K5QY's PHASED ARRAYS

1) 2- and 3-Element 80 m Phased Verticals

2) 2-Element 160 m Phased Verticals

3) K9AY Phased Receiving Array

4) 2-Element Phased 80 – 10 m Inverted Vees

1) 80 METER 2 & 3 ELEMENT PHASED VERTICALS

Why Go To The Trouble To Put Up Three HyTowers?

If you can’t hear ‘em – You can’t work ‘em…..
True on 160 m

If you hear ‘em but can’t work ‘em – You need some kickum
True on 80 m – 10 m

IMPORTANCE OF GAIN FOR Dxing

TRANSMIT SYSTEM GAIN (TSG)

$$TSG\ (dBW) = 10 \log_{10}(Pt) + (Gt) - (Lt)$$

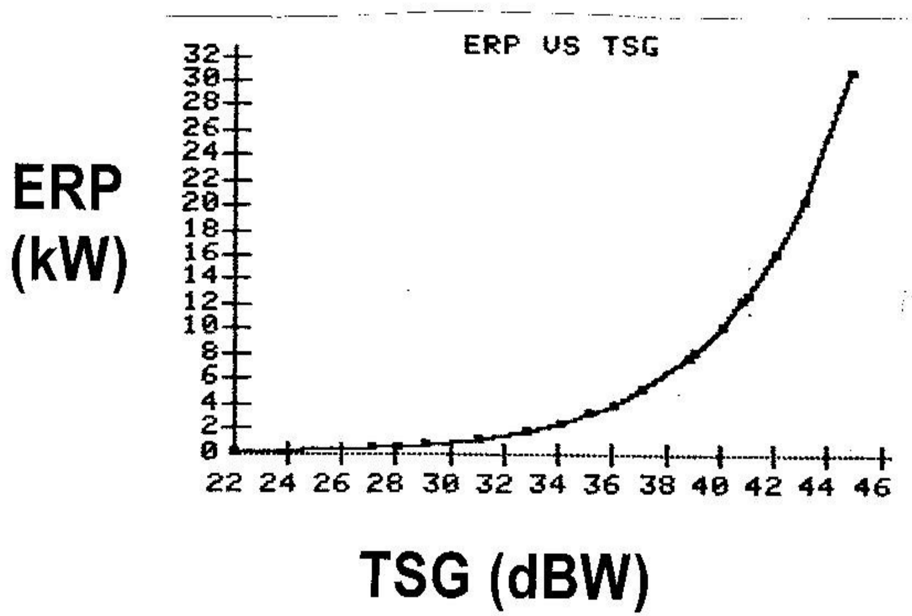
Pt = Transmit Output Power
Gt = Ant Gain (dBD) (-2.1 dB for dBi)
Lt = Coax Loss

Ex: 600 W w/RG-213 to TA-33 Beam
= approx 34 dBW TSG

1500 W w/Hardline to 5-ele Beam
= approx 41 dBW TSG

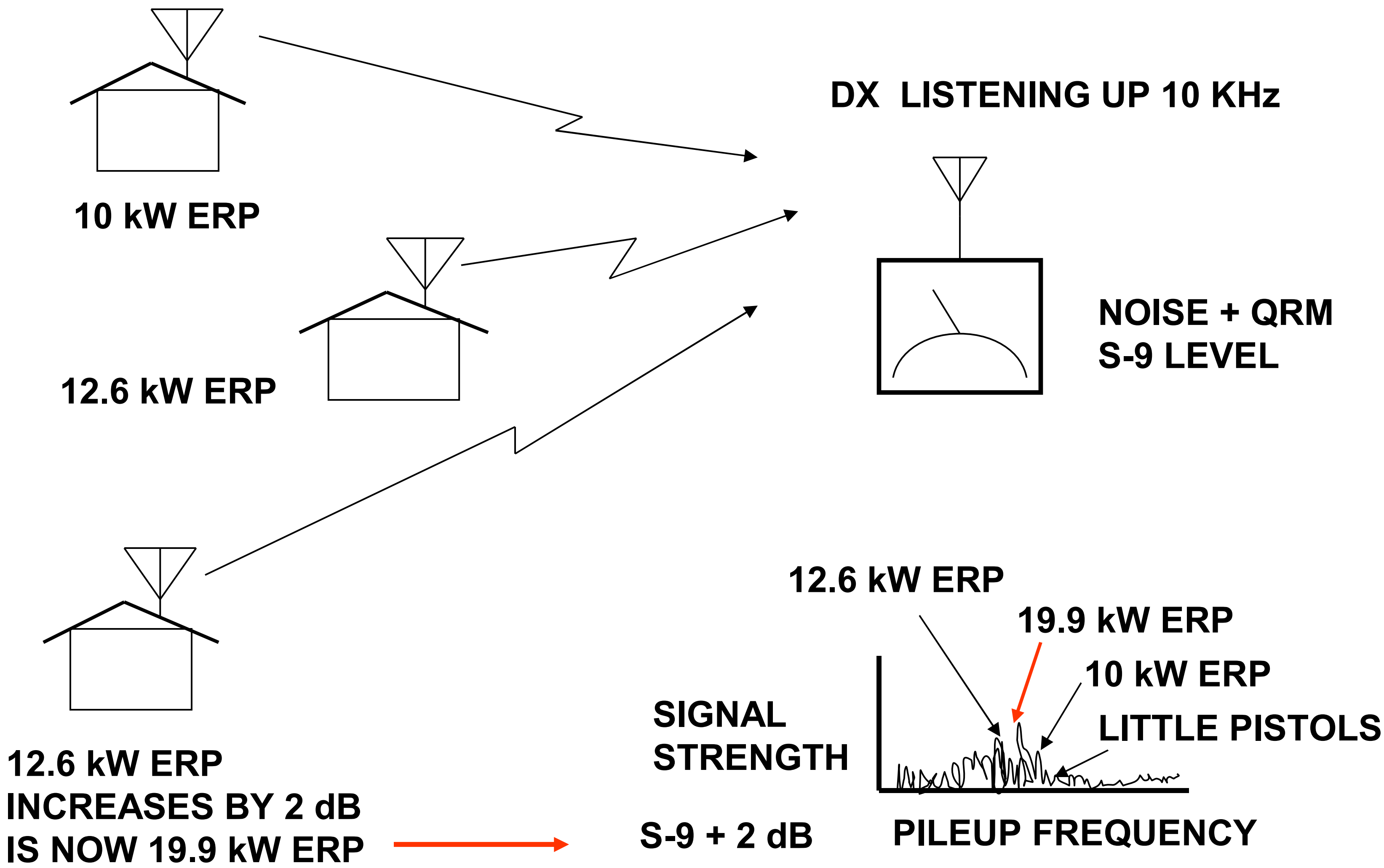
EFFECTIVE RADIATED POWER (ERP)

$$ERP = \log_{-1} (TSG / 10)$$

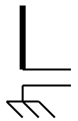


- **34 dBW TSG = 2 kW ERP**
- **41 dBW TSG = 12.6 kW ERP**

WHO WINS?

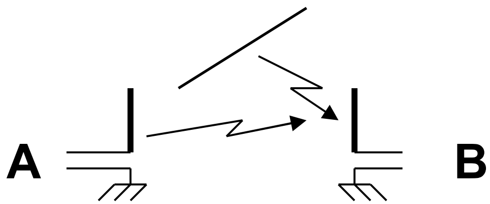

DX LISTENING UP 10 KHz
10 kW ERP
NOISE + QRM
S-9 LEVEL
12.6 kW ERP
12.6 kW ERP
19.9 kW ERP
10 kW ERP
LITTLE PISTOLS
SIGNAL
STRENGTH
12.6 kW ERP
INCREASES BY 2 dB
IS NOW 19.9 kW ERP
S-9 + 2 dB
PILEUP FREQUENCY

DEFINITIONS



Z = 37 Ohms

<u>SELF IMPEDANCE</u> – CHARACTERISTIC OF A SINGLE ELEMENT

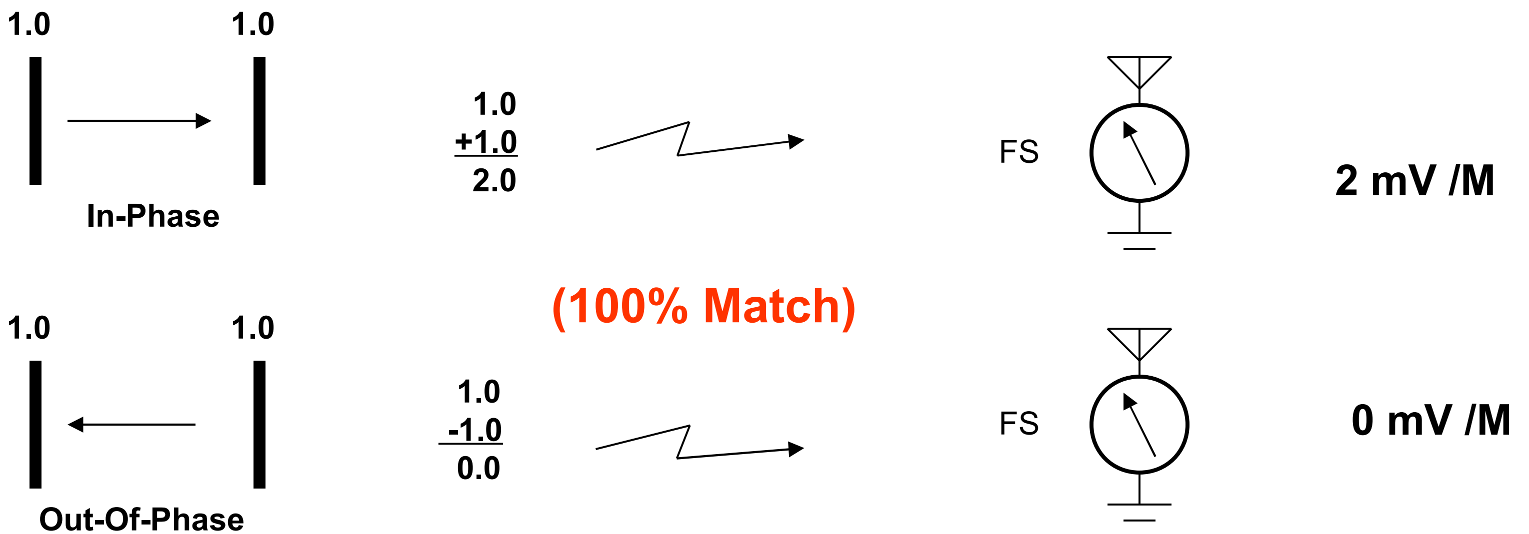


<u>MUTUAL COUPLING</u> – EFFECT ONE ELEMENT IN AN ARRAY HAS ON OTHERS (NO UNIT OF MEASURMENT)

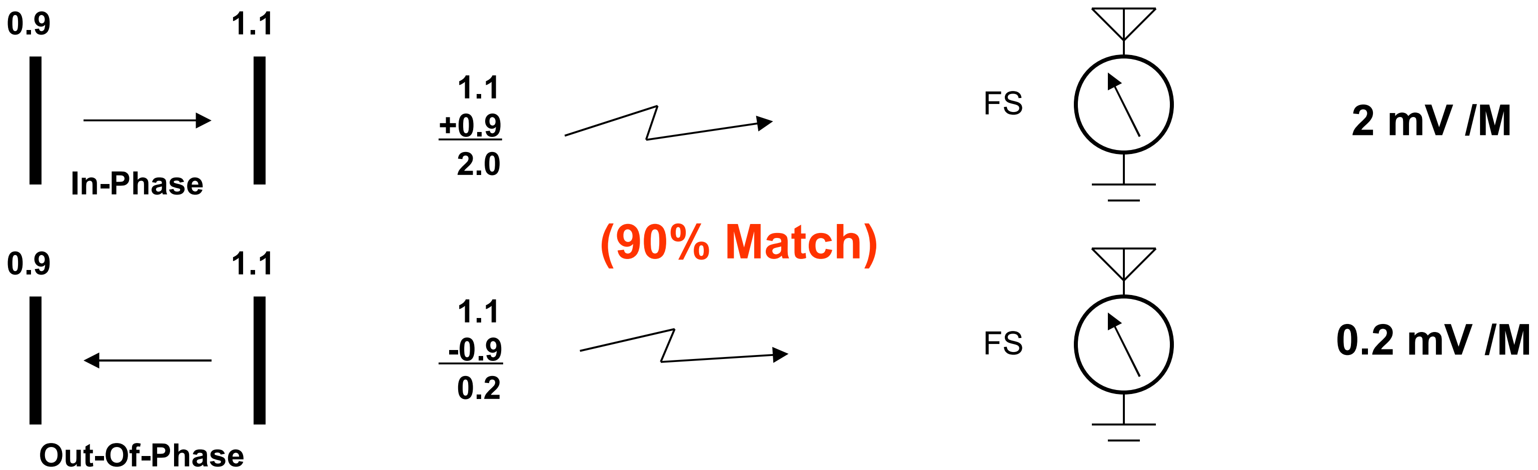
<u>COUPLED IMPEDANCE</u> – THE AMOUNT THE FEEDPOINT IMPEDANCE AN ELEMENT CHANGES DUE TO MUTUAL COUPLING

<u>FEEDPOINT IMPEDANCE</u> – SELF Z + COUPLED Z

GAIN and FRONT-T0-BACK (W7EL's Notes On Arrays)



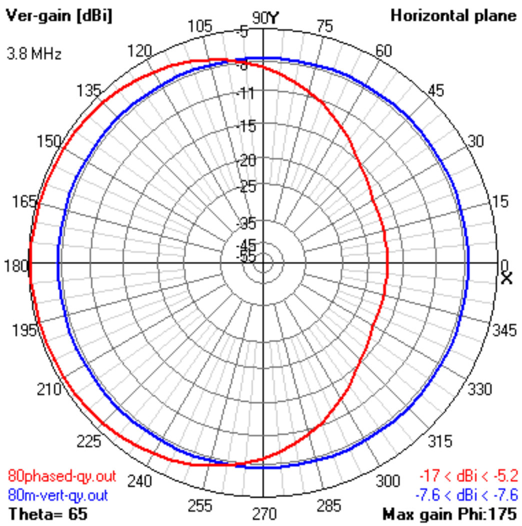
2:0 or infinite F/B Ratio



2:0.2 or 20 dB F/B Ratio

2-ELE VERTICAL ANTENNA SYSTEM

(COMPARED TO SINGLE ELEMENT)



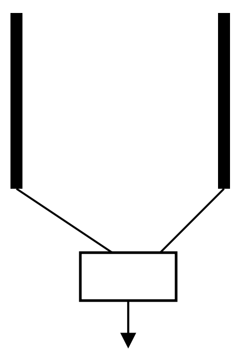
(With endfire effect due to feedpoint Z of approx 22-j20 and 40+j35 Ohms)

N

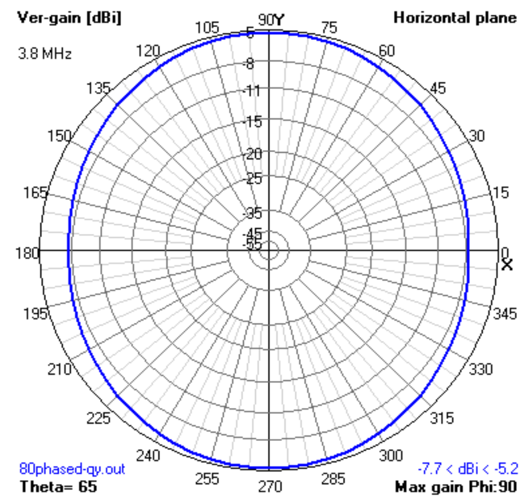
BROADSIDE
+1.3 dB
90 deg, -2.7 dB

S

¼ WAVE SPACING



XMTR



ENDFIRE WEST
+2.9 dB
90 deg, -3 dB
F/B 20 dB

ENDFIRE EAST
+2.9 dB
90 deg, -3 dB
F/B 20 dB

3-ELE MATCHING NETWORKS

0 -120 -240 Deg
1l : 1l : 1l

Jim Lawson – W2PV
QST, March 1971
5.6 dB Gain -8.7 dB F/B

0 -90 -180 Deg
1l : 2l : 1l

Forrest Gehrke – K3BT
HAM Radio, Oct 1983
Gain - Good F/B –Very Good

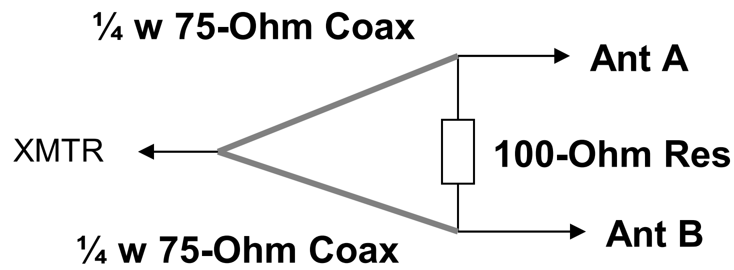
0 -90 -180 Deg
1l : 1l : 1l
1l : 2l : 1l

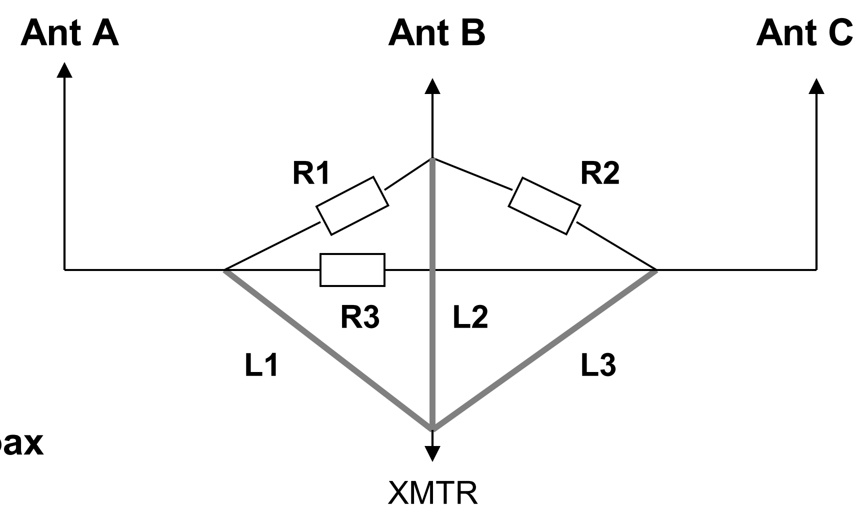
Roy Lewallen – W7EL
Notes On Phased Arrays
Gain - Good
Gain – Good F/B –Very Good

0 -90 -180 Deg
1l : 1.4l : 1l
1l : 2l : 1l

Chuck Vandament – Ant EE
Collins Radio / Rockwell Intl
4.6 dB Gain -12 dB F/B
4.6 dB Gain -22 dB F/B

WILKINSON (W1CF) POWER DIVIDER





L1, L2, L3 =
¼ W 93-Ohm
RG-62, -71 Coax

R1, R2, R2 =150 Ohms

Forrest Gehrke -K2BT L-C Feed System

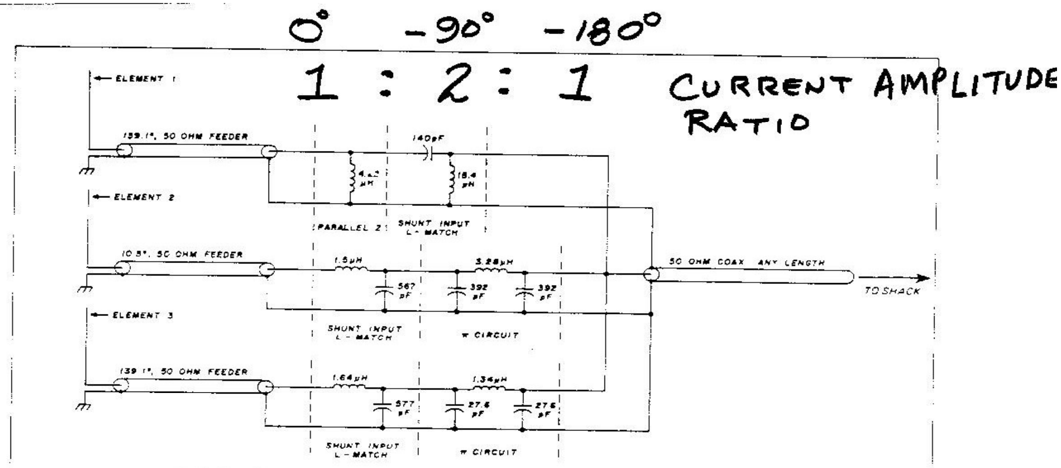


fig. 3. Matching network for a 3-element in-line array at a 3.8 MHz design frequency.

3-element in-line array. This array has a particularly deep F/B ratio extending over a wide azimuthal sector. We should be especially interested in taking advantage of this capability. Since the middle element has the same drive-point impedance regardless of array direction, there is no need to make its feeder equal in length to other feeders. Assuming the directional switch is located five feet from the middle element, equal length end element feeders are brought to the center area. At 3.8 MHz, using 0.66 velocity factor coax, these are 66 feet (139.1 degrees) and for the center element, 5 feet (10.5 degrees) with a Z_0 of 50 ohms. Assuming an array of 3 resonant 1/4-wavelength elements, [redacted] respectively, the driving point impedances are $Z_1 = 15.4 - j17$, $Z_2 = 36.2 + j0$ and $Z_3 = 75.4 + j43$. (Part 3 showed these values incorrectly).[5] As was done with the 2-element array example, the feed network is matched to the 50-ohm array feedline. The sum of the I^2R input power terms, assuming 1 ampere to the first and third elements and 2 amperes to the middle element, is 235.6 watts. Using the $E^2/R = W$ relationship, this establishes an amplitude of 108.54 volts at the array feedline connection. At that point the input impedances for each element's network are the pure resistances:

$$Z_1 = 764.94 + j0$$
$$Z_2 = 81.25 + j0$$
$$Z_3 = 156.23 + j0$$

The sequence of input parameters at each junction of the networks is shown in **table 3**.

The resulting network is shown in **fig. 3**. Illustrated in this example is the application of the parallel circuit and the use of leading and lagging phase L-match circuits. Here, element 1 is used as the reference element of the feed network. A parallel impedance circuit is used to transform the impedance seen at the input end of the feeder to a pure resistance. This is then transformed to the pure resistance required for the chain with a shunt input L-match chosen to produce a leading phase change. The resulting input voltage then becomes the objective for the other two network chains.

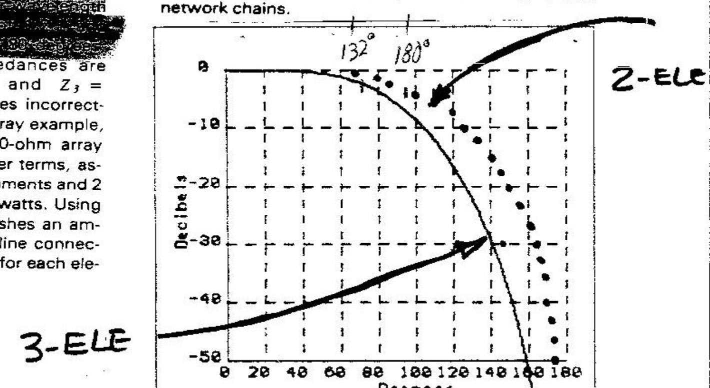
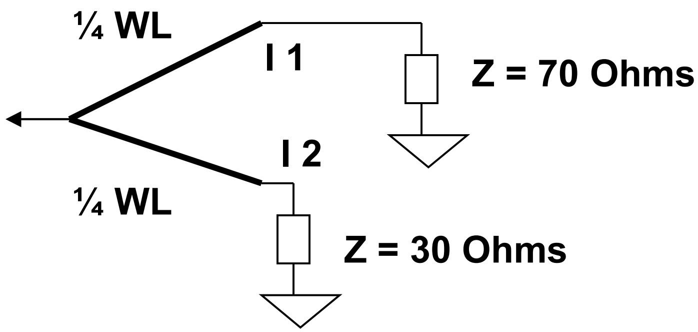


fig. 5. Three element, in-line configuration, [illegible] spacing. −90 degree and −180 degree phasing, 1:2:1 current ratios.

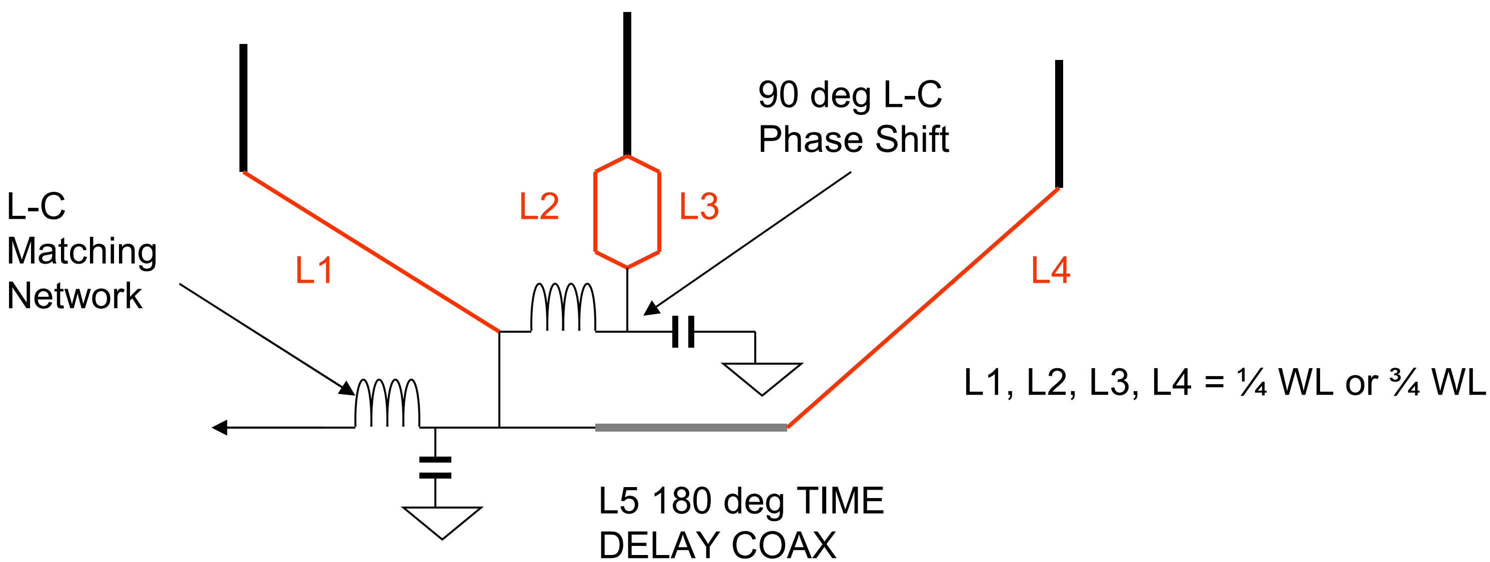
W7EL SYSTEM (PHASED ARRAY NOTES)

UTILIZES THE CHARACTERISTIC: ¼ LENGTH LINE PRODUCES A CONSTANT 90 Deg PHASE SHIFT BETWEEN INPUT VOLTAGE AND OUTPUT CURRENT, AND IF TWO LINES ARE TIED TOGETHER, EQUAL CURRENTS FLOW REGARDLESS OF TERMINATION IMPEDANCES.



I 1 = I 2

HE DESCRIBES THIS AS “FORCE FEEDING”



K5QY MATCHING METHOD

ESI Steering-Combiner
OMEGA-T Model 2000C

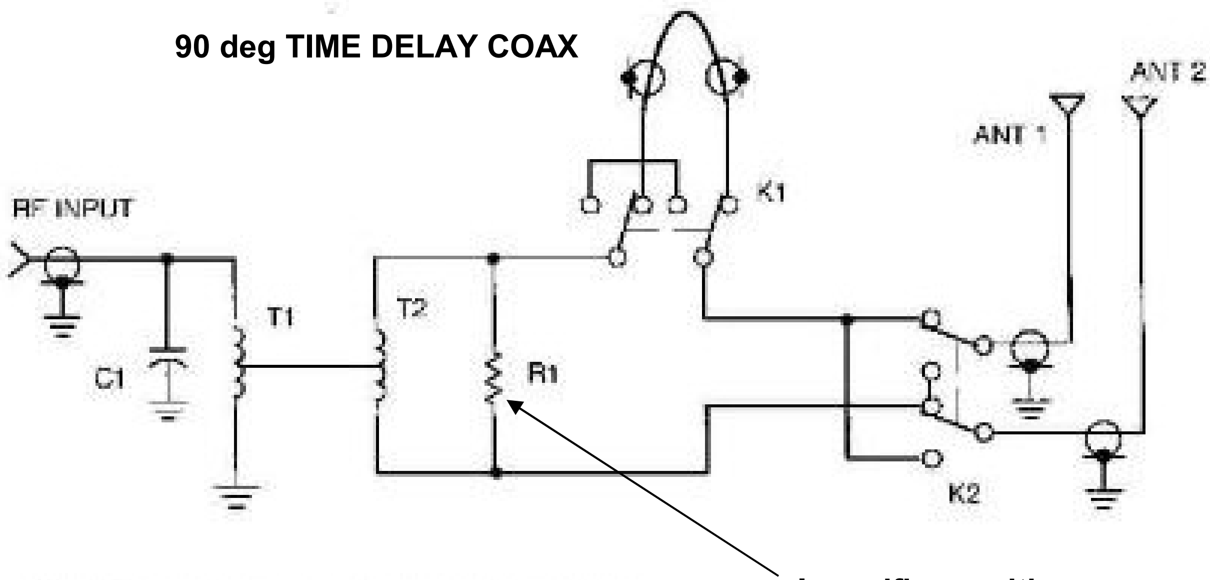
Construction Details Found in
ARRL Antenna Compendium
Volume 2

Titled

Steerable Arrays For The Low Bands
Bob Alexander -W5AH

K5QY MATCHING METHOD

HYBRID POWER DIVIDER



In endfire position, worse case R1 dissipates approx .5 dB power

T1 is a 2:1 step down transformer (50 to 25 ohms)

C1 compensates for the reactance of T1

T2 is a 1:4 impedance transformer

R1 100-ohm resistor that absorbs power imbalance between the two ports

K1 selects between endfire (90 degrees delay) or broadside (no delay)

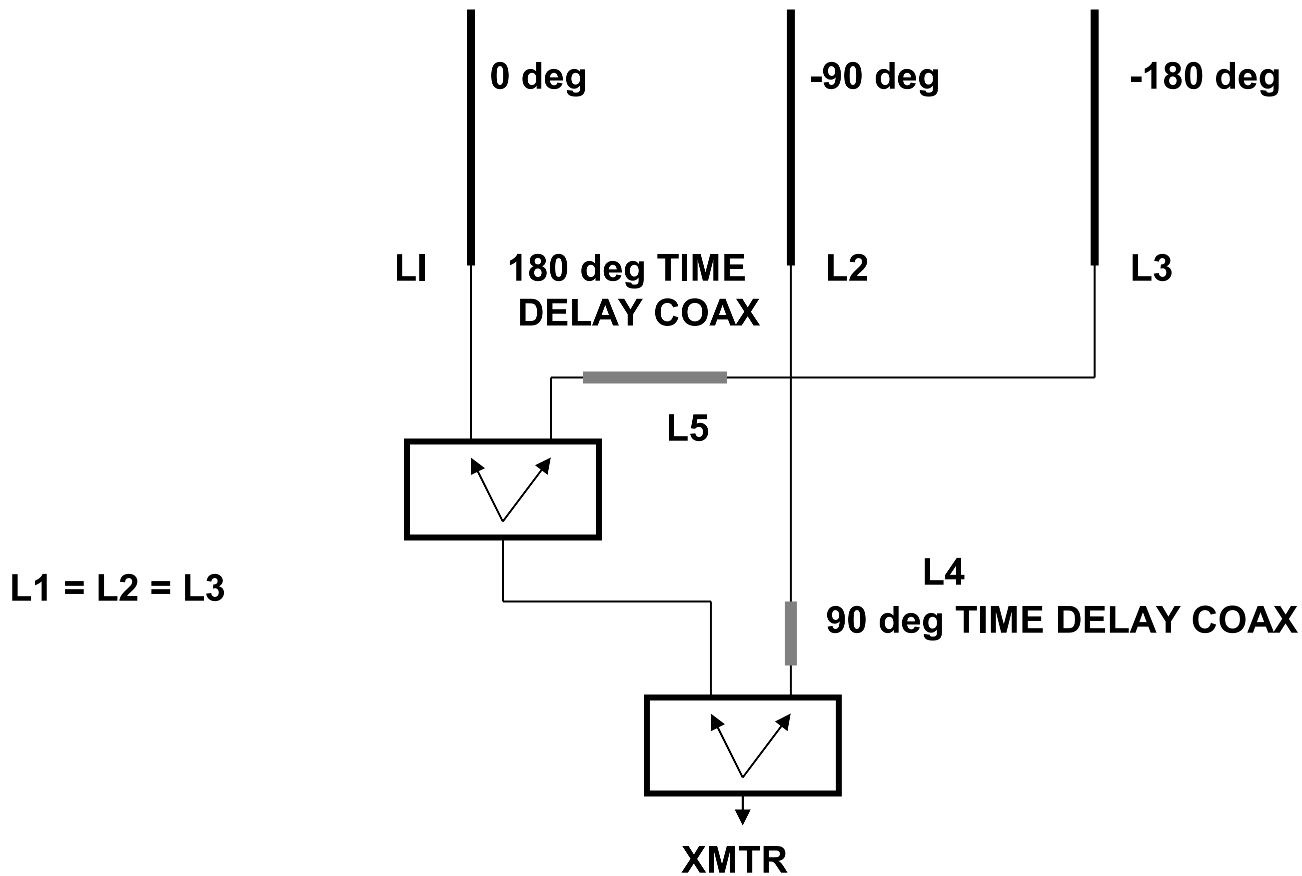
K2 switches between antenna 1 and antenna 2

SIMPLIFIED 160M POWER COMBINER–SPLITTER DIAGRAM

FIGURE 8. Power Splitter

Beam Steering-Combiner With Coax Delay Lines

FEEDING 3-ELE HYTOWER SYSTEM

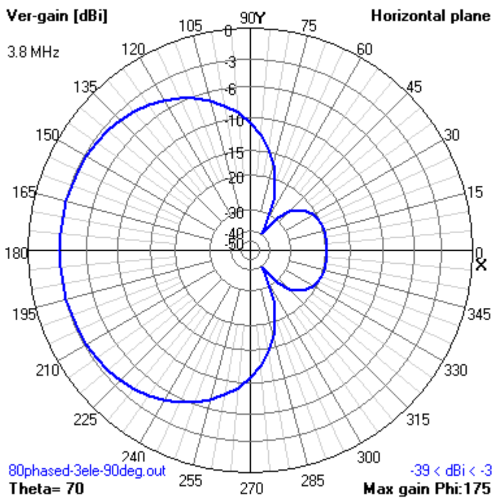


L4: Ft = 246 / f (MHz) X Velocity Factor

246 / 3.8 = 65 Ft X .66 = 43 Ft (90 deg) DELAY
L5: 2 X L4 = 43 Ft X 2 = 86 Ft (180 deg DELAY

3-ELE VERTICAL ANTENNA SYSTEM

(COMPARED TO SINGLE ELEMENT)



N

BROADSIDE

S

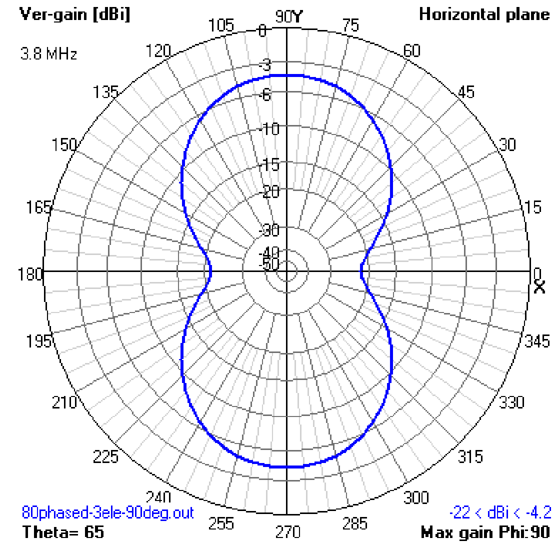
OPEN RELAY

4.1 dB
F/S -18 dB

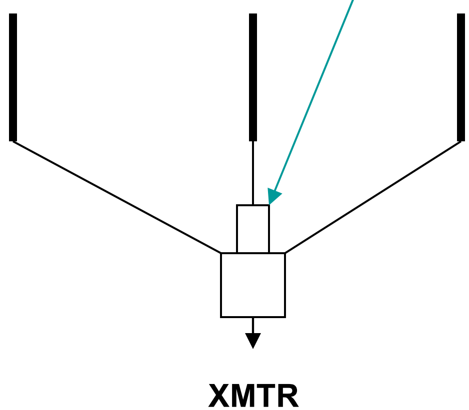
1.3 dB
F/S -2.7 dB

CLOSED RELAY

2.4 dB
F/S -5.7 dB

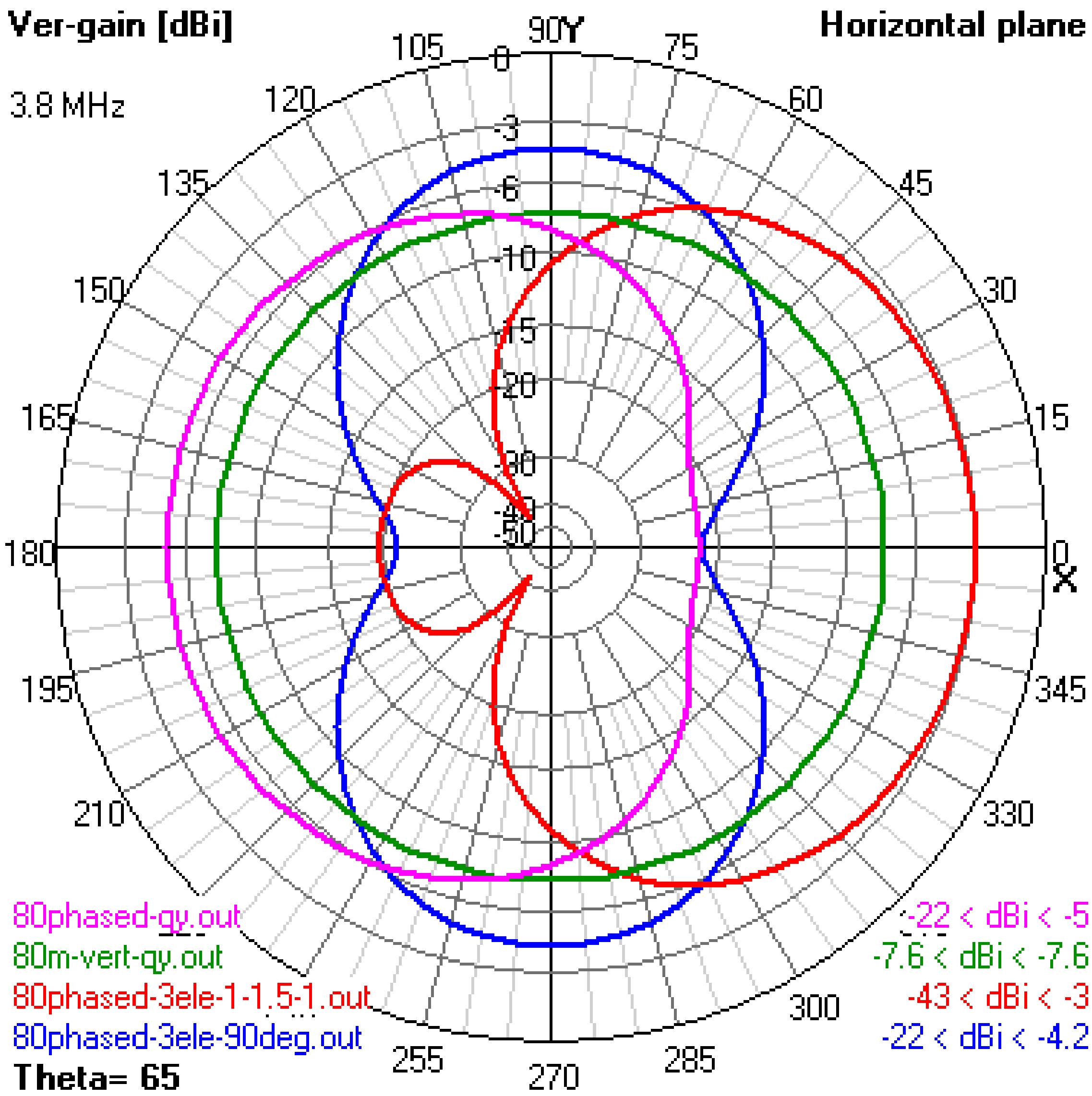


+2.9 dB
F/B 20 dB



ENDFIRE WEST
+4.6 dB
90 deg, -10 dB
110 deg, -27 dB
130 deg, -16 dB
F/B 12 dB

ENDFIRE EAST
+4.6 dB
90 deg, -10 dB
110 deg, -27 dB
130 deg, -16 dB
F/B 12 dB



Ver-gain [dBi]
Horizontal plane
3.8 MHz
90Y
X
80phased-qy.out
80m-vert-qy.out
80phased-3ele-1-1.5-1.out
80phased-3ele-90deg.out
Theta= 65
-22 < dBi < -5
-7.6 < dBi < -7.6
-43 < dBi < -3
-22 < dBi < -4.2

2) 160-METER PHASED HYTOWERS

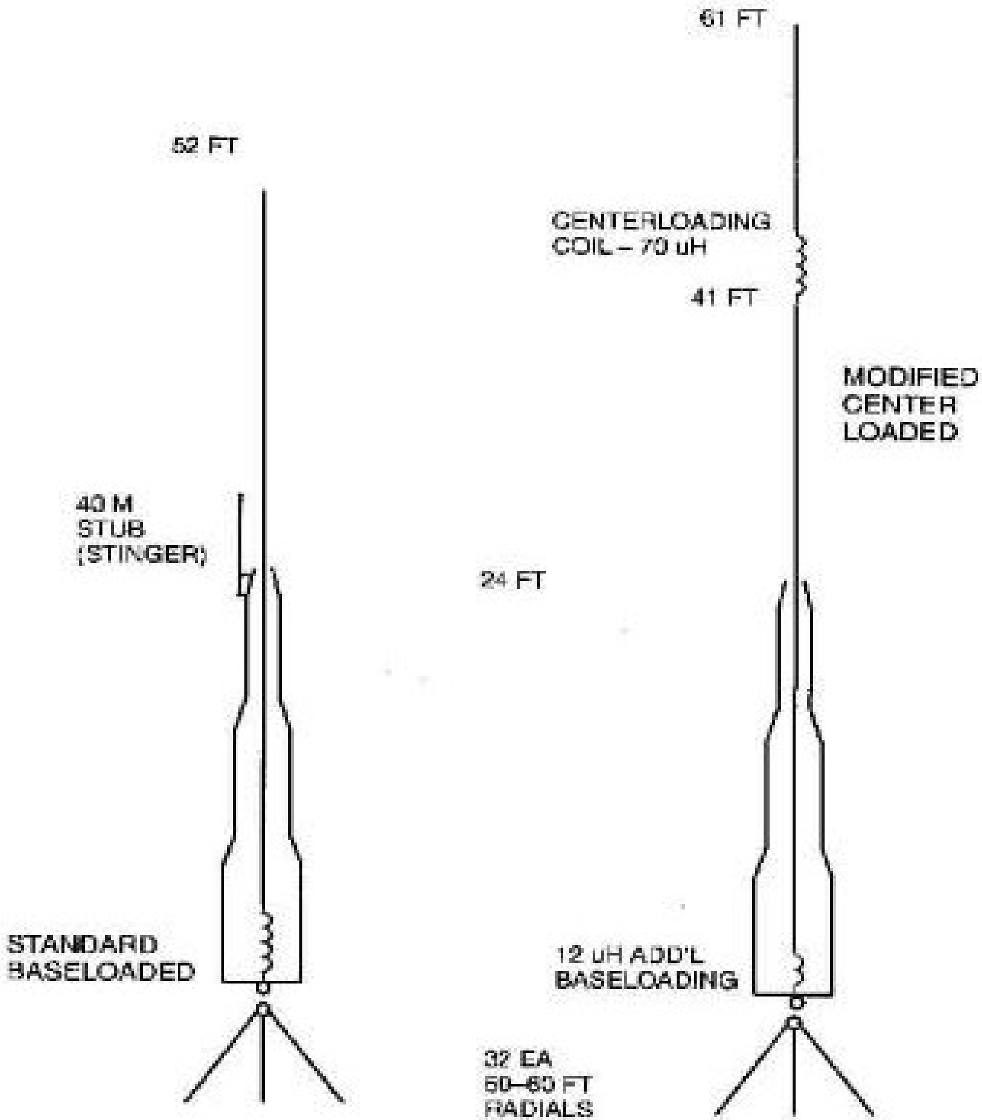


FIGURE 5. Baseloaded and Centerloaded Hytower

EZNEC MODELS

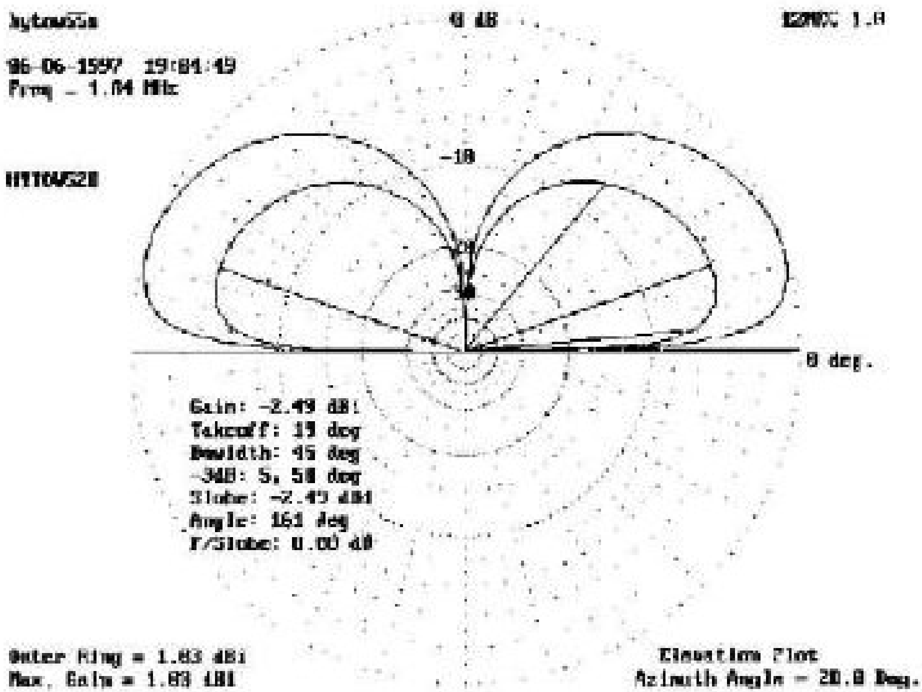
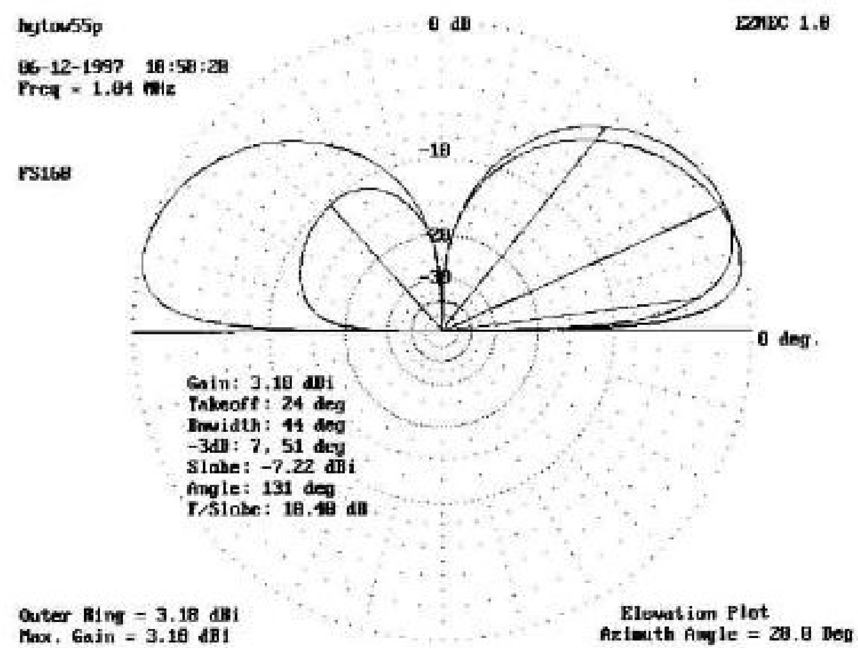


FIGURE 6. Baseloaded vs Centerloaded Hytower Elevation



ANT 1 = .4 AMP – ANT 2 = .6 AMP
∠ 90 Deg MED GROUND

FS160 = 1 AMP VG GROUND

FIGURE 9. 160 Meter Vertical vs Two Centerloaded Hytowers Elevation Pattern

160 METER 2-ELEMENT PHASED VERTICALS

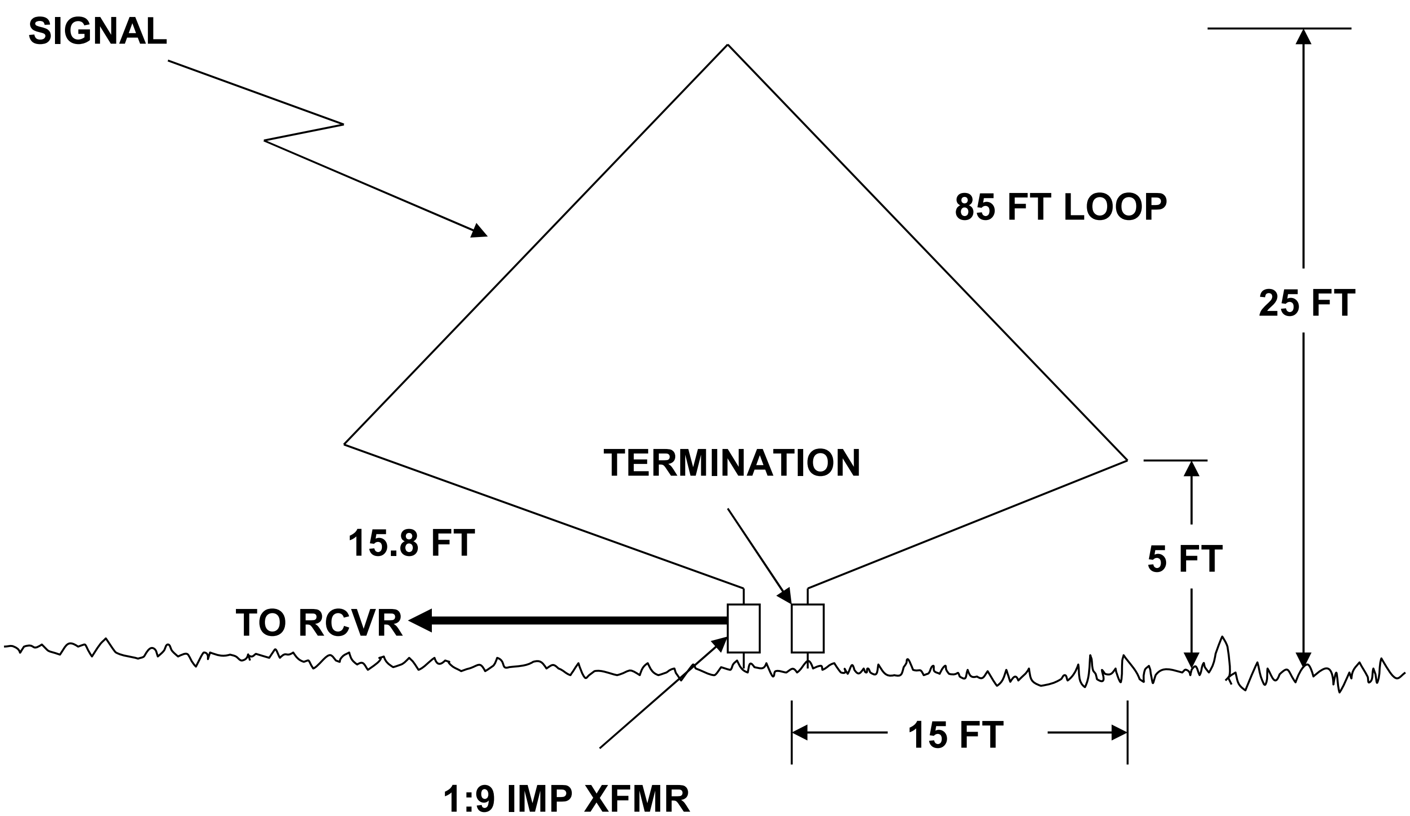
3) HEARING 160 METER DX

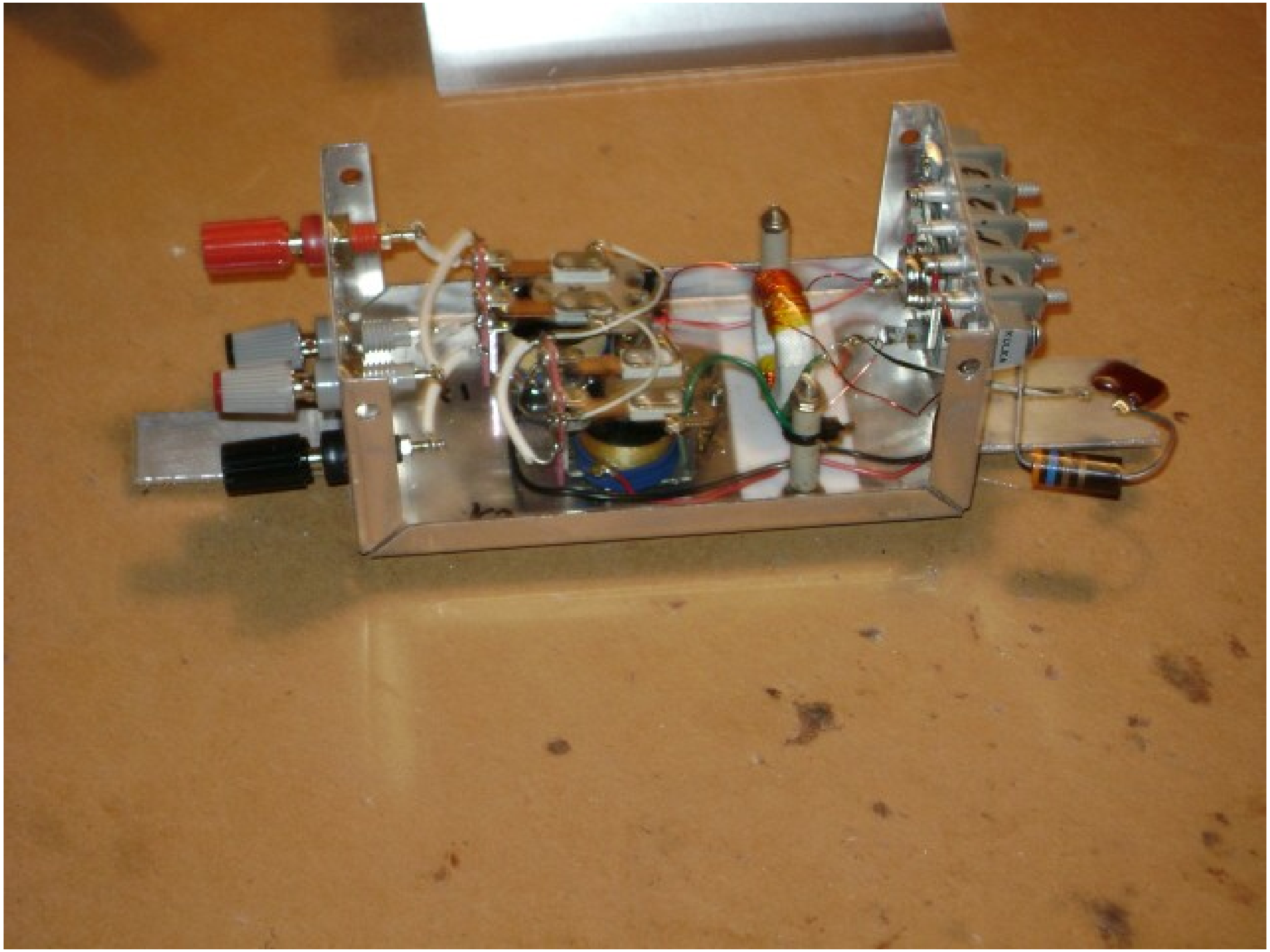
720 ft BEVERAGE

K9AY RECEIVING LOOP ARRAY
Encouraged By Steve Bartz -AD5UQ

K9AY RECEIVING LOOP

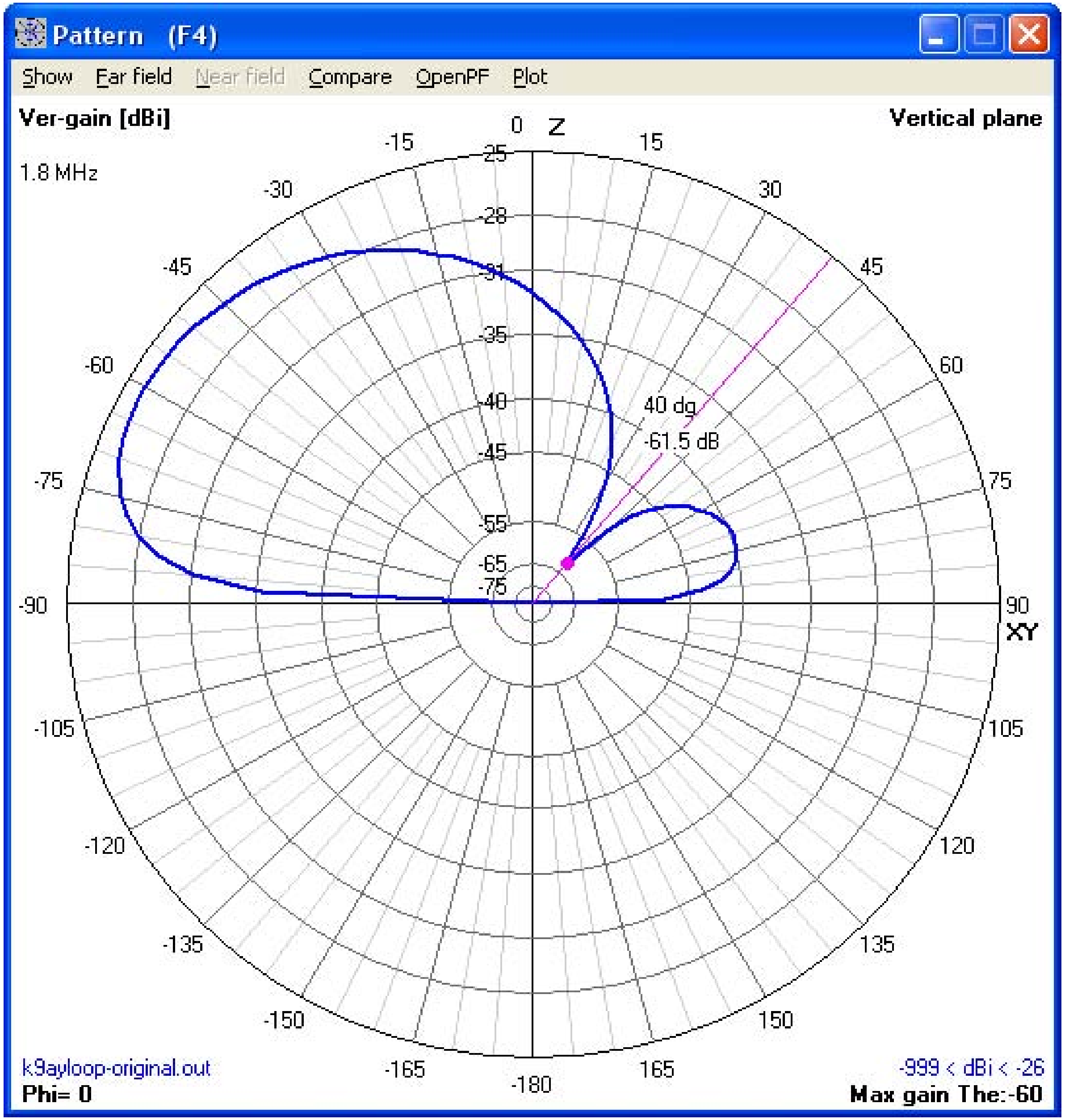
K9AY RECEIVING LOOP ARRAY



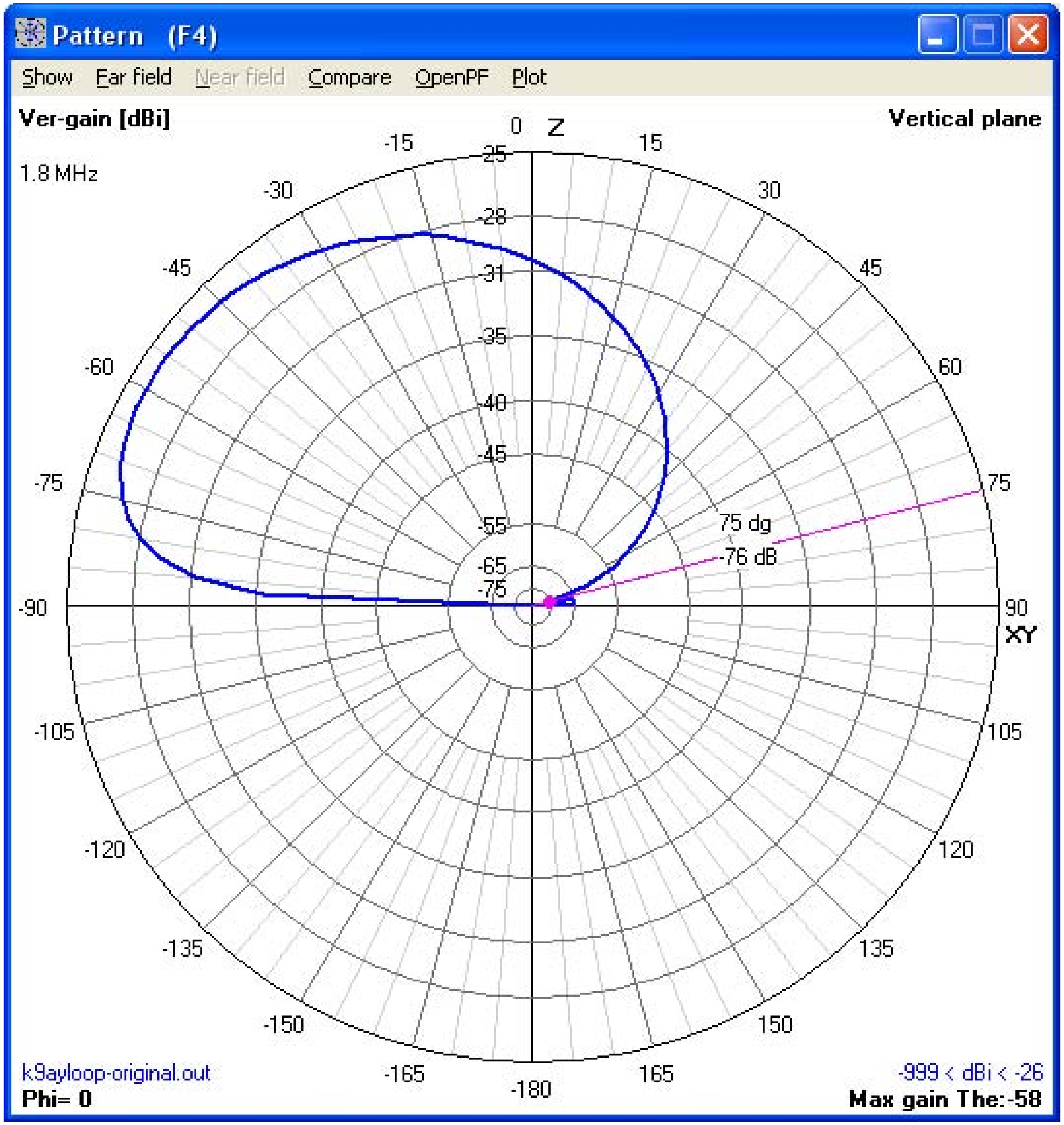


K9AY LOOP MATCHING & SWITCHING BOX

4NEC2 MODELING OF K9AY LOOP
Modeled by Tom McDermott -N5EG



500-OHM TERMINATION



390 OHM + 1000 pF TERMINATION

4) PHASED INVERTED-VEEs

Improved Field Day Antenna

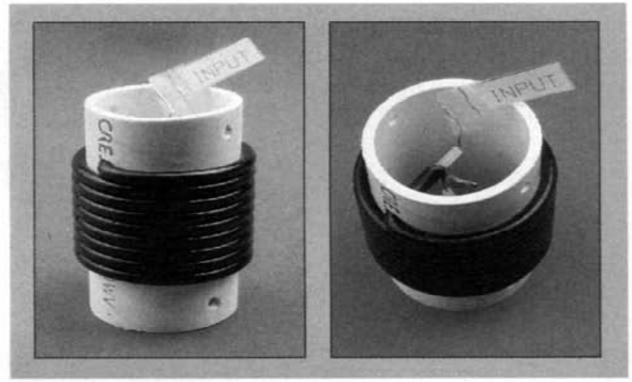
Practice Modeling Using 4NEC2

Antenna for Woody Pope KE5YXO

Multiband - No External Tuner - Inexpensive

- Broadband Folded Dipole (BFD)
- Off-Center-Fed Dipoles (OCF)
- Parallel Inverted Vees
- Slopers

Two New Multiband Trap Dipoles



W8NX details a new coax trap design used in two multiband antennas; one covering 80, 40, 20, 15 and 10 meters, and the other covering 80, 40, 17 and 12 meters.

By Al Buxton, W8NX
2225 Woodpark Rd
Akron, OH 44333

Over the last 60 or 70 years, amateurs have used many kinds of multiband antennas to cover the traditional HF bands. The availability of the 30, 17 and 12-meter bands has expanded our need for multiband antenna coverage. A fortunate few have the space and resources for multiband antennas like rhombics or long Vs, but many hams have employed inverted-L long wires or parallel dipoles. Old-timers will recall the off-center-fed *Windom* of the '30s—the first version using a single-wire transmission line, and the later design using two-wire feed line. Over the years, random-length dipoles with open-wire feeders and associated tuners have been used successfully as multiband antennas. The G5RV multiband antenna is a specialized example of this approach.[1]

The *log periodic array* represents a kind of brute-force approach to the goal of achieving coverage of multiple HF ham bands. It seems inefficient because of the large gaps between our relatively narrow amateur HF bands.

Over the last few decades, two factors have affected the development of multiband antennas—the popularity of low-impedance (usually 50-Ω) coaxial feed lines, and the appearance of untuned, 50-Ω solid-state amplifiers. The impedance of an antenna is relatively low only at its fundamental frequency and at odd-order harmonics. Although antenna tuners are often necessary to resonate an antenna system, the quest for expanded multiband coverage with simple antennas continues.

At the end of the 1930s, a different technological approach appeared in the form of resonant traps in antennas. The *Mims Signal Squirter* is the grandfather of modern day tribanders.[2] This article discusses in detail an innovative trap design employed in two multiband dipoles.

One W8NX Trap Design—Two Multiband Dipoles

Two different antennas are described here. The first covers 80, 40, 20, 15 and 10 meters, and the second covers 80, 40, 17 and 12 meters. Each uses the same type of W8NX trap—connected for different modes of operation—and a pair of short capacitive stubs to enhance coverage. Both antennas were designed using my "All About Trap Dipoles" software package.[3] The new W8NX coaxial-cable traps have two different modes: a high- and a low-impedance mode. The inner-conductor windings and shield windings of the traps are connected in series in the conventional manner for both modes. However, either the low- or high-impedance point can be used as the trap's output terminal. For low-impedance trap operation, only the center conductor turns of the trap windings are used. For high-impedance operation, all turns are used, in the conventional manner for a trap. The short stubs on each antenna are strategically sized and located to permit more flexibility in adjusting the resonant frequencies of the antenna.

Figure 1 shows the configuration of the 80, 40, 20, 15 and 10-meter antenna. The radiating elements are made of #14 stranded copper wire. The element lengths are the wire span lengths in feet. These lengths do not include the lengths of the pigtails at the balun, traps and insulators. The 32.3-foot-long inner 40-meter segments are measured from the eyelet of the input balun to the tension relief hole in the trap coil form. The 4.9-foot segment length is measured from the tension relief hole in the trap to the 6-foot stub. The 16.1-foot outer-segment span is measured from the stub to the eyelet of the end insulator. The coaxial-cable traps are wound on PVC pipe coil forms and use the low-impedance output connection. The stubs are 6-foot lengths of 1/8-inch stiffened aluminum or copper rod hanging perpendicular to the radiating elements. The first inch of their length is bent 90° to permit attachment to the radiat-

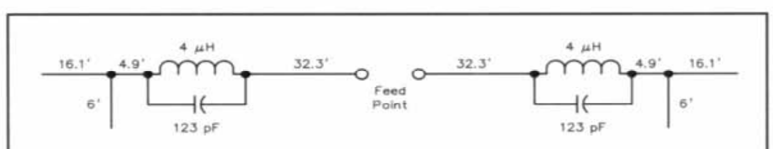
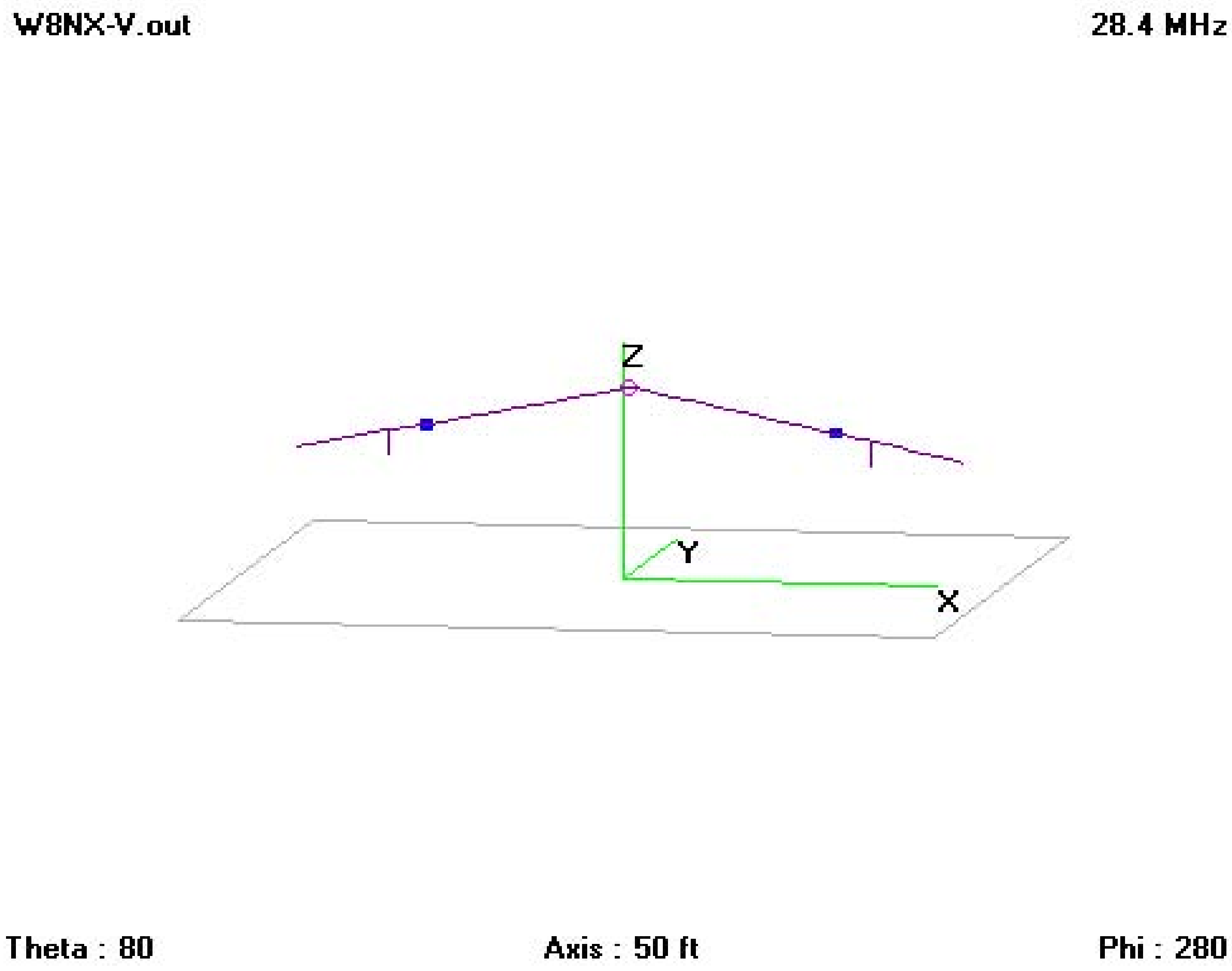


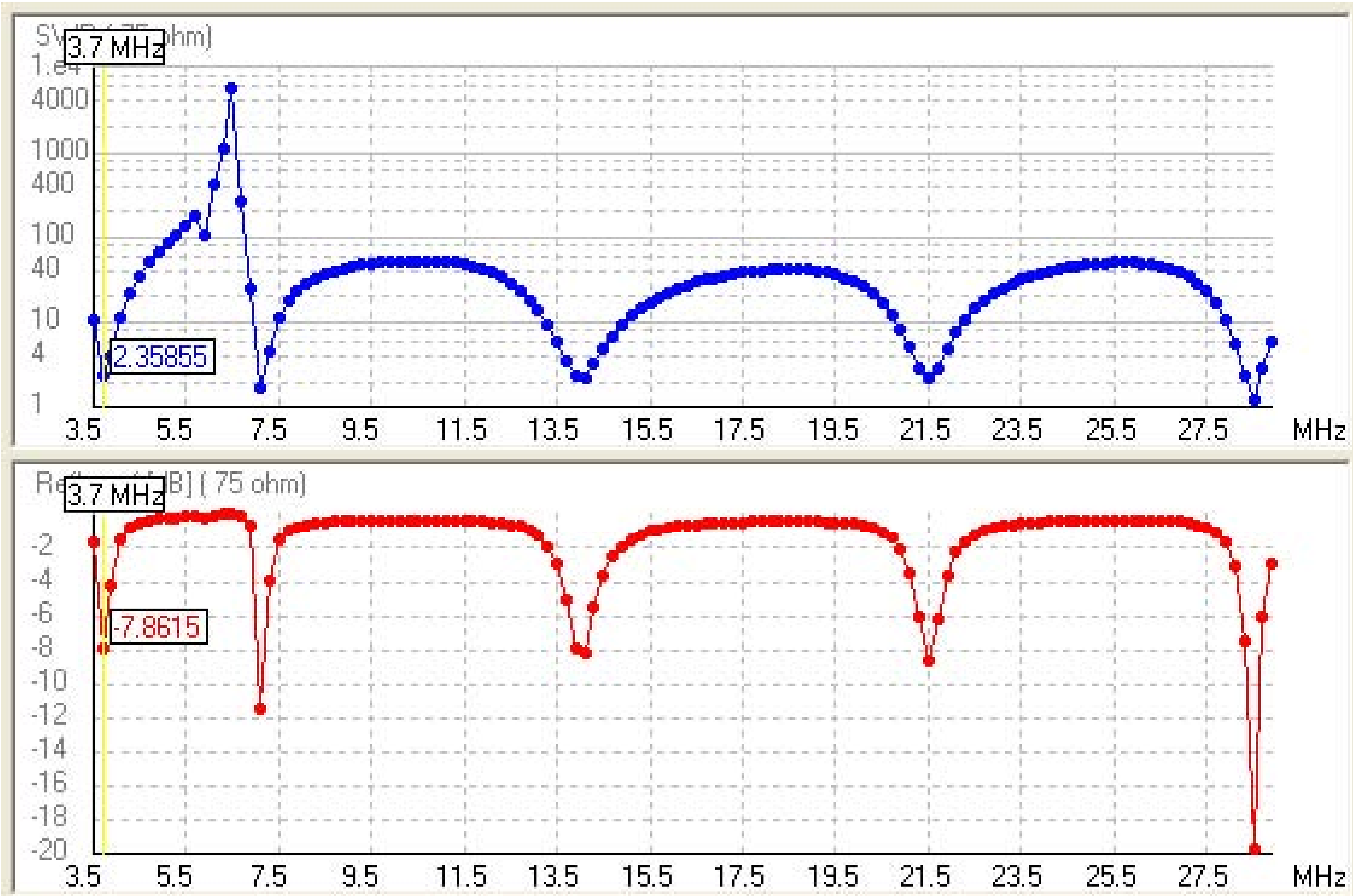
Figure 1—A W8NX multiband dipole for 80, 40, 20, 15 and 10 meters. The values shown (123 pF and 4 µH) for the coaxial-cable traps are for parallel resonance at 7.15 MHz. The low-impedance output of each trap is used for this antenna.

[1]Notes appear on page 29.

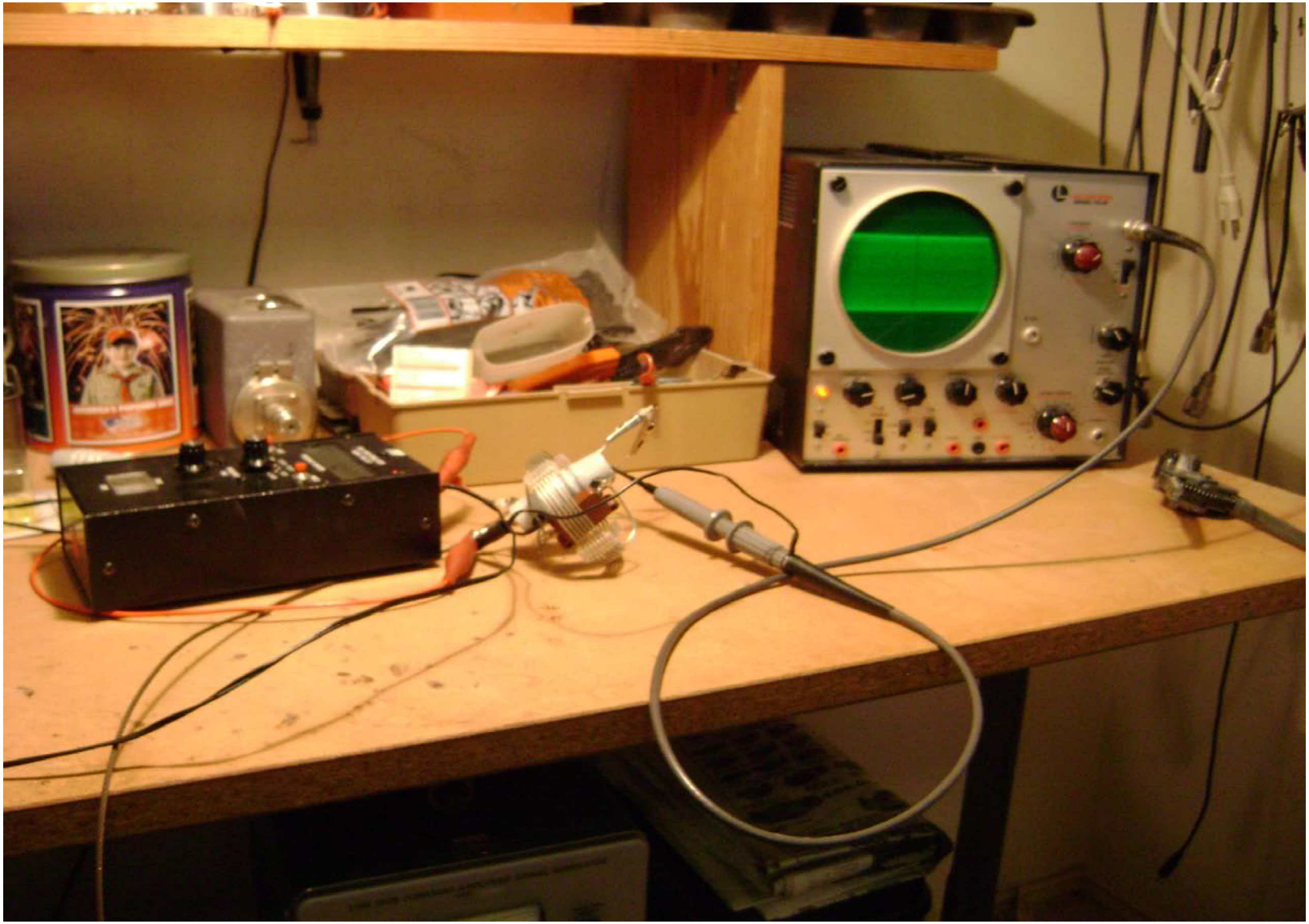
4NEC2 MODELING FOR 38 FT VEE



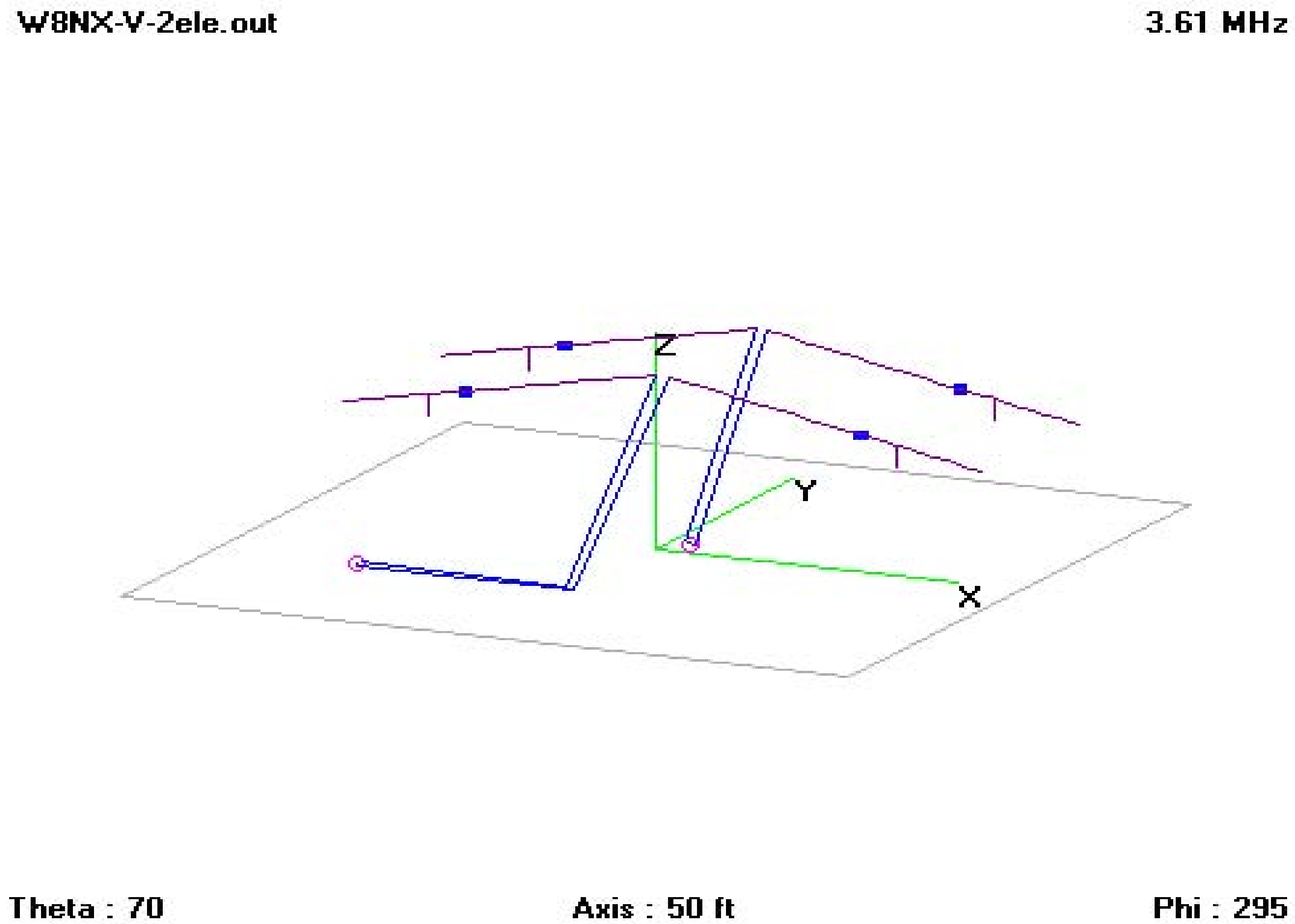
4NEC2 MODELING FOR 38 FT VEE



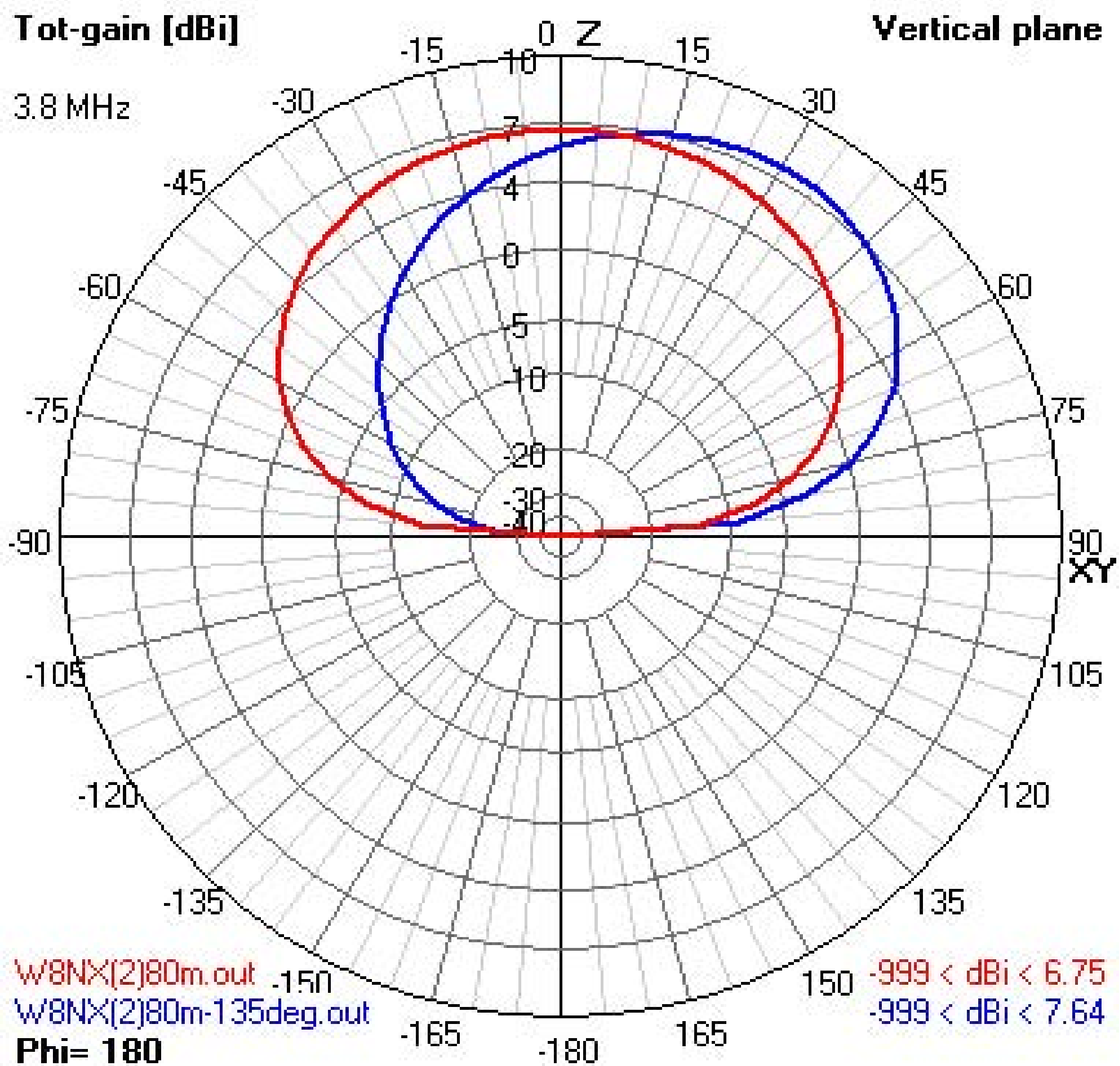
W8NX L-C TRAPS

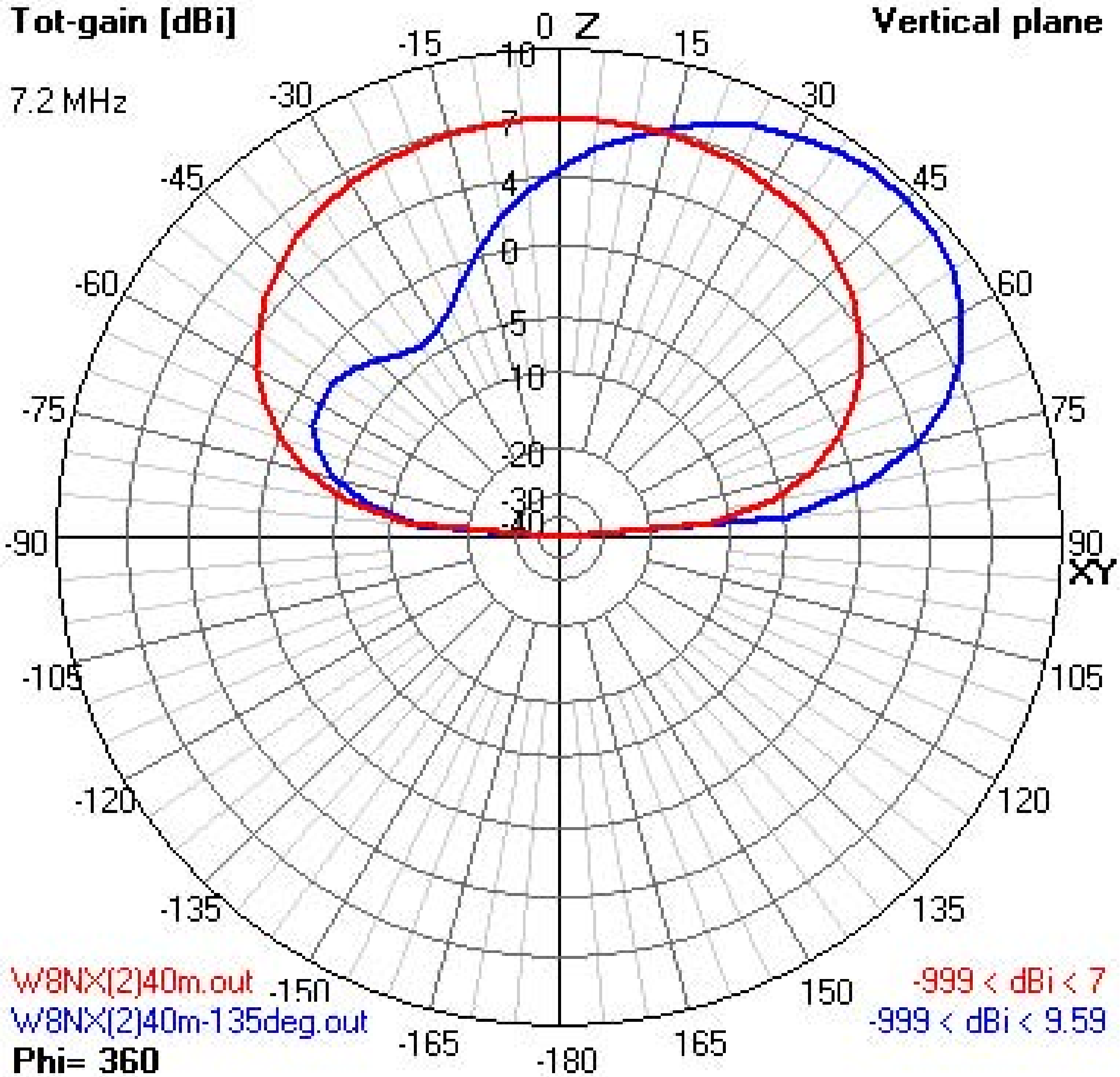


TWO PHASED W8NX VEEs SPACED 32 FT AT 38 FT HIGH

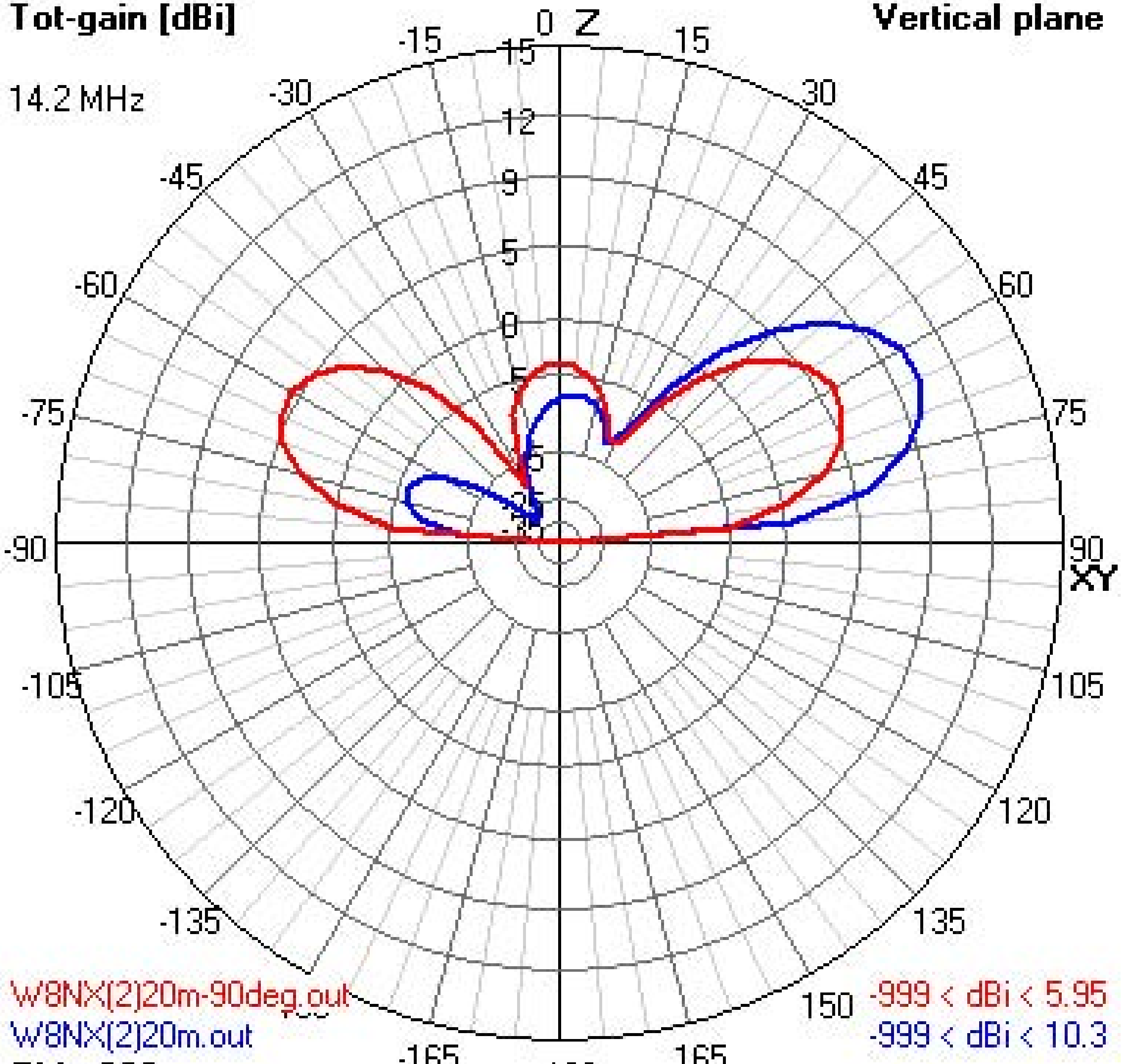


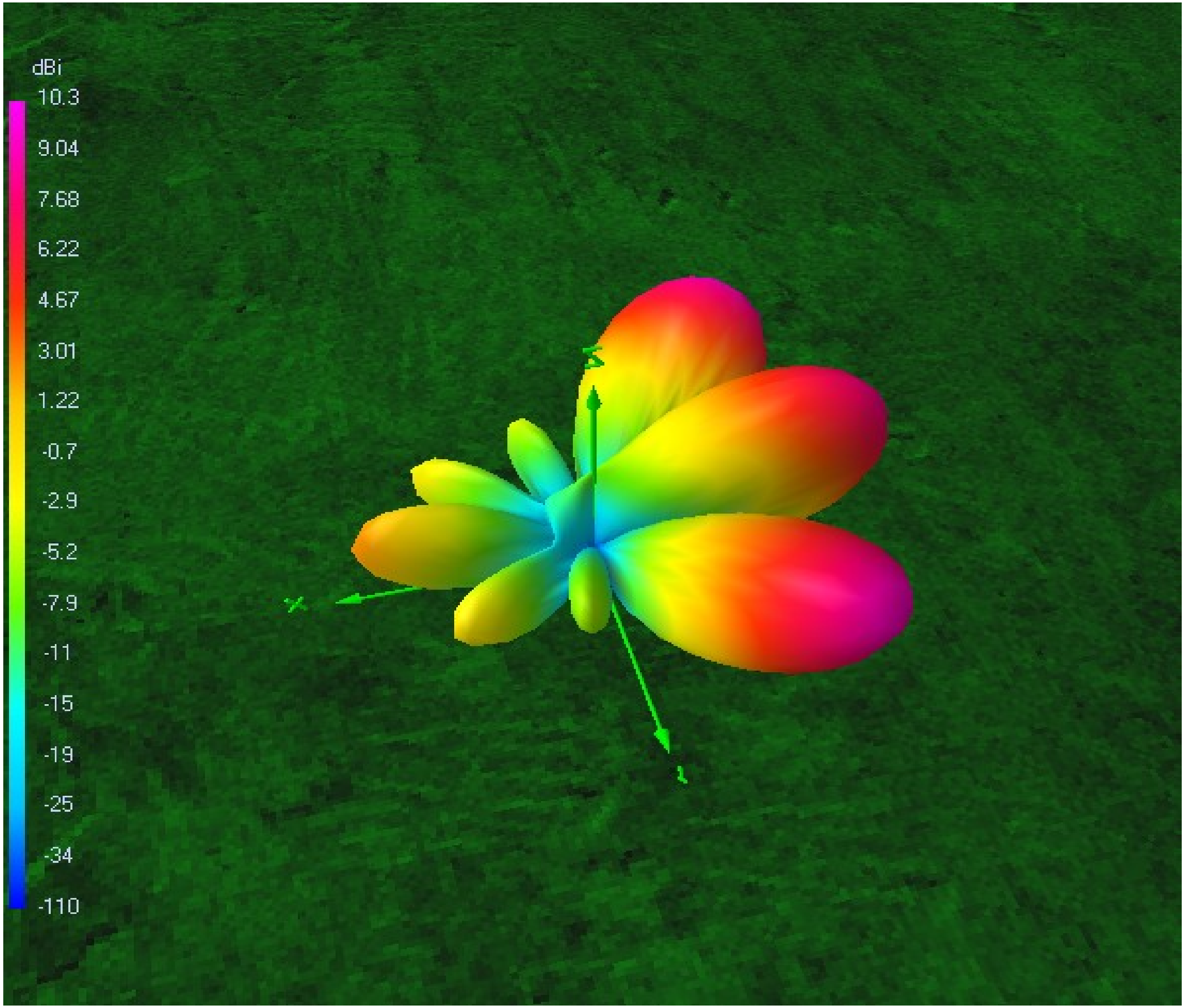
4NEC2 PATTERN PLOTS FOR PHASED W8NX VEEs





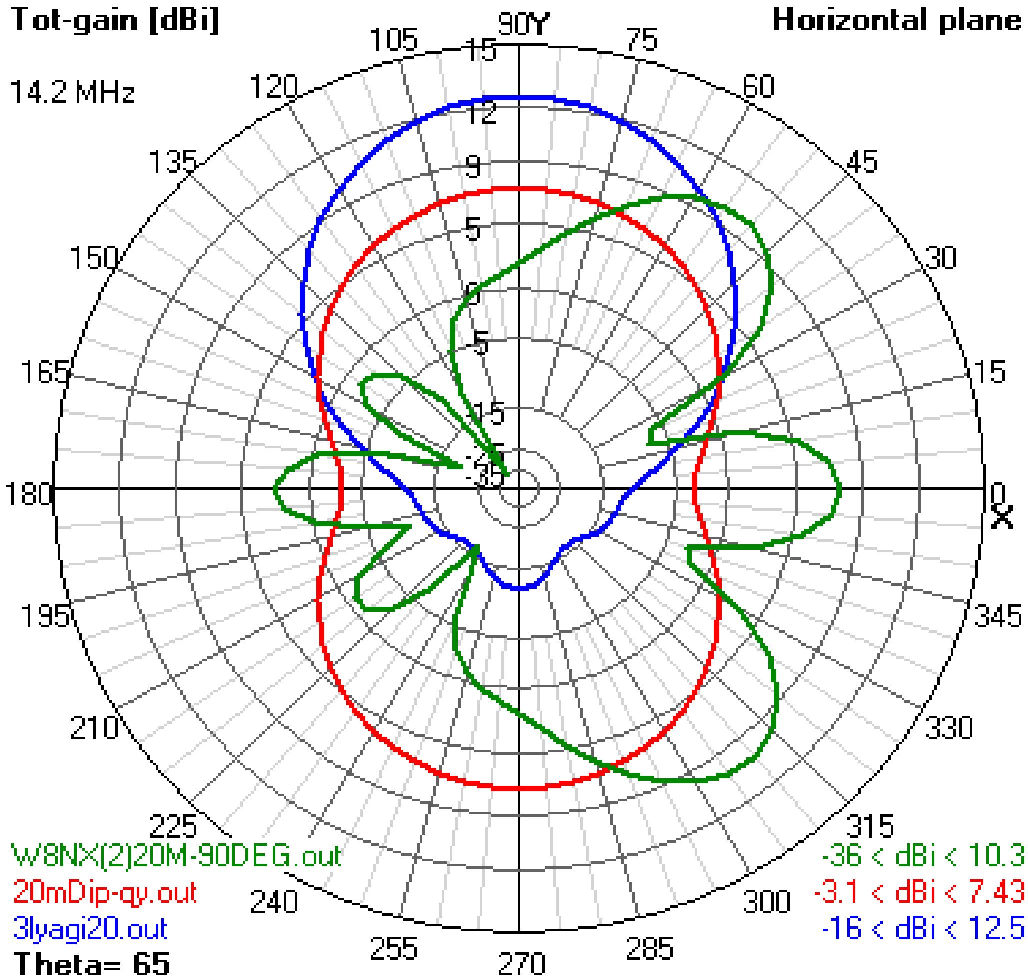
Tot-gain [dBi]
7.2 MHz
Vertical plane
0
Z
-15
15
-30
30
-45
45
-60
60
-75
75
-90
90
XY
-105
105
-120
120
-135
135
-150
150
-165
165
-180
10
7
4
0
-5
-10
-20
-30
-40
W8NX(2)40m.out
W8NX(2)40m-135deg.out
Phi= 360
-999 < dBi < 7
-999 < dBi < 9.59


Tot-gain [dBi]
Vertical plane
14.2 MHz
W8NX(2)20m-90deg.out
W8NX(2)20m.out
Phi= 230
-999 < dBi < 5.95
-999 < dBi < 10.3


dBi
10.3
9.04
7.68
6.22
4.67
3.01
1.22
-0.7
-2.9
-5.2
-7.9
-11
-15
-19
-25
-34
-110

W8NX ARRAY COMPARISONS (38 ft)

GREEN: W8NX ARRAY RED: FULL-SIZE INVERTED VEE BLUE: FULL-SIZE 3-ELE BEAM



Tractor-Pulley-Mast Lifting System

Two W8NX 80 -10 Meter Inverted Vees
Spaced 32 ft and 38 ft High

THE END

K5QY's Phased Arrays

http://mysite.verizon.net/k5qy/