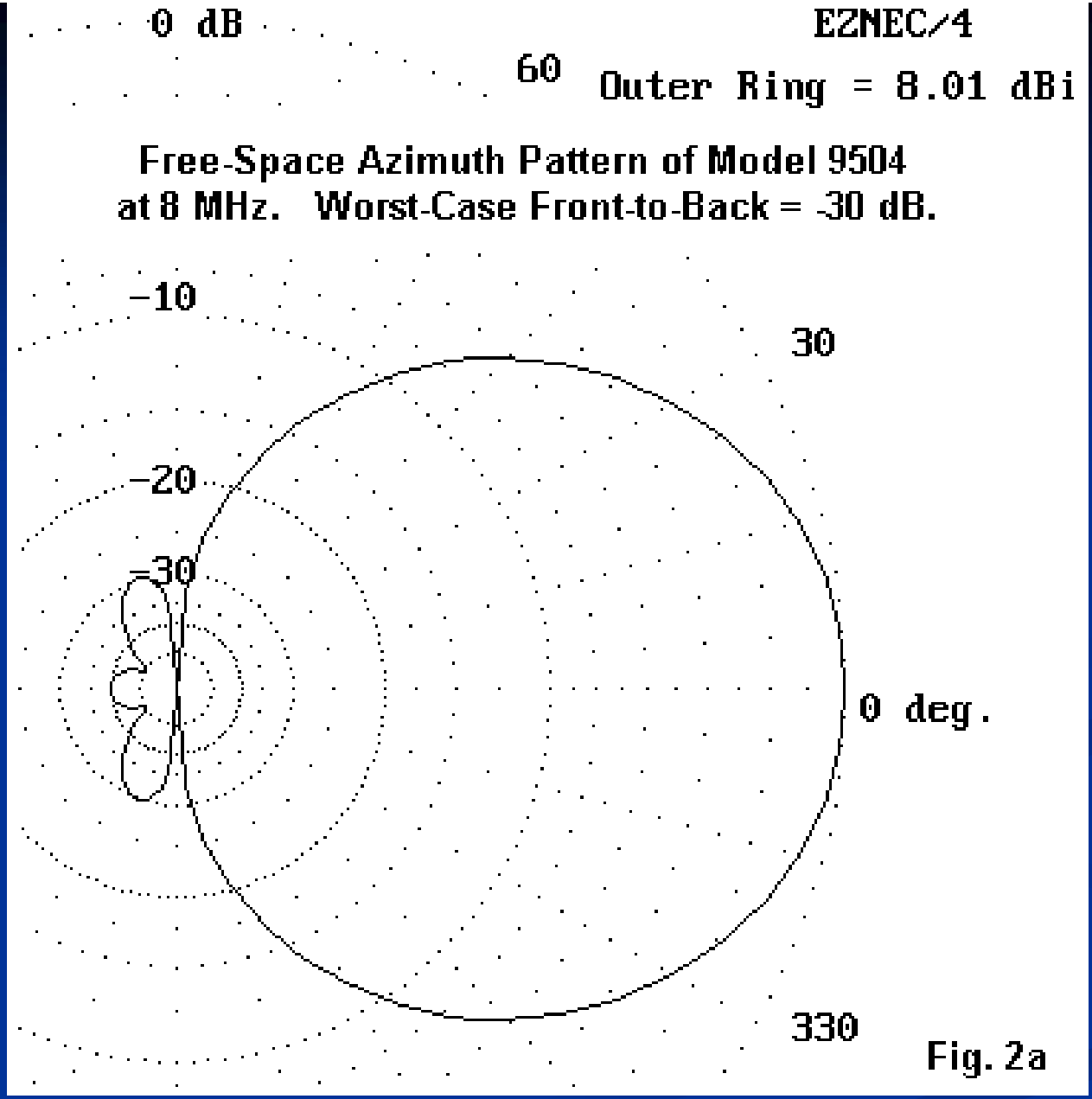


Fig. 6

LPDA SWR Plot

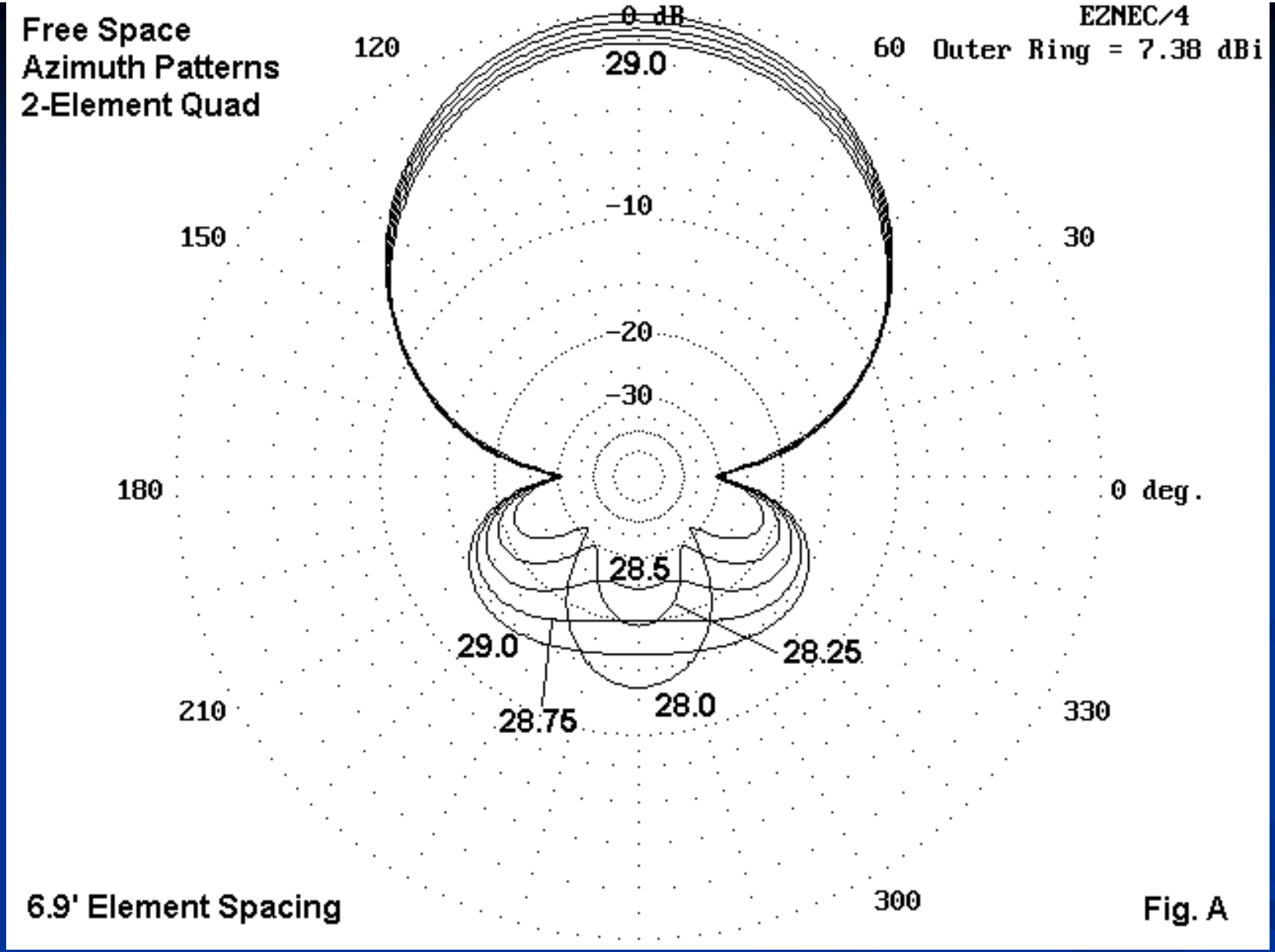


LPDA Azimuth Pattern

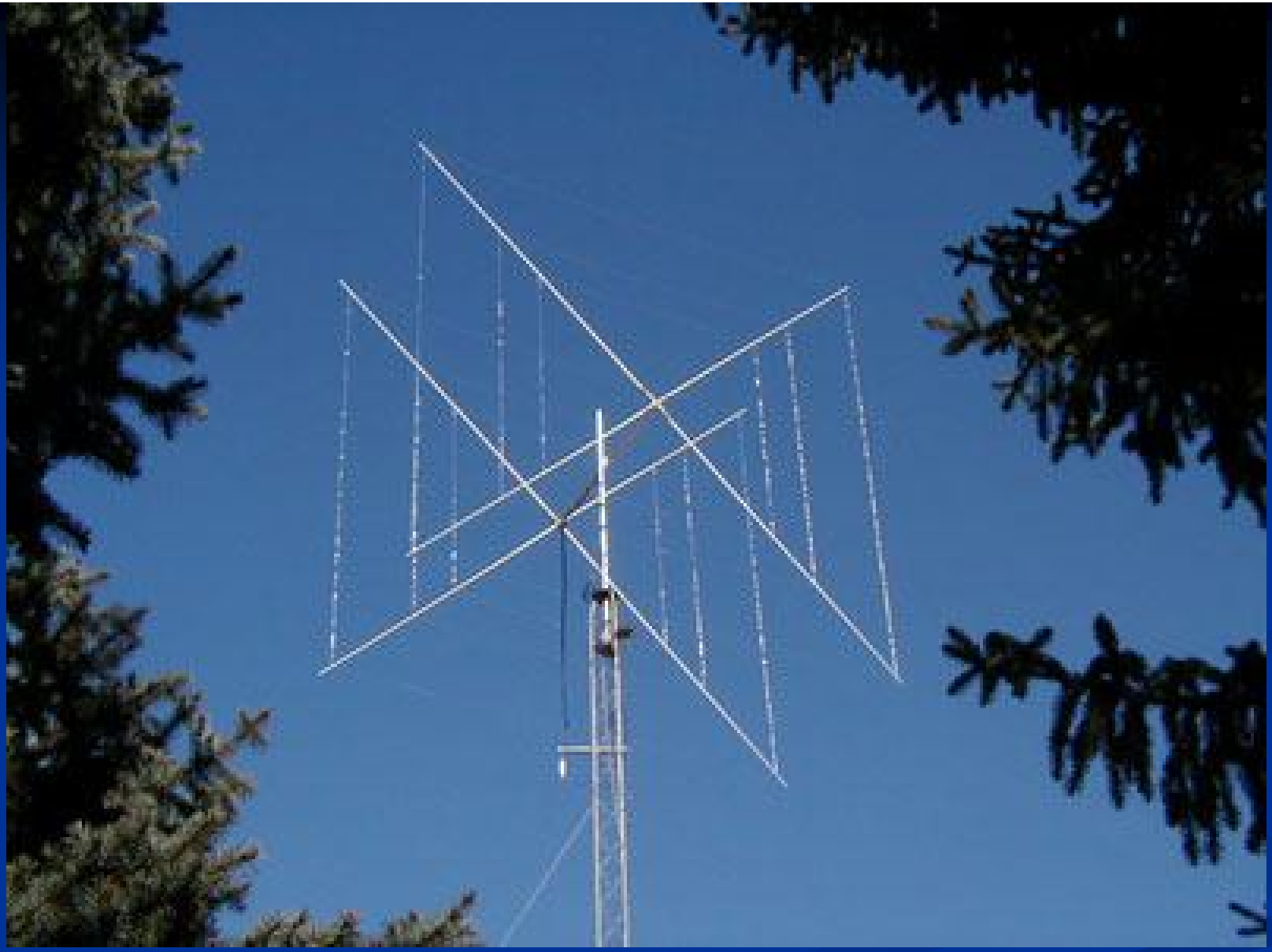
Tennadyne T-8 13 – 30 MHz

Quad

- Developed by Clarence C. Moore , W9LZX , at missionary radio station HCJB in Equador
- Lightweight, made of wire usually
- Usually two to four elements (2 element Quads are called “Cubical Quads” because of the cubical shape
- Can be monoband or multiband
- Multiband is complex to adjust because of element interaction



Quad Azimuth Pattern



Cubex Mk II, 2 Element Triband

Hex Beam

- Small and light with low wind loading
- Can be used on a lightweight tower with a small rotor
- Less gain than a Yagi
- Relatively poor F/B ratio as you move farther from the resonant frequency
- Looks kind of odd

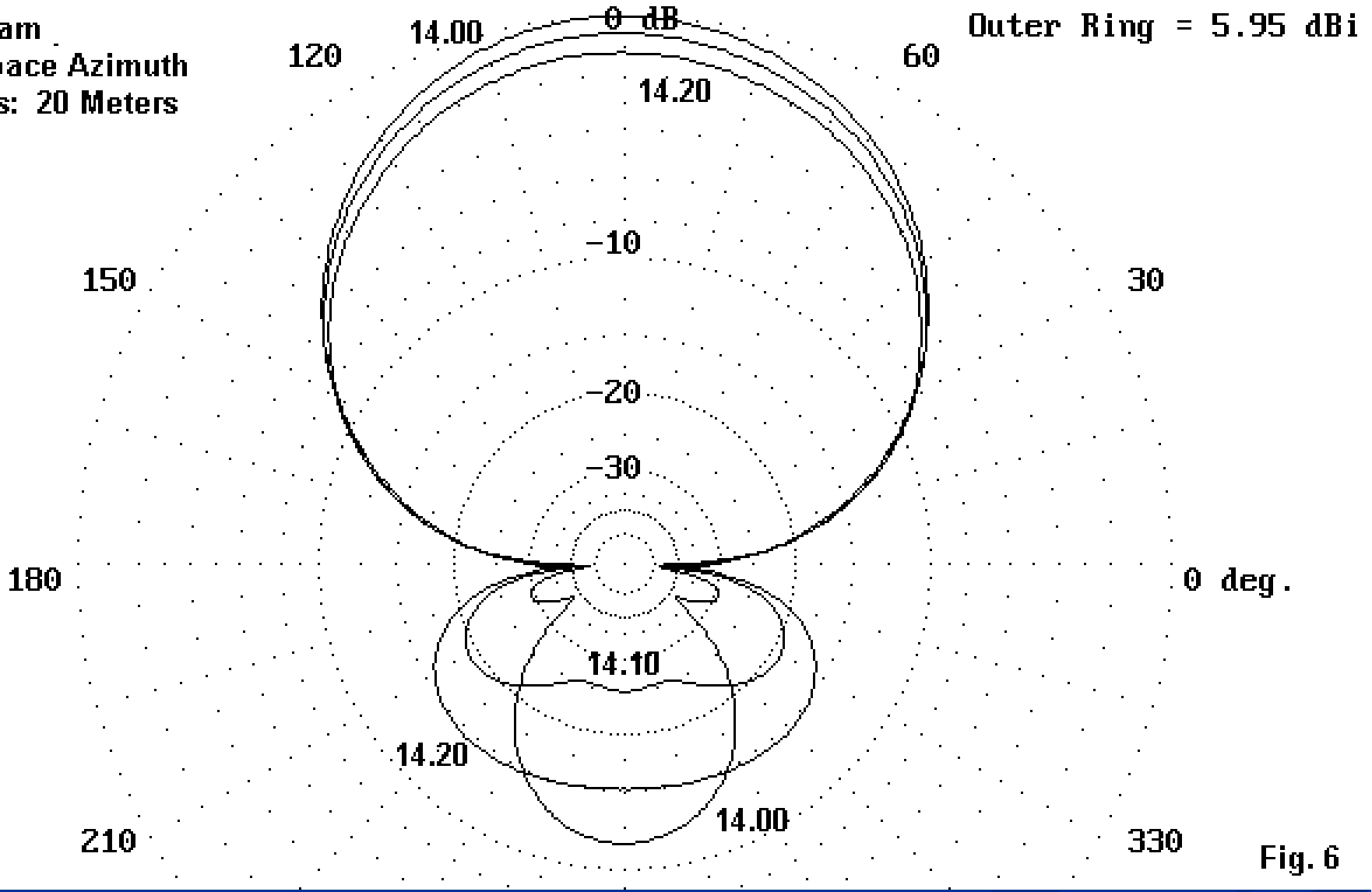


Fig. 6

Hex Beam Azimuth Pattern

Traffie Hex Beam

Questions?

Sources:

- Arrl Antenna Handbook – A must-have book, you can purchase a used copy for under $20.00
- www.cebik.com – Website of L.B. Cebik, W4RNL (SK). Must register, but it's free. There more good information here than anywhere!
- www.google.com is your friend.