NFARL
September 2009
HF Antennas
FOR
HF Beginners

What we will cover.

- A little theory
- Types of antennas suited for beginners
- Some antenna show and tell

IF YOU DON'T REMEMBER ANYTHING ELSE FROM TONIGHT. REMEMBER THESE THREE THINGS!

1.

ALL MULTIBAND ANTENNAS ARE A COMPERMISE IN SOME PARAMETER!

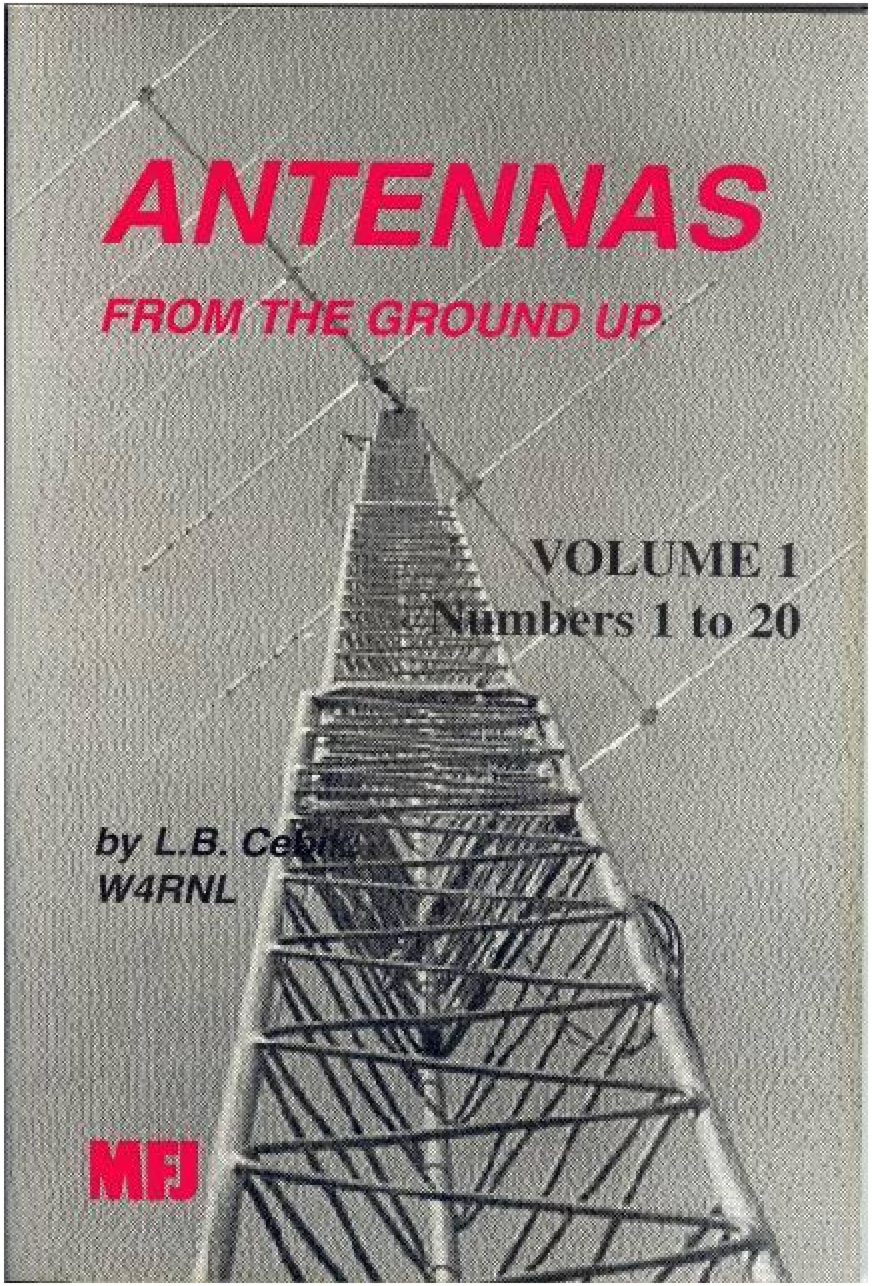
2.

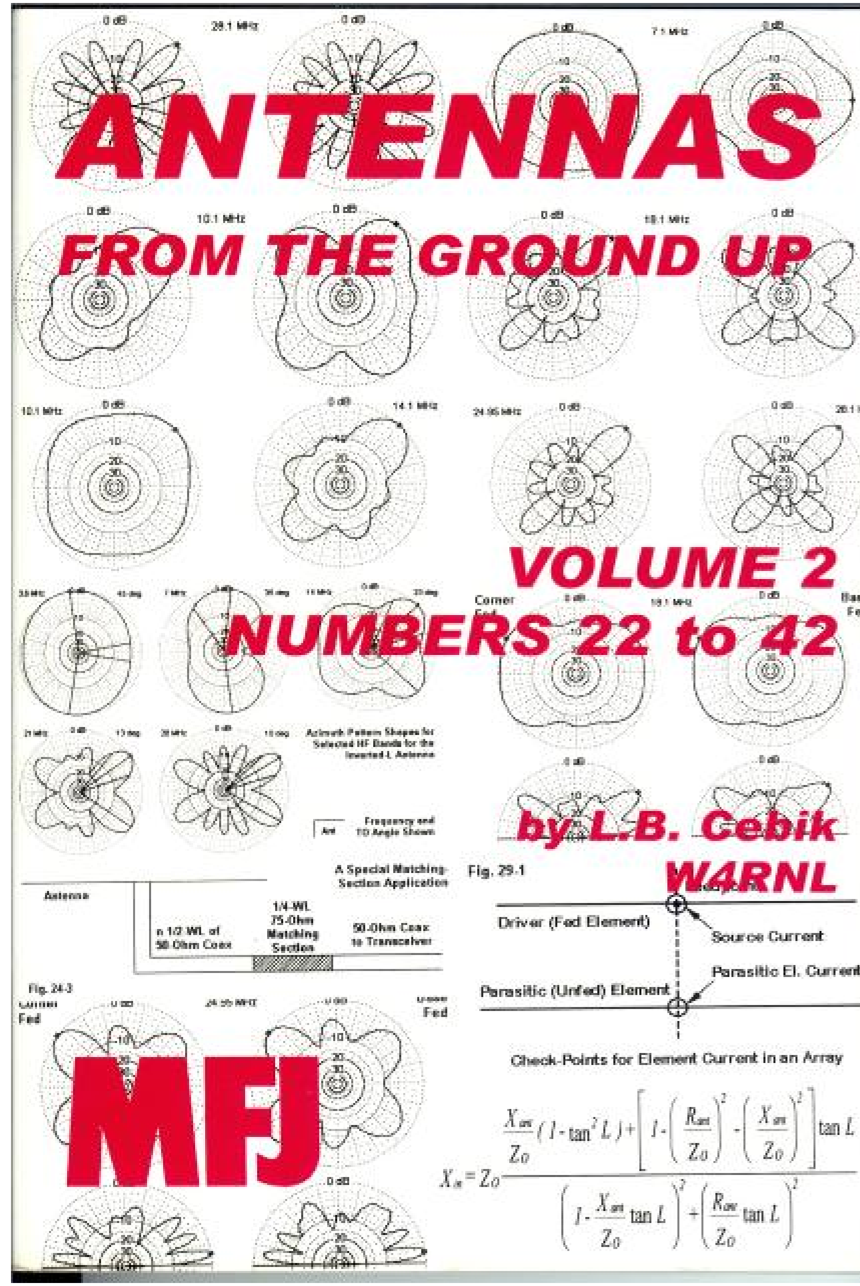
There ain’t no free lunch.

3.

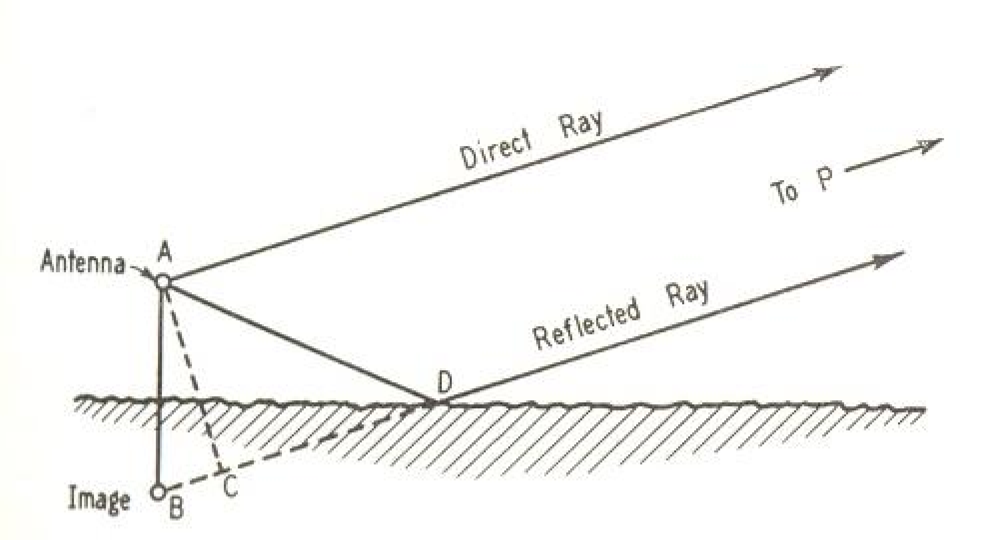
You get nothing for nothing!

Santa Claus is DEAD!


ANTENNAS
FROM THE GROUND UP
VOLUME 1
Numbers 1 to 20
by L.B. Cebik
W4RNL
MFJ


ANTENNAS
FROM THE GROUND UP
VOLUME 2
NUMBERS 22 to 42
by L.B. Cebik
W4RNL
MFJ
A Special Matching-Section Application
Antenna
n 1/2 WL of 50-Ohm Coax
1/4-WL 75-Ohm Matching Section
50-Ohm Coax to Transceiver
Fig. 29-1
Driver (Fed Element)
Source Current
Parasitic (Unfed) Element
Parasitic El. Current
Check-Points for Element Current in an Array

Band		1/8 WL	1/4 WL	1/2 WL	1WL	2 WL	3 WL	10 WL
160		68 Ft.	136 Ft,	273 Ft.	546 Ft.	1092 Ft	1638 Ft	5460 Ft
80		35 Ft	70 Ft	140 Ft	281 Ft.	562 Ft	843 Ft	2810 Ft
40		17 Ft	35 Ft	70 Ft	140 Ft.	280 Ft	420 Ft	1400 Ft
20		8 Ft	17 Ft	35 Ft	70 Ft.	140 Ft	210 Ft	700 Ft
17		6 Ft	13 Ft	27 Ft	54 Ft.	108 Ft	162 Ft	540 Ft
15		6 Ft	12 Ft	24 Ft	49 Ft.	98 Ft	147 Ft	490 Ft
12		5 Ft	10 Ft	20 Ft	39 Ft.	78 FT	117 Ft	390 Ft
10		4 Ft	8 Ft	17 Ft	35 Ft.	70 Ft	105 Ft	350 Ft



This is the conventional method of depicting signal reflection from the earth by assuming there is an image antenna below the surface and the same distance below the surgace as the real antenna is above the surface. By using a little geometry it can be shown that the reflected wave travels a greater distance, the distance is equal to the length of line BC, and this length determines the phase of the two signals at the distance point P. Each antenna, whether vertical or horizontal, has an effective height and this determines where the signal reflects from the earth. This usually occurs approximately 1.5 to 2 wave length from the antenna. The point I want to make is that nothing you do directly under the antenna, such as increased radial fields, will effect the signal reflection point. It may increase the efficiency of the antenna but, it will not help the reflected signal. The only way to do that is to make the first reflection occur over salt water.

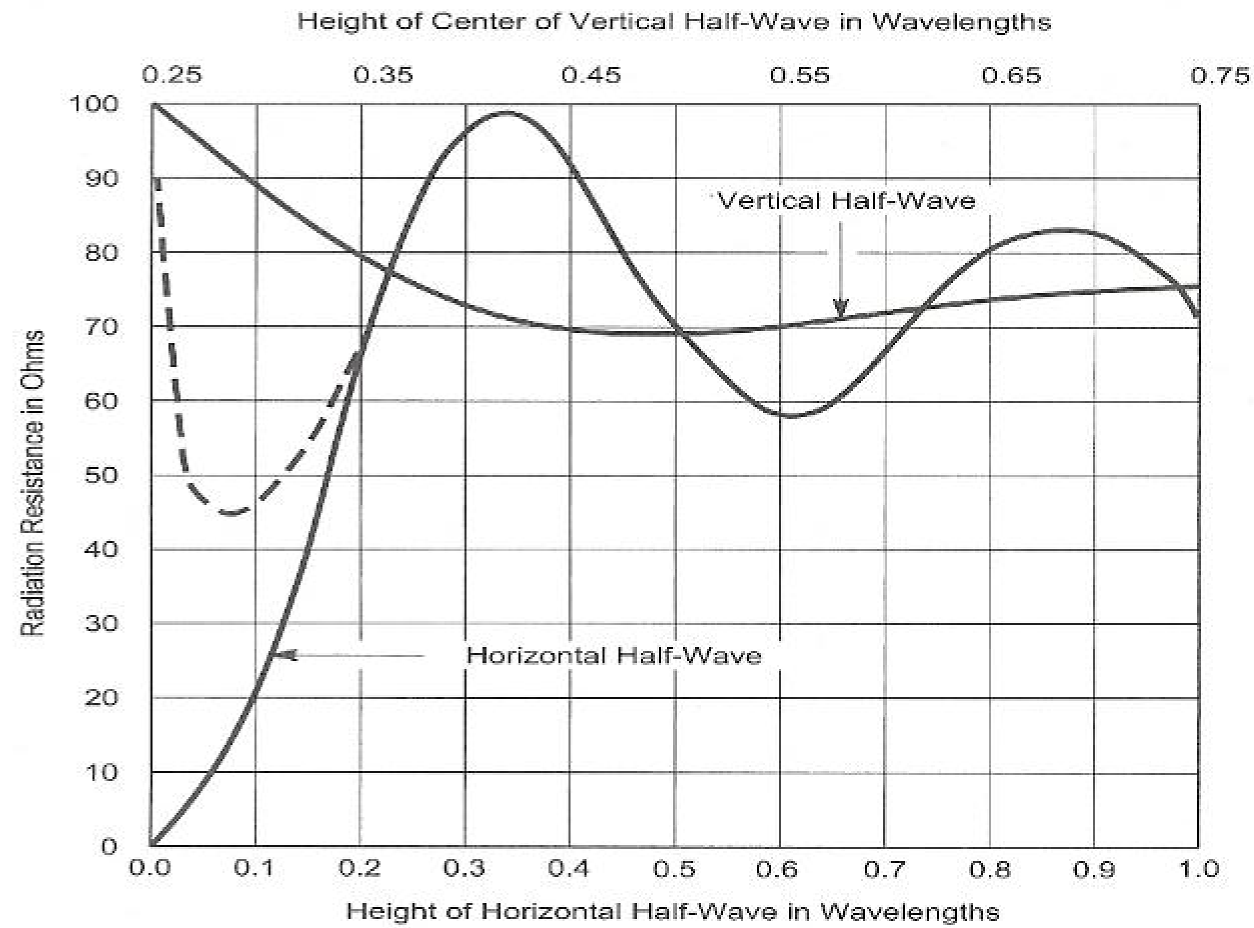


Fig 1—Variation in radiation resistance of vertical and horizontal half-wave antennas at various heights above flat ground. Solid lines are for perfectly conducting ground; the broken line is the radiation resistance of horizontal half-wave antennas at low height over real ground.

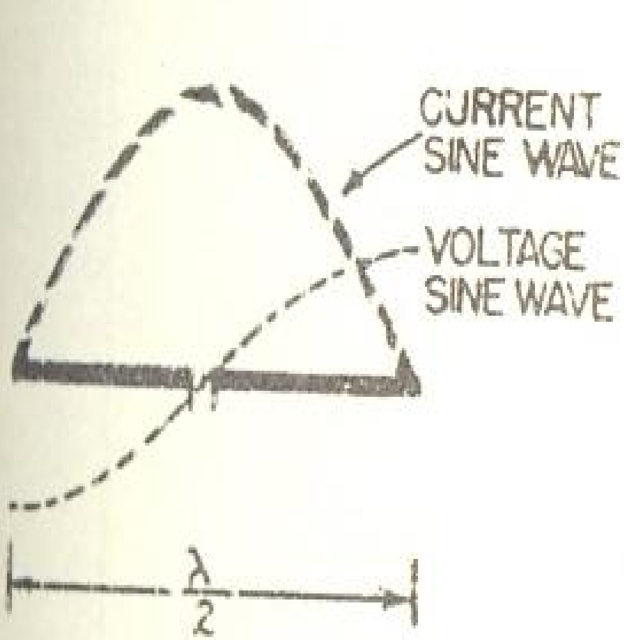


Fig. 8 Current and voltage distribution along a half-wave dipole.

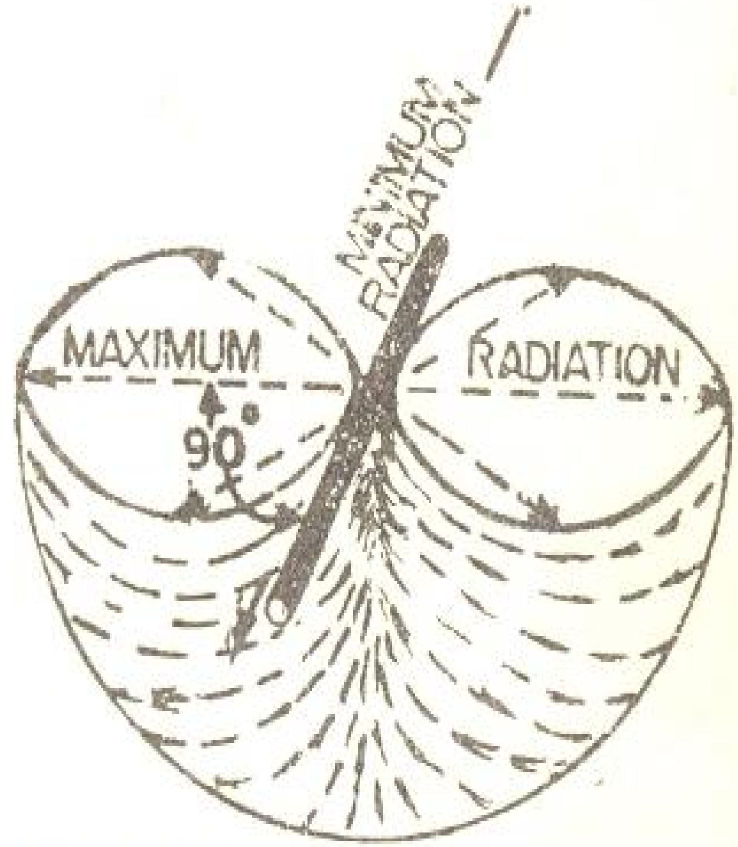


Fig. 9 Cross section of surface pattern for a half-wave dipole in space (based on horizontal and vertical field patterns of dipole).

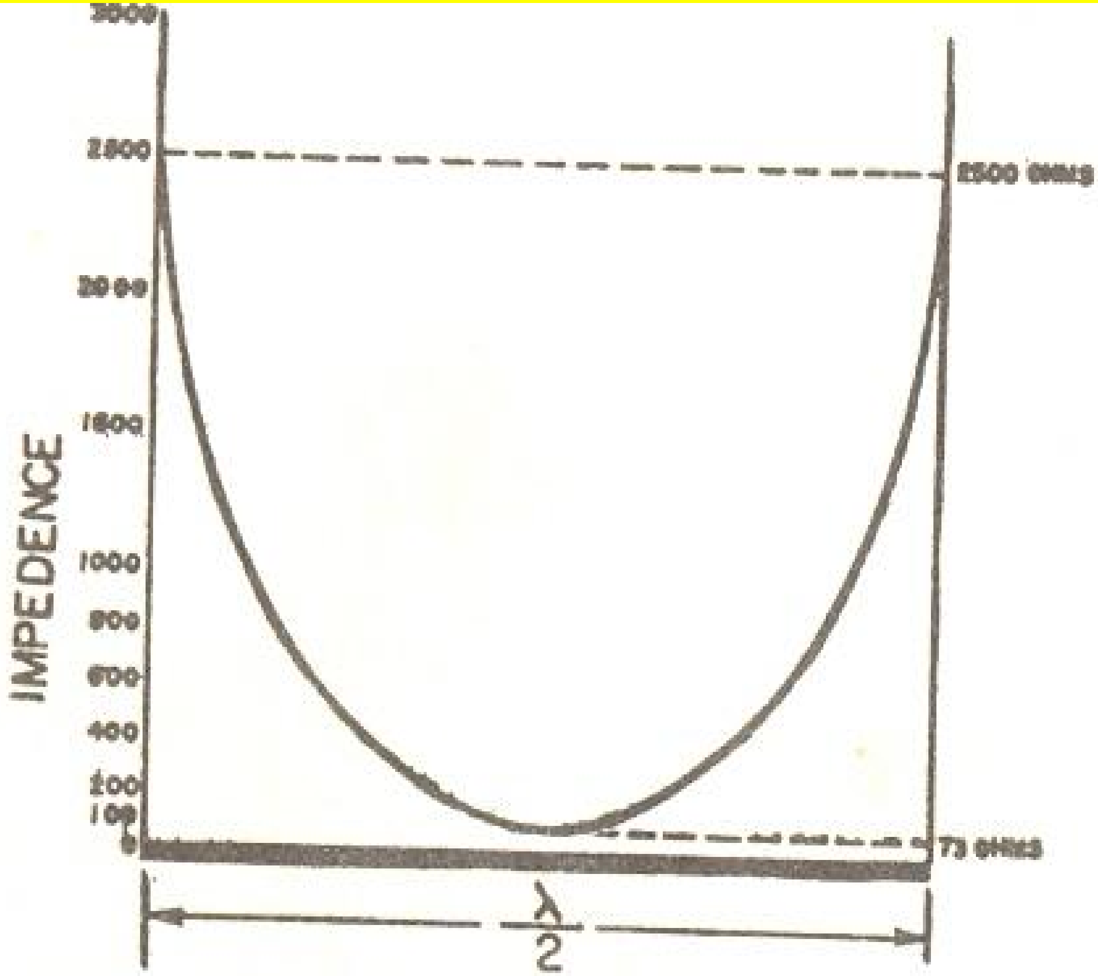


Fig. 13 Impedance along a typical half-wave dipole.

FEED LINE MATCHED LOSS per 100 FT.

	1 MHZ	10MHZ	100MHZ
RG-213	0.2 db	0.6 db	1.9 db
LMR-500	0.1 db	0.4 db	1.2 db
RG-58A	0.4 db	1.3 db	4.5 db
CQ-553 Ladder Line	0.02 db	0.08 db	0.3 db

100 Wts input at 10 MHz Results in

	Watts Out
RG-213	87.1
LMR-500	91.2
RG-58A	74.13
CQ-553	98.17

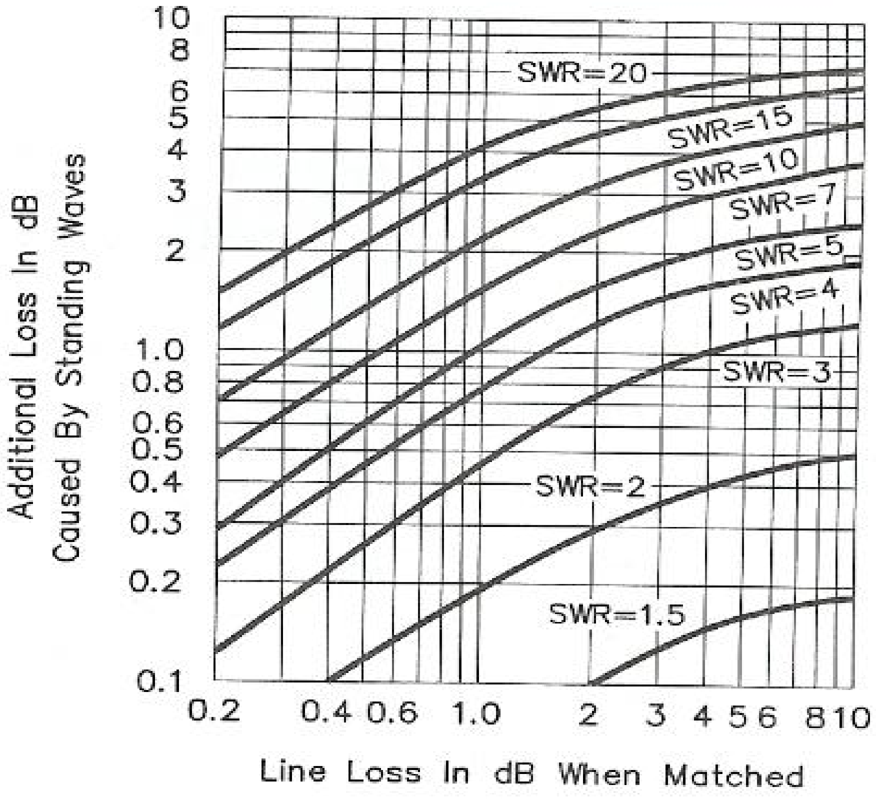


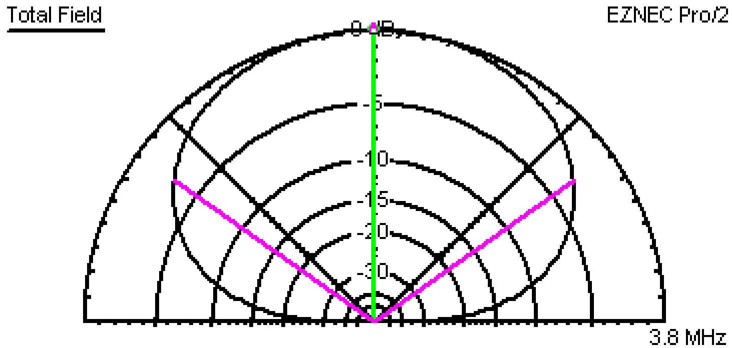
Fig 14—Additional line loss due to standing waves (SWR, measured at the load). See Fig 23 for matched-line loss. To determine the total loss in dB, add the matched-line loss to the value from this graph.


MADE IN USA

This is one method of handling bringing ladder line down the side of a tower. The stand offs are made of 1-1/2 inch PVC pipe cut 24-inches long and then a hole saw of 1-1/4 inch diameter is used to cut a hole through the middle of the PVC pipe. This gives you 2 pieces appoximately12-inches long with a half-moon on one end. This end will just fit around the leg of Rhon 25 tower. About 1/2-inch ahead of the half-moon cut a vertical slots on each side of the pipe that will allow a hose clamp to slide through. When this is placed around the leg of the tower and tightened it make a very stout stand-off.

On the other end cut a vertical slot deep enough to allow the ladder line to slide all the way in. Drill a 1/4-inch hole through the pipe at right angles to the slot. This will allow the use of a tie wrap to be used to hold the ladder line in the slot.

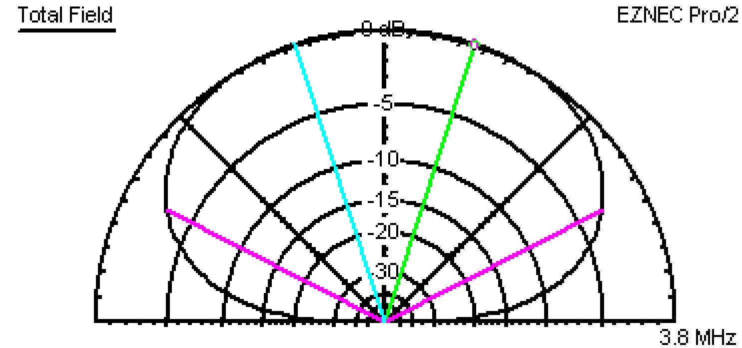
Give the ladder line about 1 twist per foot and this will keep the line from being whipped in the wind. It also allows the ladder line to have equal exposure on each wire to the tower .



Elevation Plot | | Cursor Elev | 90.0 deg.
Azimuth Angle | 0.0 deg. | Gain | 6.31 dBi
Outer Ring | 6.31 dBi | | 0.0 dBmax

Slice Max Gain 6.31 dBi @ Elev Angle = 90.0 deg.
Beamwidth 109.2 deg.; -3dB @ 35.4, 144.6 deg.
Sidelobe Gain < -100 dBi
Front/Sidelobe > 100 dB

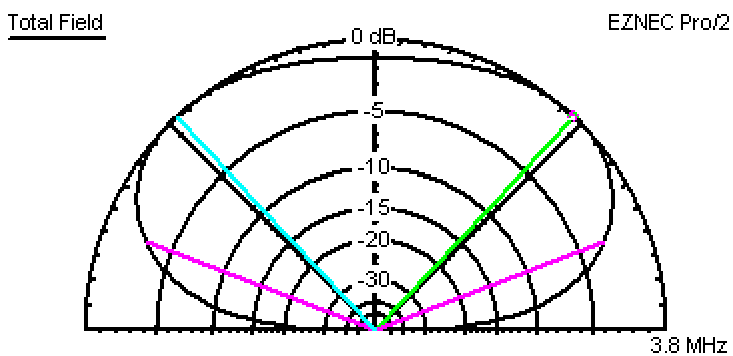
40 feet **61.09 - J 3.236**



Elevation Plot | | Cursor Elev | 72.0 deg.
Azimuth Angle | 0.0 deg. | Gain | 6.23 dBi
Outer Ring | 6.23 dBi | | 0.0 dBmax

Slice Max Gain 6.23 dBi @ Elev Angle = 72.0 deg.
Beamwidth 125.6 deg.; -3dB @ 27.2, 152.8 deg.
Sidelobe Gain 6.23 dBi @ Elev Angle = 108.0 deg.
Front/Sidelobe 0.0 dB

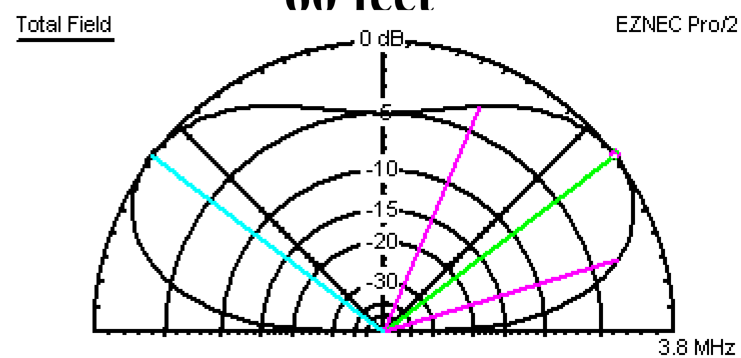
60 feet **80.33 - J 9.067**



Elevation Plot | | Cursor Elev | 47.0 deg.
Azimuth Angle | 0.0 deg. | Gain | 6.07 dBi
Outer Ring | 6.07 dBi | | 0.0 dBmax

Slice Max Gain 6.07 dBi @ Elev Angle = 47.0 deg.
Beamwidth 138.2 deg.; -3dB @ 20.9, 159.1 deg.
Sidelobe Gain 6.07 dBi @ Elev Angle = 133.0 deg.
Front/Sidelobe 0.0 dB

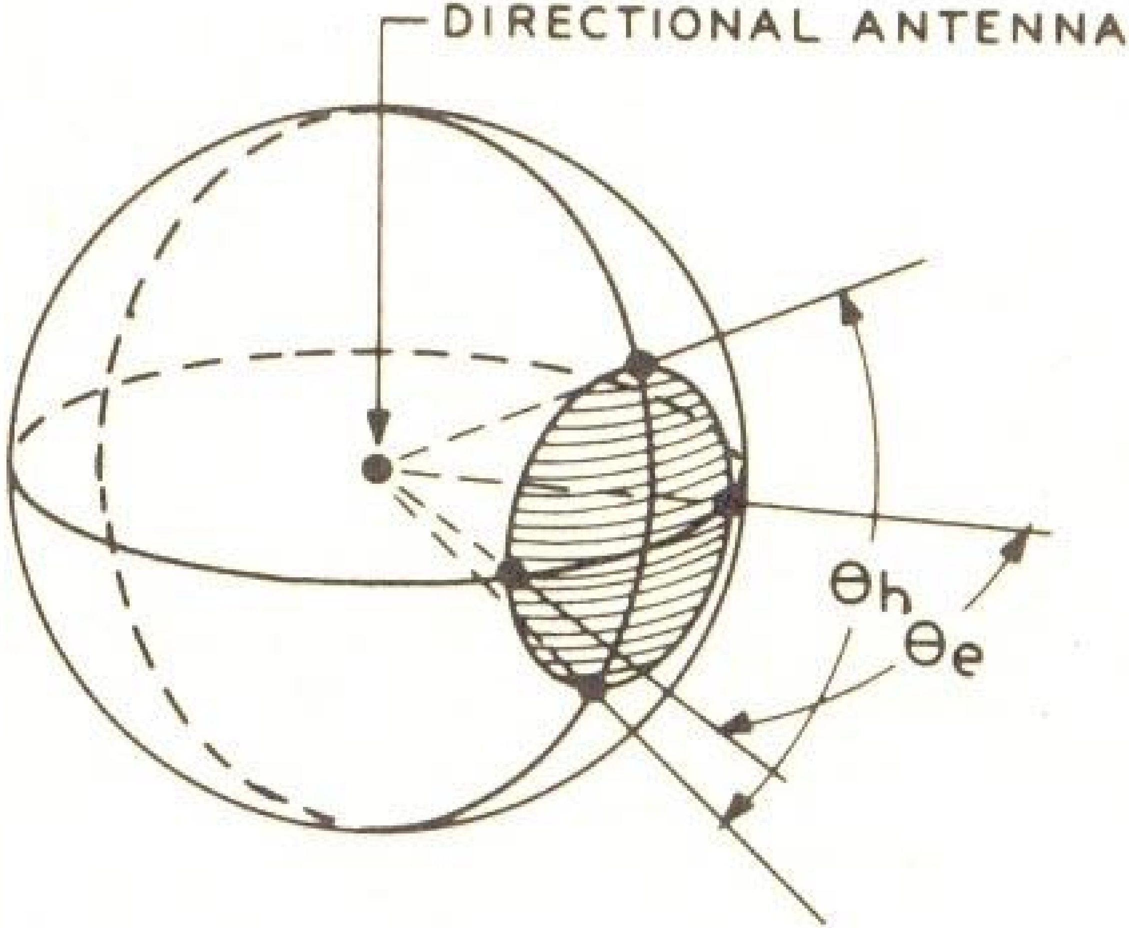
80 feet **87.89 - J 24.72**



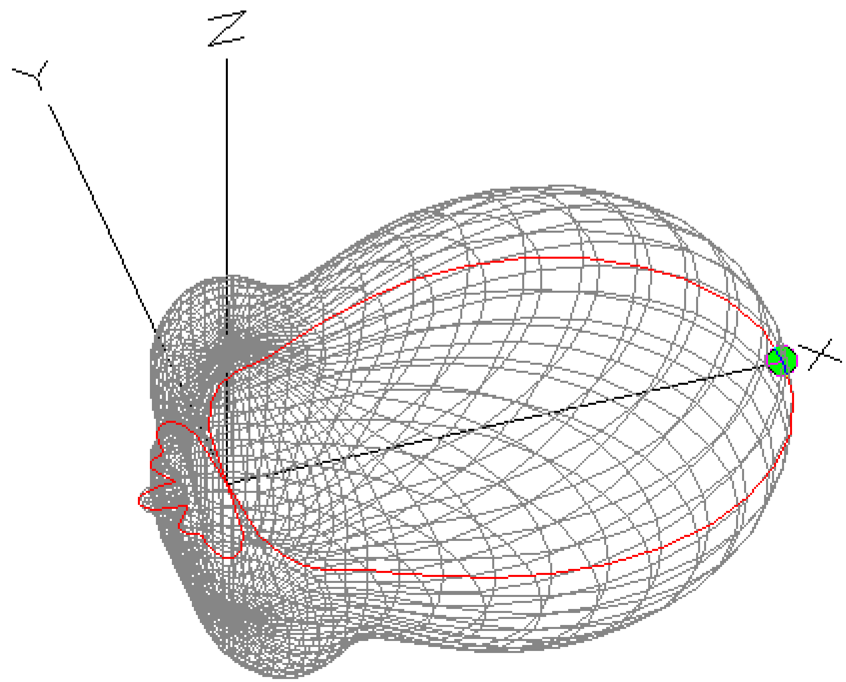
Elevation Plot | | Cursor Elev | 37.0 deg.
Azimuth Angle | 0.0 deg. | Gain | 6.51 dBi
Outer Ring | 6.51 dBi | | 0.0 dBmax

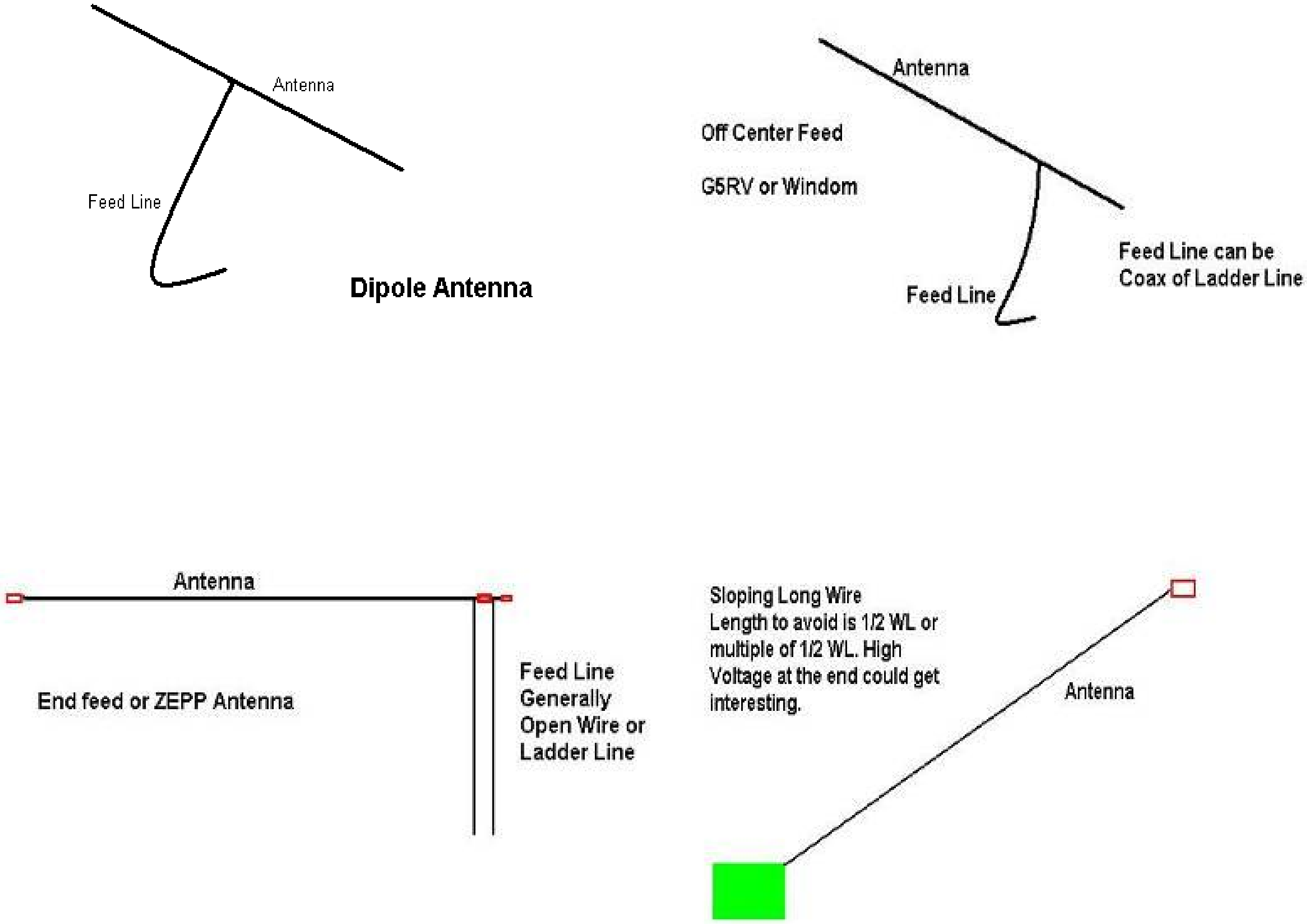
Slice Max Gain 6.51 dBi @ Elev Angle = 37.0 deg.
Beamwidth 49.6 deg.; -3dB @ 17.0, 66.6 deg.
Sidelobe Gain 6.51 dBi @ Elev Angle = 143.0 deg.
Front/Sidelobe 0.0 dB

100 feet **81.98 - J 38.17**

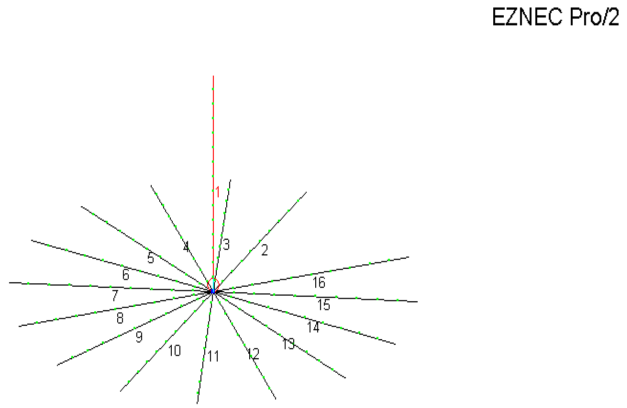

DIRECTIONAL ANTENNA
θh
θe

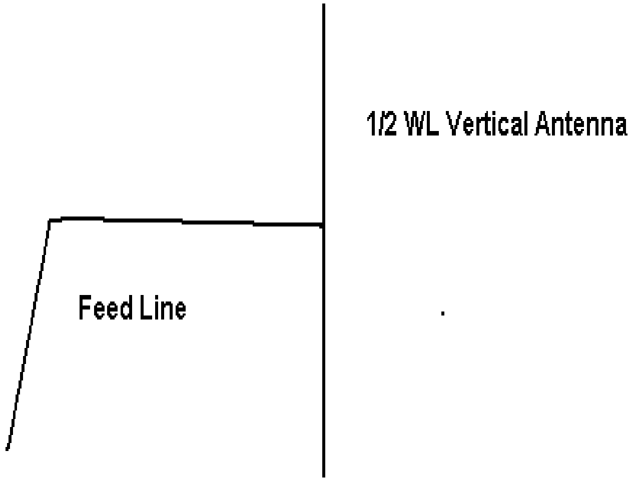
EZNEC Pro/2





4 Types of Wire Antennas

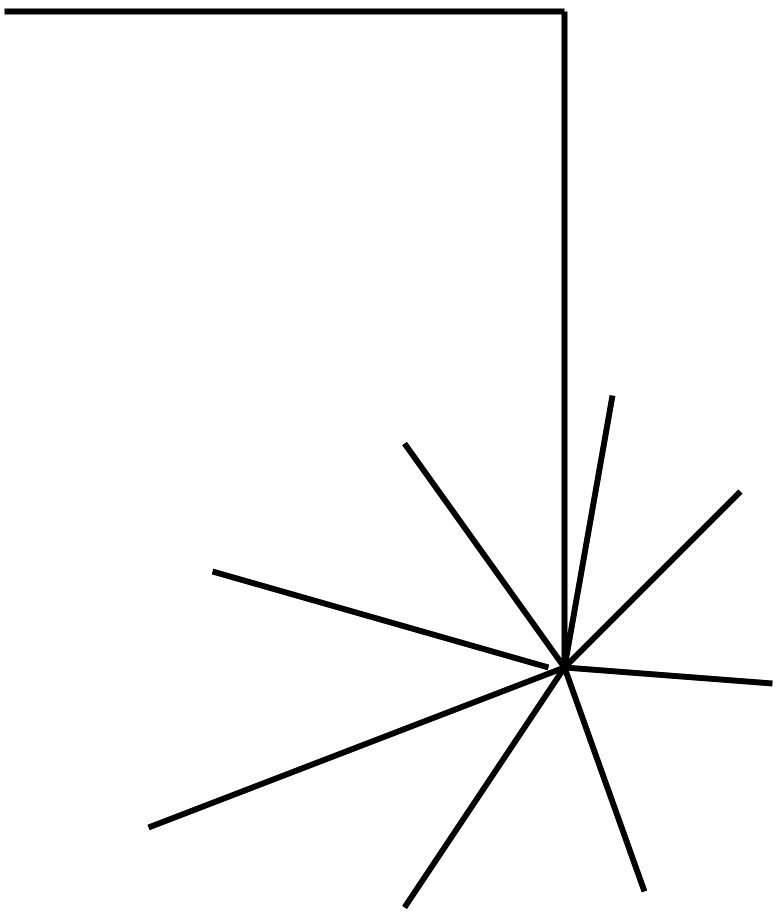


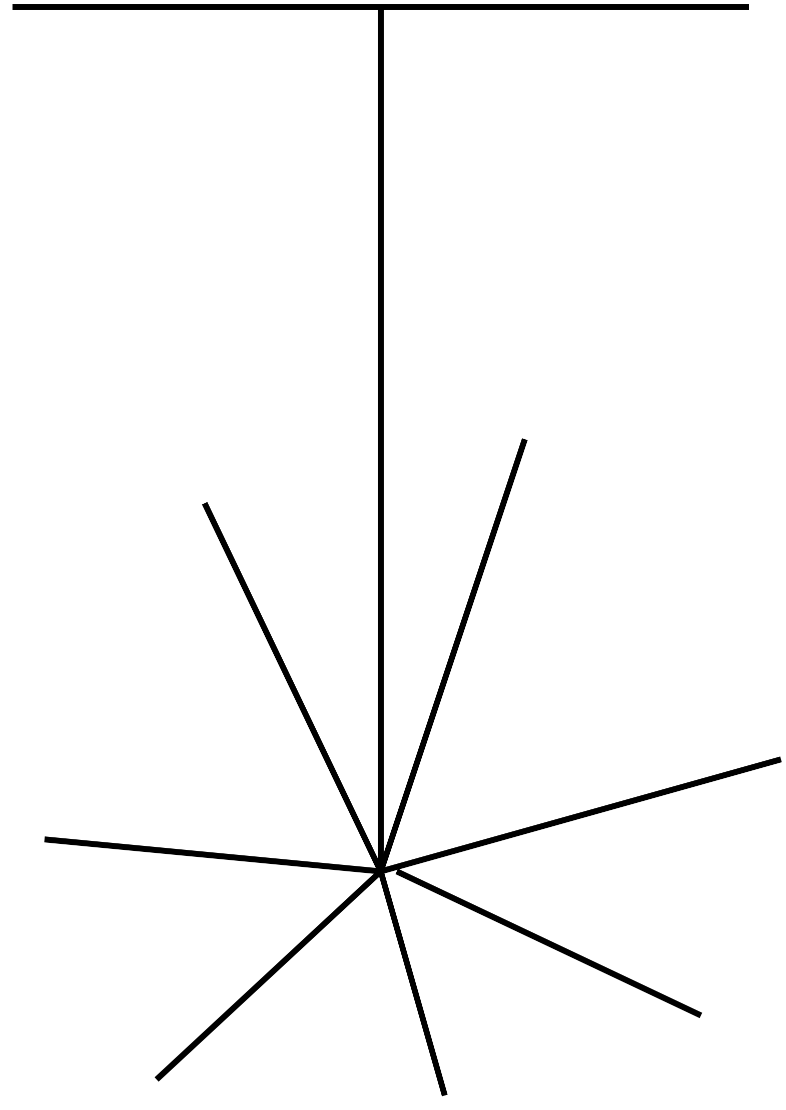


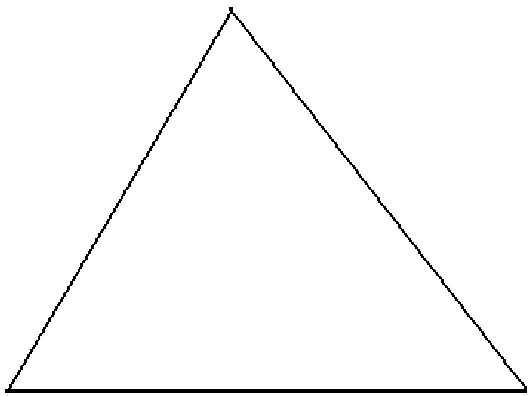
Vertical Antenna

“T” Antenna

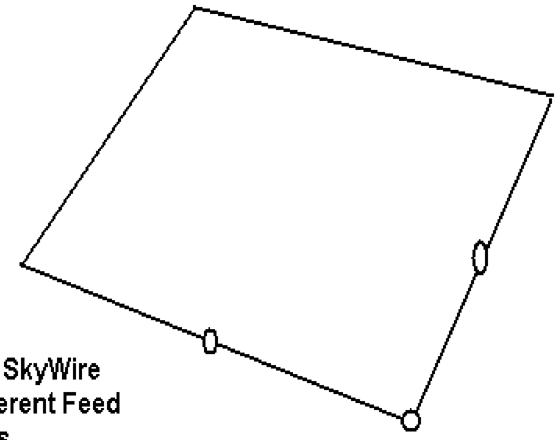
Inverted “L”







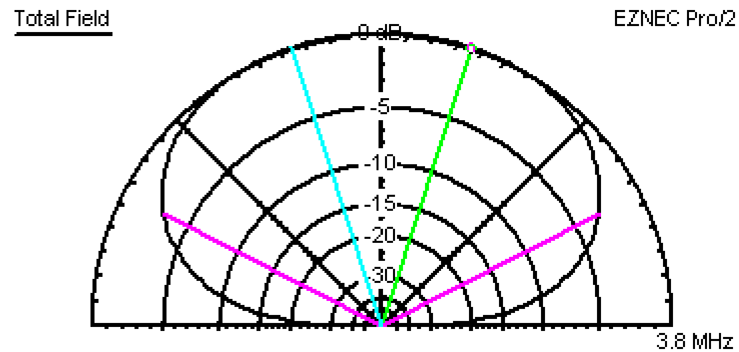
Delta Loop. Can be feed at several points.



Loop SkyWire
3 Different Feed
Points

Loop Antennas

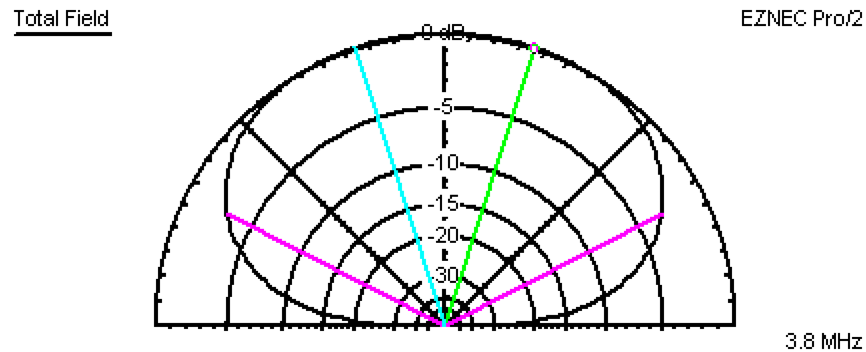
DIPOLE ANTENNA WITH DIFFERENT FEEDS



Elevation Plot		Cursor Elev	72.0 deg.
Azimuth Angle	0.0 deg.	Gain	6.23 dBi
Outer Ring	6.23 dBi		0.0 dBmax

Slice Max Gain	6.23 dBi @ Elev Angle = 72.0 deg.
Beamwidth	125.6 deg.; -3dB @ 27.2, 152.8 deg.
Sidelobe Gain	6.23 dBi @ Elev Angle = 108.0 deg.
Front/Sidelobe	0.0 dB

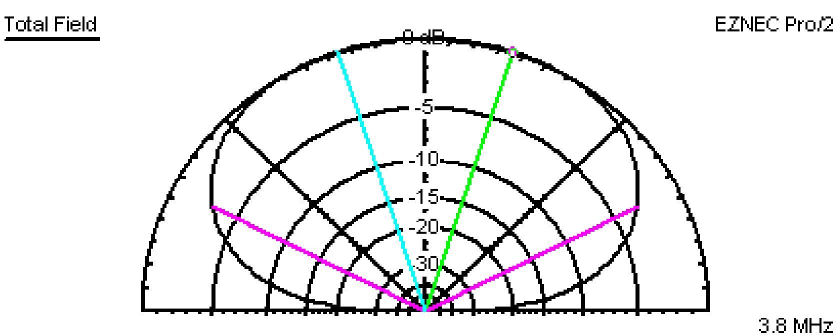
Center Feed 60 foot



Elevation Plot		Cursor Elev	72.0 deg.
Azimuth Angle	0.0 deg.	Gain	6.23 dBi
Outer Ring	6.23 dBi		0.0 dBmax

Slice Max Gain	6.23 dBi @ Elev Angle = 72.0 deg.
Beamwidth	125.6 deg.; -3dB @ 27.2, 152.8 deg.
Sidelobe Gain	6.23 dBi @ Elev Angle = 108.0 deg.
Front/Sidelobe	0.0 dB

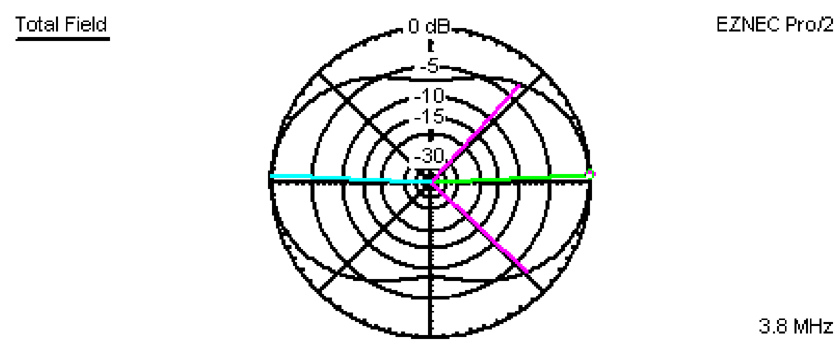
Feed 33% from end 60 foot



Elevation Plot		Cursor Elev	72.0 deg.
Azimuth Angle	0.0 deg.	Gain	6.21 dBi
Outer Ring	6.21 dBi		0.0 dBmax

Slice Max Gain	6.21 dBi @ Elev Angle = 72.0 deg.
Beamwidth	125.6 deg.; -3dB @ 27.2, 152.8 deg.
Sidelobe Gain	6.21 dBi @ Elev Angle = 108.0 deg.
Front/Sidelobe	0.0 dB

End feed 60 feet

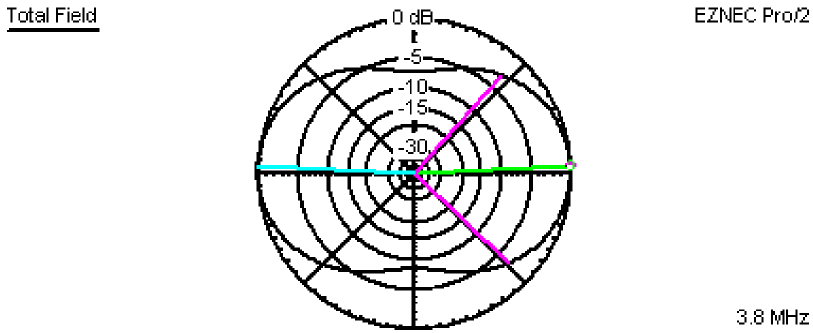


Azimuth Plot		Cursor Az	3.0 deg.
Elevation Angle	30.0 deg.	Gain	3.78 dBi
Outer Ring	3.78 dBi		0.0 dBmax

Slice Max Gain	3.78 dBi @ Az Angle = 3.0 deg.
Front/Back	0.04 dB
Beamwidth	92.8 deg.; -3dB @ 316.2, 49.0 deg.
Sidelobe Gain	3.78 dBi @ Az Angle = 177.0 deg.
Front/Sidelobe	0.0 dB

Azimuth Pattern for all 3 feeds

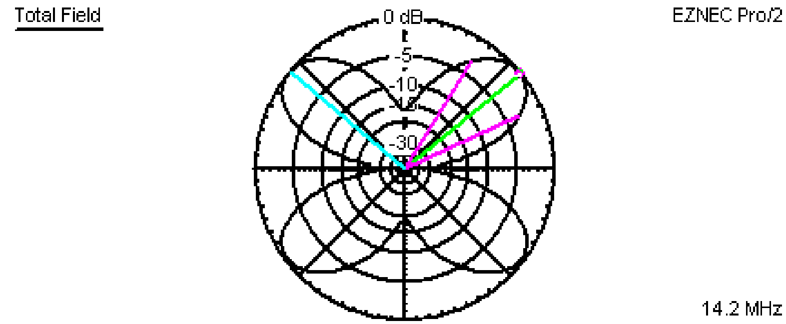
Dipole Antenna with 3 Different Feeds on 20-Meters



Azimuth Plot		Cursor Az	3.0 deg.
Elevation Angle	30.0 deg.	Gain	3.78 dBi
Outer Ring	3.78 dBi		0.0 dBmax

Slice Max Gain	3.78 dBi @ Az Angle = 3.0 deg.
Front/Back	0.04 dB
Beamwidth	92.8 deg.; -3dB @ 316.2, 49.0 deg.
Sidelobe Gain	3.78 dBi @ Az Angle = 177.0 deg.
Front/Sidelobe	0.0 dB

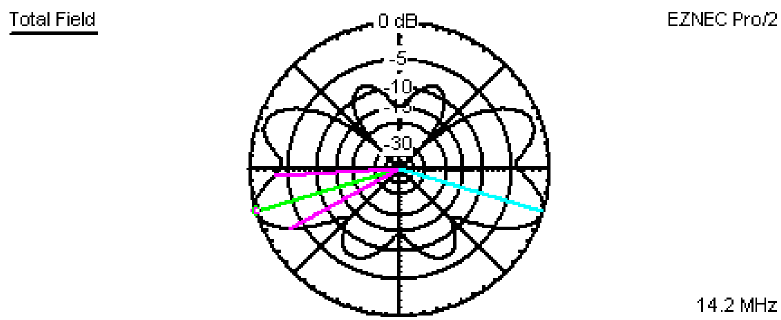
3.8 MHz Dipole



Azimuth Plot		Cursor Az	39.0 deg.
Elevation Angle	16.0 deg.	Gain	8.85 dBi
Outer Ring	8.85 dBi		0.0 dBmax

Slice Max Gain	8.85 dBi @ Az Angle = 39.0 deg.
Front/Back	0.25 dB
Beamwidth	33.4 deg.; -3dB @ 24.4, 57.8 deg.
Sidelobe Gain	8.85 dBi @ Az Angle = 140.0 deg.
Front/Sidelobe	0.0 dB

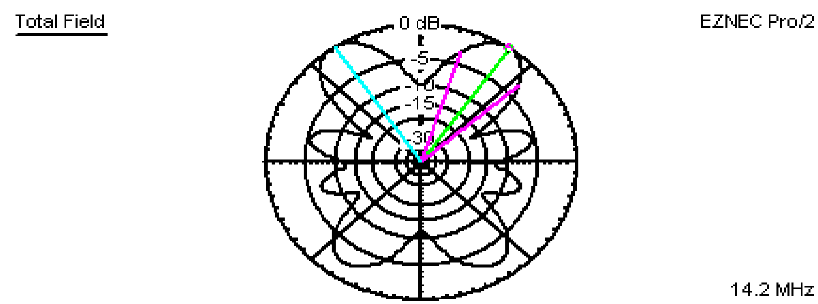
3.8 MHz dipole on 14.2 MHz Center Feed



Azimuth Plot		Cursor Az	197.0 deg.
Elevation Angle	16.0 deg.	Gain	8.78 dBi
Outer Ring	8.78 dBi		0.0 dBmax

Slice Max Gain	8.78 dBi @ Az Angle = 197.0 deg.
Front/Back	1.02 dB
Beamwidth	25.9 deg.; -3dB @ 183.4, 209.3 deg.
Sidelobe Gain	8.78 dBi @ Az Angle = 343.0 deg.
Front/Sidelobe	0.0 dB

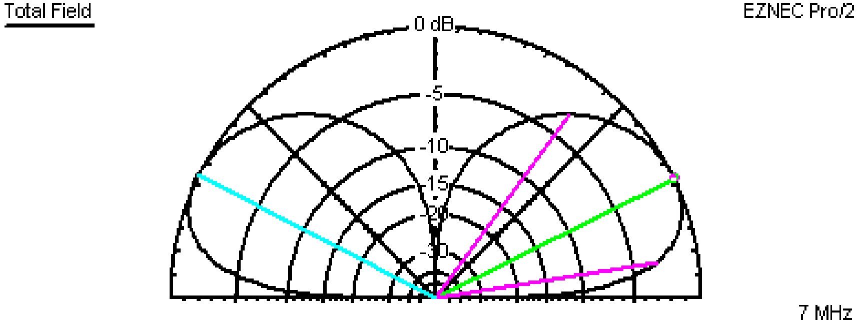
3.8 MHz dipole on 14.2 MHz 33% feed



Azimuth Plot		Cursor Az	55.0 deg.
Elevation Angle	15.0 deg.	Gain	10.09 dBi
Outer Ring	10.09 dBi		0.0 dBmax

Slice Max Gain	10.09 dBi @ Az Angle = 55.0 deg.
Front/Back	2.12 dB
Beamwidth	30.6 deg.; -3dB @ 41.5, 72.1 deg.
Sidelobe Gain	10.09 dBi @ Az Angle = 124.0 deg.
Front/Sidelobe	0.0 dB

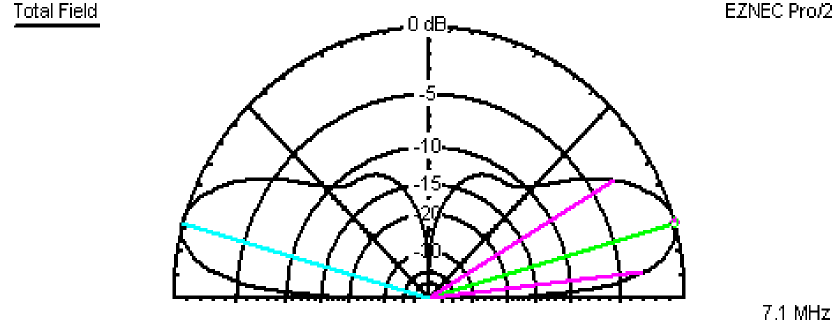
3.8 MHz dipole on 14.2 MHz End feed



Elevation Plot		Cursor Elev	26.0 deg.
Azimuth Angle	270.0 deg.	Gain	-0.03 dBi
Outer Ring	-0.03 dBi		0.0 dBmax

Slice Max Gain -0.03 dBi @ Elev Angle = 26.0 deg.
Beamwidth 44.1 deg.; -3dB @ 9.0, 53.1 deg.
Sidelobe Gain -0.03 dBi @ Elev Angle = 153.0 deg.
Front/Sidelobe 0.0 dB

40 Meter Vertical over Ground
Impedance = 36.03 + J 0.1224 ohms

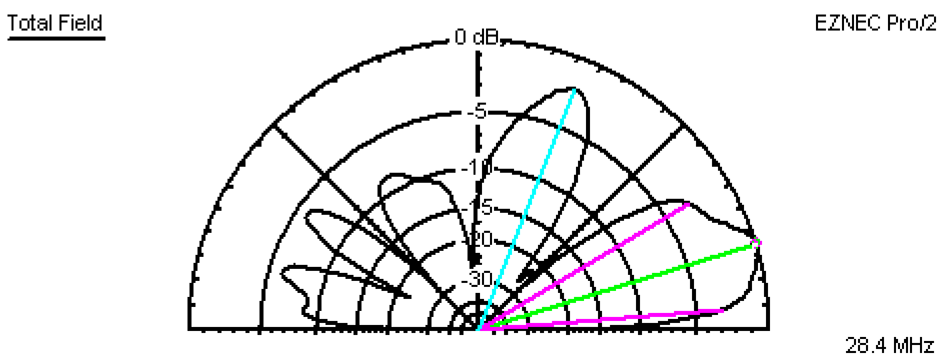


Elevation Plot		Cursor Elev	16.0 deg.
Azimuth Angle	0.0 deg.	Gain	0.0 dBi
Outer Ring	0.0 dBi		0.0 dBmax

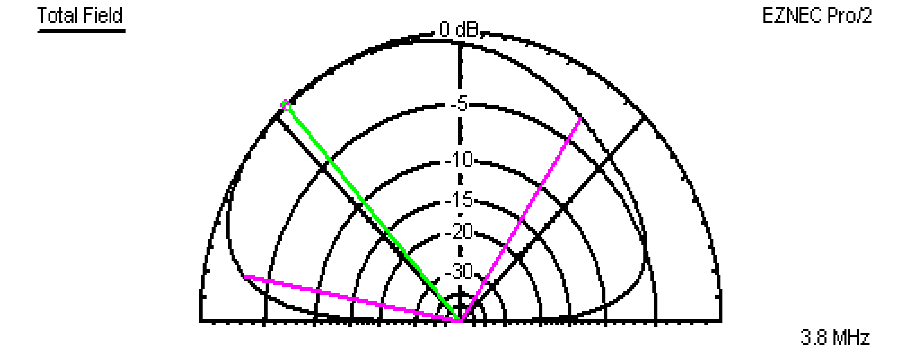
Slice Max Gain 0.0 dBi @ Elev Angle = 16.0 deg.
Beamwidth 24.4 deg.; -3dB @ 6.4, 30.8 deg.
Sidelobe Gain 0.0 dBi @ Elev Angle = 164.0 deg.
Front/Sidelobe 0.0 dB

40 meter 1/2 Wave Vertical over Ground
Impedance = 85.78 + J 0.07887 ohms

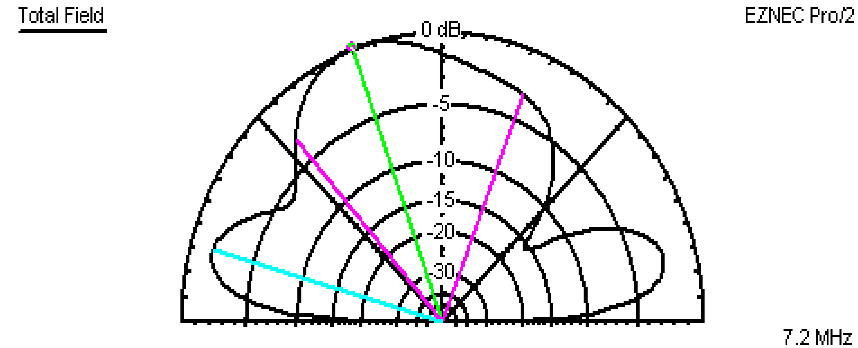
Random Length wire 92-Feet long @ Appox. 45-Degrees



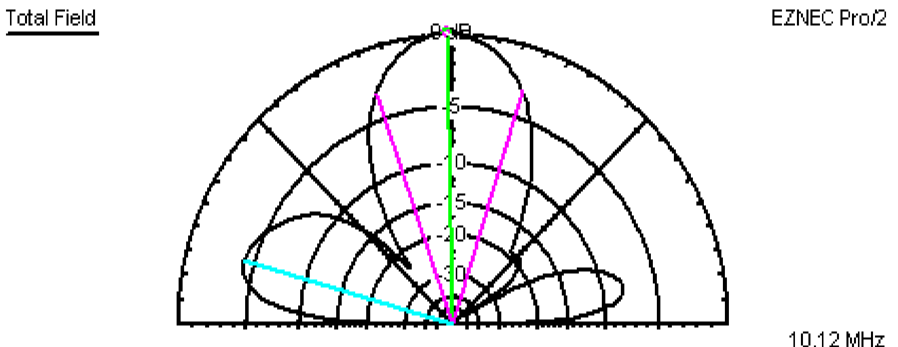
28.4 MHz Impedance = 712.2 + J 734.1 ohms



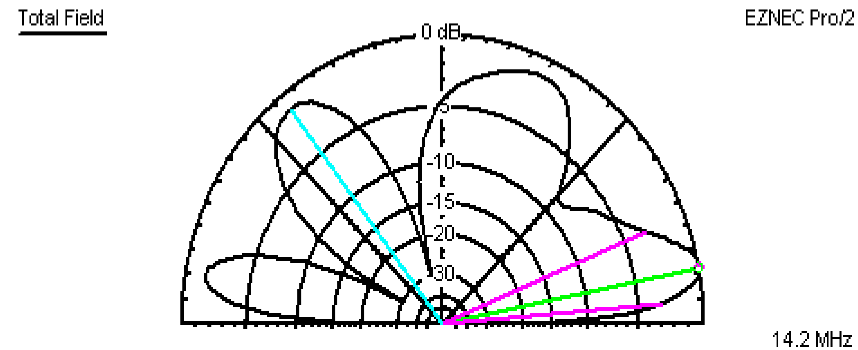
3.8 MHz Impedance = 234.5 + J 857.7 ohms



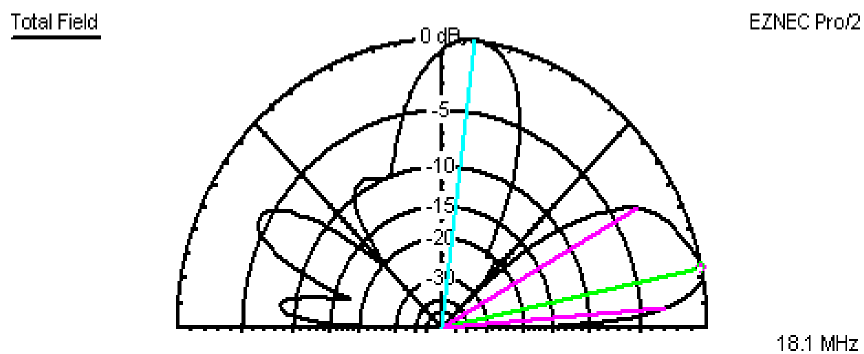
7.2 MHz Impedance = 65.26 + J 1.476 ohms



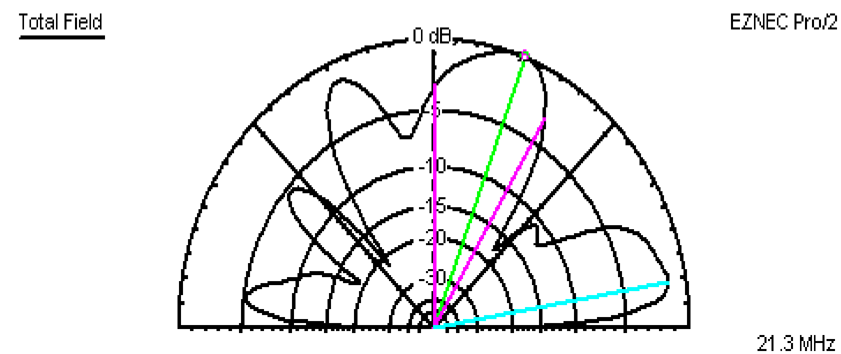
10.12 MHz Impedance = 403.3 - J 981.9 ohms



14.2 MHzImpedance = 2039 + J 763.8 ohms

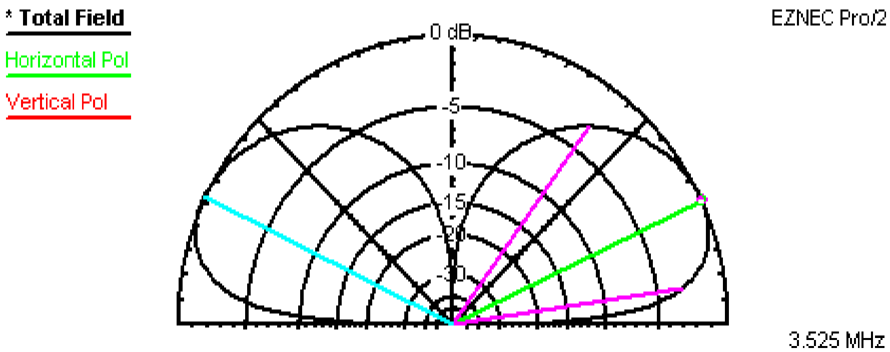


18.1 MHz Impedance = 252.5 + J 492.5 ohms



21.3 MHz Impedance = 106.1 - J 93.99 ohms

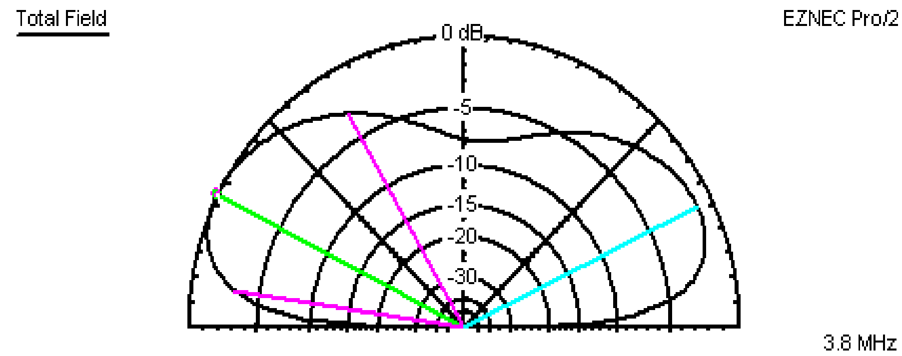
Random Length wire 92 feet long @ Appox. 45-degree



Elevation Plot		Cursor Elev	25.0 deg.
Azimuth Angle	0.0 deg.	Gain	0.58 dBi
Outer Ring	0.58 dBi		0.0 dBmax

Slice Max Gain	0.58 dBi @ Elev Angle = 25.0 deg.
Beamwidth	45.4 deg.; -3dB @ 8.4, 53.8 deg.
Sidelobe Gain	0.58 dBi @ Elev Angle = 154.0 deg.
Front/Sidelobe	0.0 dB

80-Meter “T”
Impedance = 27.46 - J 5.174 ohms



Elevation Plot		Cursor Elev	153.0 deg.
Azimuth Angle	0.0 deg.	Gain	0.88 dBi
Outer Ring	0.88 dBi		0.0 dBmax

Slice Max Gain	0.88 dBi @ Elev Angle = 153.0 deg.
Beamwidth	51.1 deg.; -3dB @ 120.2, 171.3 deg.
Sidelobe Gain	-0.16 dBi @ Elev Angle = 26.0 deg.
Front/Sidelobe	1.04 dB

80-Meter Inverted “L”
Impedance = 69.71 + J 315.9 ohms

Now here to explain the Loop SkyWire and Loops in general
is the originator of the Loop SkyWire Antenna

Dr. Dave Fisher W7FB (W0MHS)

Article first published in

November 1985 QST

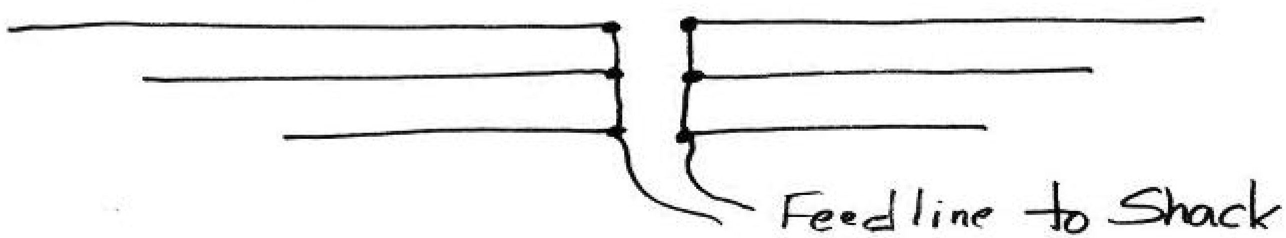
HALF WAVE DIPOLE

$$Z_a = R + jX$$

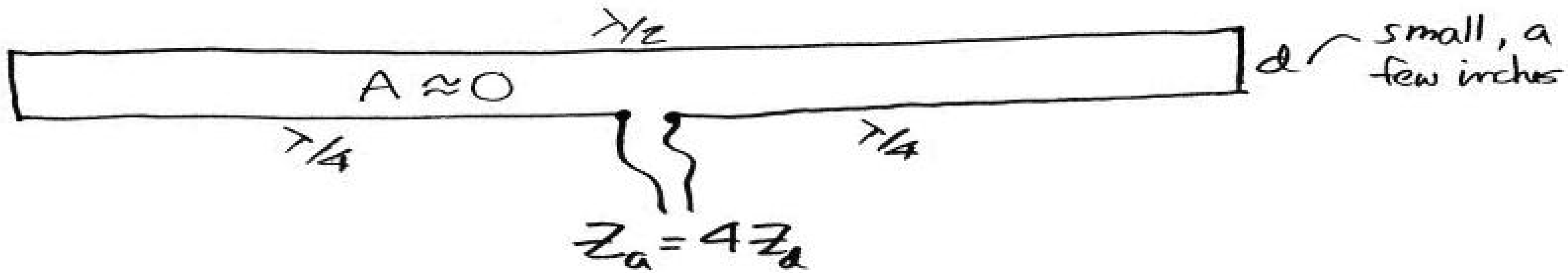
$$\lambda F = s \qquad \lambda = s/F$$

Z_a is "reasonable" for $F_1 = \underbrace{(2n+1)}_{\text{ODD INTEGER}}F$

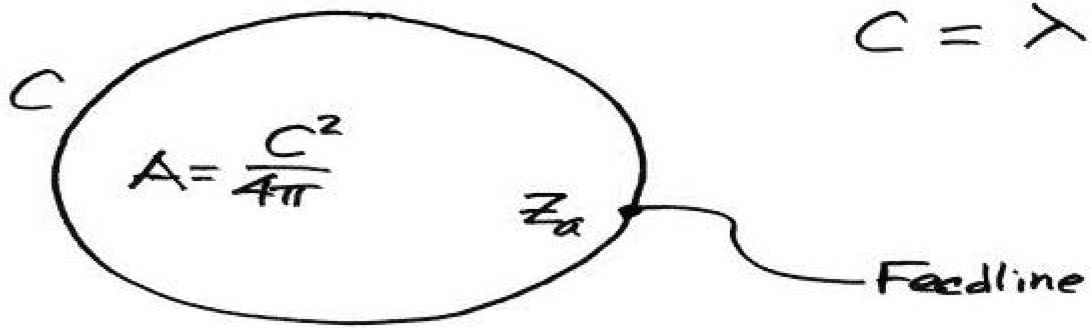
MULTI-BAND HALF WAVE DIPOLES (¼ VERTICALS)



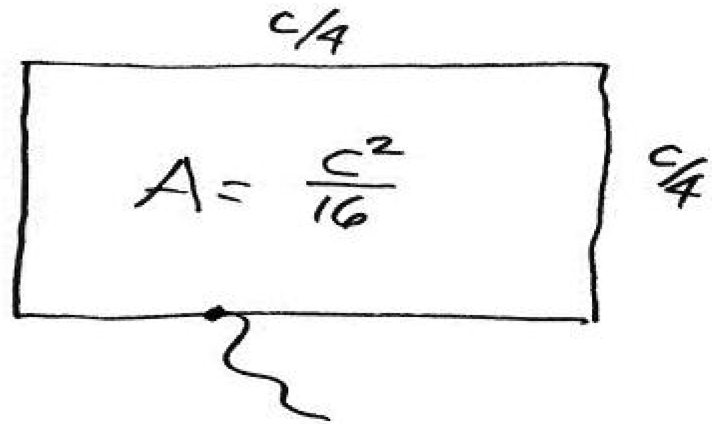
FOLDED DIPOLE



$C = \lambda$ @ F



Z_a is "reasonable" at ALL multiples (harmonics) of F

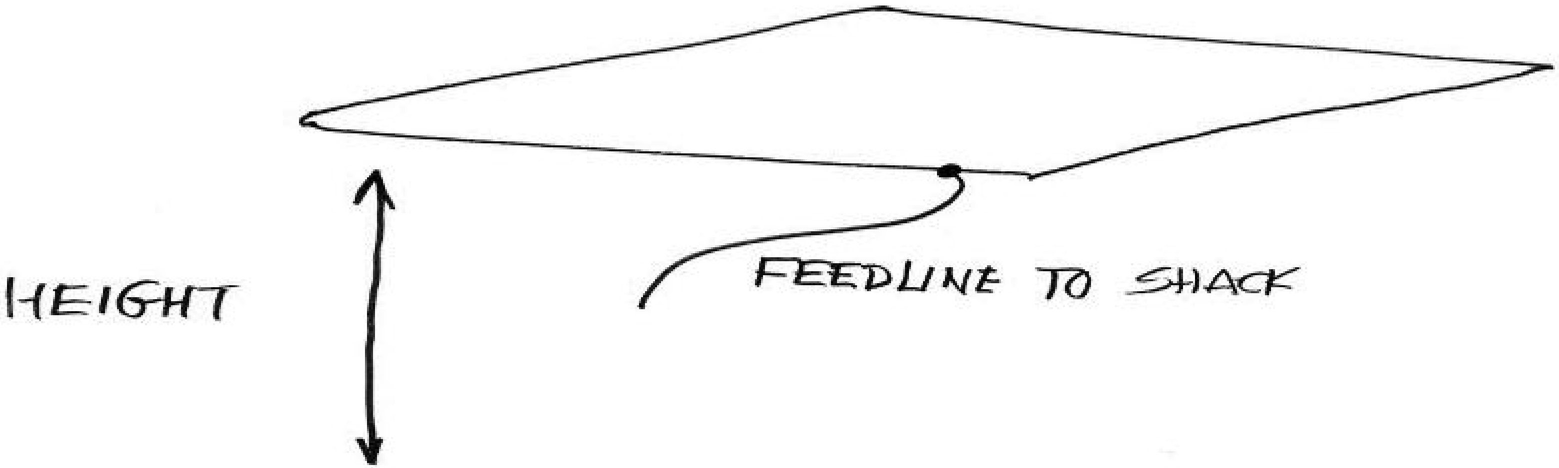


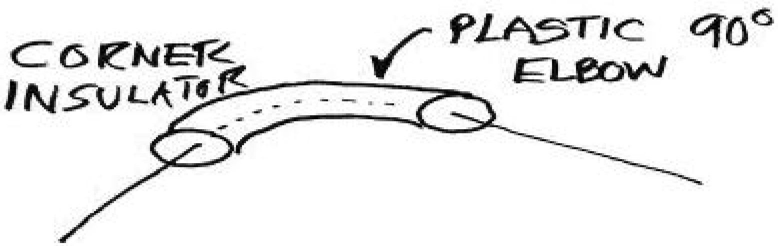
$r = \frac{\pi}{4} \approx 78\%$ of CIRCLE AREA

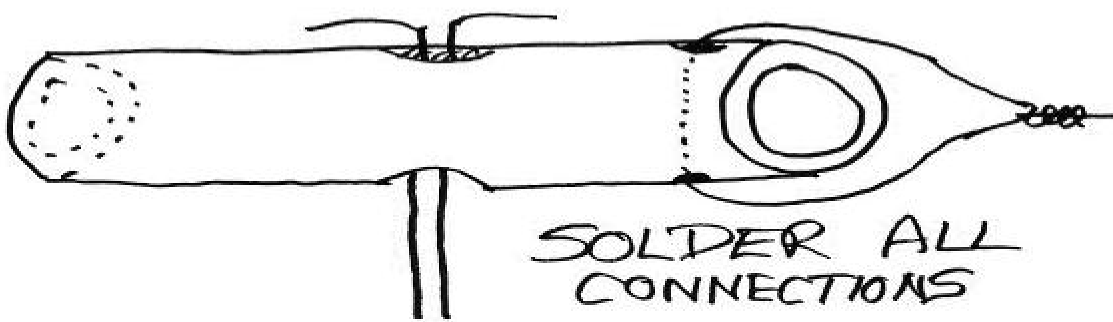
$$\lambda_{LOOP} = \frac{1005}{F_{mHz}} \ldots \text{feet}$$

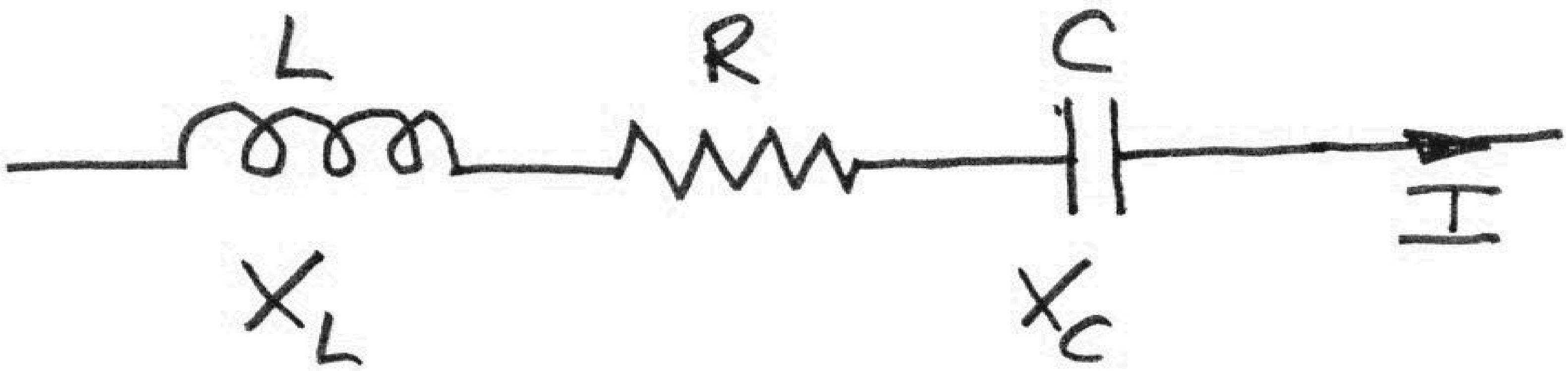
LOOP SKYWIRE

MULTIBAND
@ ITS BEST!









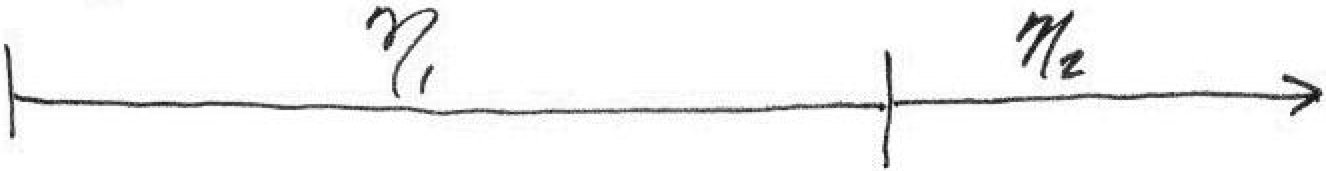
$$X = X_L + X_C$$

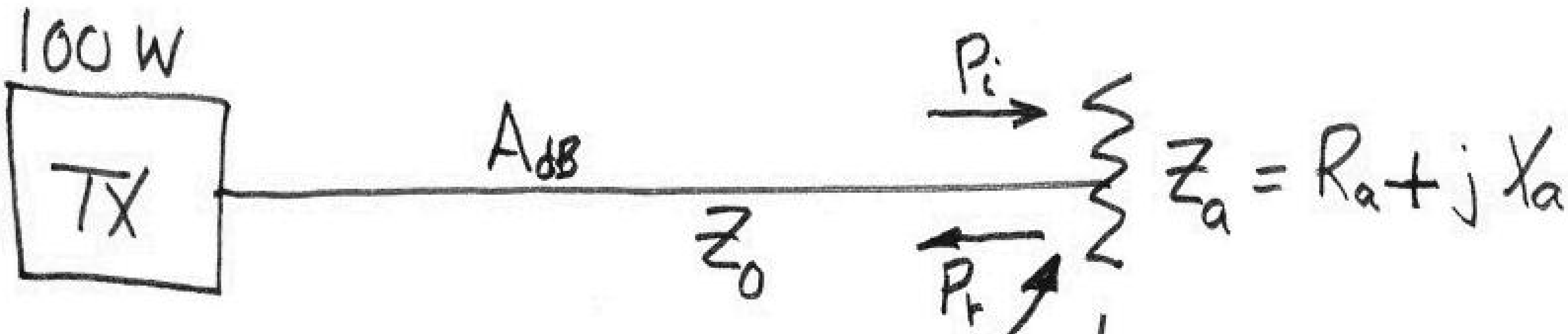
$X_L \geq 0$ $X_C \leq 0$

RESONANCE

$$\boxed{X = 0}$$

$$\eta_s = \eta_1 \times \eta_2$$





$$\rho = \frac{V_r}{V_i} = \frac{I_r}{I_i} = \sqrt{\frac{P_r}{P_i}} \quad \therefore \quad \rho^2 = \frac{P_r}{P_i}$$

$$\boxed{0 \le \rho \le 1}$$

$$P_r = P_i\,(\rho^2) \qquad P_a = P_i\,(1 - \rho^2)$$

==>> ==>> Power Transfer Worksheet <<==

note ==>>

Freq (mhz) ==>>

A=	Total Line Attn (dB)	3.0	0.3	3.0	0.3	3.0
B=	Line (Zo) ohms	50.0	50.0	300.0	50.0	450.0
C=	Load (R) ohms	100.0	100.0	100.0	100.0	100.0
D=	Load (X) ohms	200.0	200.0	200.0	200.0	200.0
E=	Line Loss Factor	0.501	0.944	0.501	0.933	0.501
F=	Refl Coeff @ Load (ant)	0.825	0.825	0.632	0.825	0.689
G=	Load SWR (@ant)	10.40	10.40	4.44	10.40	5.43
H=	Refl Coeff @ Input	0.413	0.778	0.317	0.770	0.345
I=	Input SWR (@shack)	2.41	8.03	1.93	7.68	2.05
				No Conjugate Match		
J=	Fwd Power @ Input (FWD)	100.0	100.0	100.0	100.0	100.0
K=	Power @ Load (ant)	50.1	94.4	50.1	93.3	50.1
L=	Power Reflected @ Load	34.1	64.2	20.0	63.5	23.8
M=	Pwr Return @ Input(REF)	17.1	60.6	10.0	59.2	11.9
N=	Net Power Out @ Input	82.9	39.4	90.0	40.8	88.1
P=	Power Xfr to Load (ant)	16.0	30.2	30.1	29.9	26.3
Q=	Transfer Ratio (%)	19.3	76.7	33.4	73.2	29.9
R=	Total Power Loss (dB)	7.1	1.2	4.8	1.4	5.2
S=	Total Pwr Loss (S-unit)	1.2	0.2	0.8	0.2	0.9
T=	Total Mismatch Loss(dB)	4.1	0.9	1.8	1.1	2.2
				Conjugate Match		
U=	Fwd Power @ Input (FWD)	120.6	253.8	111.2	245.3	113.5
V=	Power @ Load (ant)	60.4	239.6	55.7	228.9	56.9
W=	Power Reflected @ Load	41.1	163.0	22.3	155.6	27.0
X=	Pwr Return @ Input(REF)	20.6	153.8	11.2	145.3	13.5
Y=	Net Power Out @ Input	100	100	100	100	100
Z=	Power Xfr to Load (ant)	19.3	76.7	33.4	73.2	29.9
AA=	Transfer Ratio (%)	19.3	76.7	33.4	73.2	29.9
BB=	Improvement (watts)	3.3	46.5	3.4	43.4	3.6
CC=	Shack SWR ==>>(:>)	<1:1>	<1:1>	<1:1>	<1:1>	<1:1>

NOTES

==>> maximum source power is taken to be 100 watts (= %power)

==>> INPUT parameters are A, B, C and D.
==>> A is always non-negative. It is the total feedline loss in dB.
==>> B is the characteristic impedance Zo=Ro+j0 of the feedline
==>> The load (ant) impedance is Z = R + jX. C = R, the resistance and D = X, the reactance.

===>>> ALL output values are determined by values E and F. <<<===

==>> E changes only when the line loss/attenuation (A) changes
==>> F changes only when either Zo or Z (=R + jX) changes.
i.e F changes only when the characteristic impedance (Zo=Ro) changes or when either load R (resistance) or X (reactance) changes.

==>> No tuning or matching network changes E or F !!!!!!!!!!!!

EQUATIONS for Power Transfer Worksheet

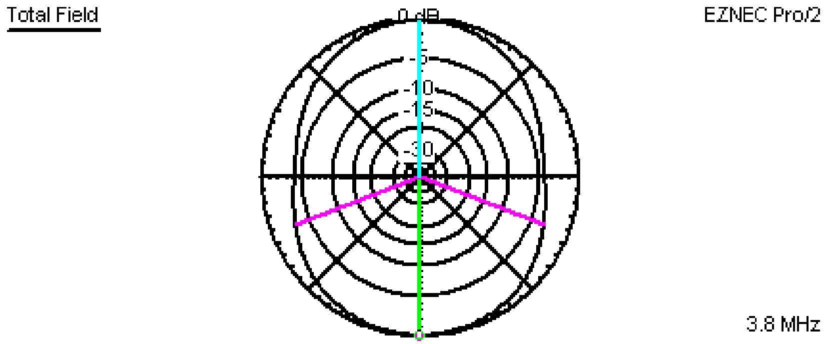
```
--------------------------------------------------------------------------------------
E = 10pwr(-A/10) = 10^(-A/10)
F = SQRT[(B-C)^2 + D^2]/SQRT[(B+C)^2 + D^2]

G = (1+F)/(1-F)
H = E*F
I = (1+H)/(1-H) = (1+(E*F))/(1-(E*F))
J = 100
K = E*J
L = K*(F^2) = 100*E*(F^2)
M = E*L = 100*(E*F)^2
N = J-M = 100*(1-(E*F)^2)
P = K-L = 100*E*(1-(F^2))
Q = 100*(P/N) = 100*E*(1-F^2)/(1-(E*F)^2)
R = 10*LOG(N/P) = A + LOG[(1-F^2)/(1-(E*F)^2)]
S = R/6
T = R-A = LOG[(1-F^2)/(1-(E*F)^2)]

U = 100/(1-(E*F)^2)
V = E*U = 100*E/(1-(E*F)^2)
W = V * F^2 = 100*E*(F^2)/(1-(E*F)^2)
X = E*W = 100*((E*F)^2)/(1-(E*F)^2)
Y = U-X = 100
Z = V*(1-F^2) = 100*E*(1-F^2)/(1-(E*F)^2) = Q = AA
AA= 100*Z/Y = 100*E*(1-F^2)/(1-(E*F)^2) = Q = AA
BB = Z-P = 100*(E^3)*(F^2)*(1-F^2)/(1-(E*F)^2)
```

==>> ==>> ==>> Power Xfr Worksheet <<== <<== <<==
note ==>> nfarl: 102' g5rv apex@50 ends@24.5 angle 120degs

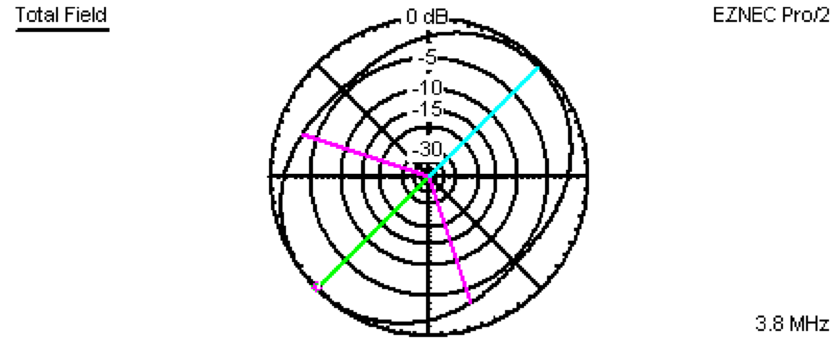
Freq (mhz) ==>>	28	24	21	18	14	10	7	3.5
Total Line Attn (dB)	0.58	0.51	0.44	0.45	0.39	0.32	0.26	0.17
Line (Zo) ohms	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
Load (R) ohms	3390.0	143.0	365.0	1972.0	114.0	1898.0	508.0	2808.0
Load (X) ohms	738.0	274.0	1169.0	1918.0	-142.0	2221.0	1138.0	-249.0
Line Loss Factor	0.875	0.889	0.904	0.902	0.914	0.929	0.942	0.962
Refl Coeff@Load(ant)	0.844	0.606	0.871	0.856	0.535	0.876	0.829	0.808
Load SWR (@ant)	11.84	4.08	14.45	12.87	3.30	15.08	10.69	9.43
Refl Coeff @ Input	0.739	0.539	0.787	0.772	0.489	0.813	0.781	0.777
Input SWR (@shack)	6.65	3.34	8.38	7.75	2.91	9.72	8.12	7.98
	No Conjugate Match							
Fwd Pwr@Input (FWD)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Pwr@Load(ant)	87.5	88.9	90.4	90.2	91.4	92.9	94.2	96.2
Pwr Refltd@Load	62.4	32.7	68.5	66.0	26.1	71.2	64.7	62.8
Pwr Return@Input(REF)	54.6	29.1	61.9	59.5	23.9	66.2	61.0	60.4
Net Pwr Out@Input	45.4	70.9	38.1	40.5	76.1	33.8	39.0	39.6
Pwr Xfr to Load(ant)	25.1	56.2	21.9	24.1	65.3	21.7	29.5	33.3
Transfer Ratio (%)	55.3	79.3	57.4	59.6	85.8	64.0	75.5	84.2
Pwr Loss (dB)	2.6	1.0	2.4	2.2	0.7	1.9	1.2	0.7
Pwr Loss (S-unit)	0.4	0.2	0.4	0.4	0.1	0.3	0.2	0.1
Mismatch Loss(dB)	2.0	0.5	2.0	1.8	0.3	1.6	1.0	0.6
	Conjugate Match							
Fwd Pwr@Input(FWD)	220.1	141.0	262.4	247.1	131.4	295.6	256.1	252.6
Pwr @ Load (ant)	192.6	125.3	237.1	222.8	120.1	274.6	241.2	242.9
Pwr Refltd@Load	137.3	46.1	179.7	163.1	34.3	210.5	165.7	158.7
Pwr Return@Input(REF)	120.1	41.0	162.4	147.1	31.4	195.6	156.1	152.6
Net Pwr Out@Input	100	100	100	100	100	100	100	100
Pwr Xfr to Load(ant)	55.3	79.3	57.4	59.6	85.8	64.0	75.5	84.2
Transfer Ratio (%)	55.3	79.3	57.4	59.6	85.8	64.0	75.5	84.2
Improvement (watts)	30.2	23.0	35.5	35.5	20.5	42.4	46.0	50.9
Shack SWR ==>>(:>)	<1:1>	<1:1>	<1:1>	<1:1>	<1:1>	<1:1>	<1:1>	<1:1>



Azimuth Plot		Cursor Az	270.0 deg.
Elevation Angle	35.0 deg.	Gain	3.39 dBi
Outer Ring	3.39 dBi		0.0 dBmax

Slice Max Gain	3.39 dBi @ Az Angle = 270.0 deg.
Front/Back	0.35 dB
Beamwidth	137.5 deg.; -3dB @ 201.2, 338.7 deg.
Sidelobe Gain	3.04 dBi @ Az Angle = 90.0 deg.
Front/Sidelobe	0.35 dB

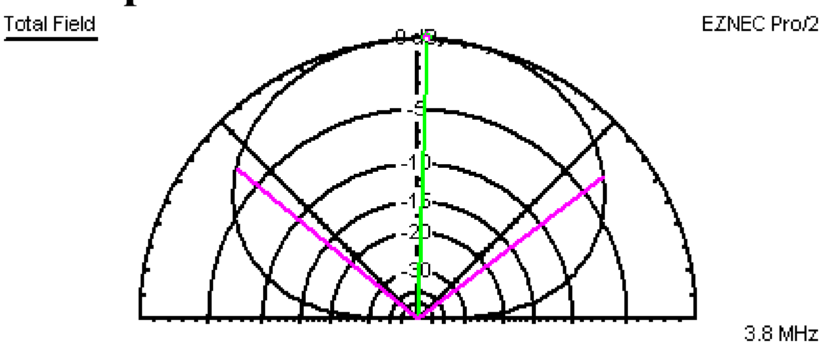
80-Meter Loop Feed Center of one side
Impedance = 147.6 - J 63.13 ohms



Azimuth Plot		Cursor Az	225.0 deg.
Elevation Angle	35.0 deg.	Gain	3.52 dBi
Outer Ring	3.52 dBi		0.0 dBmax

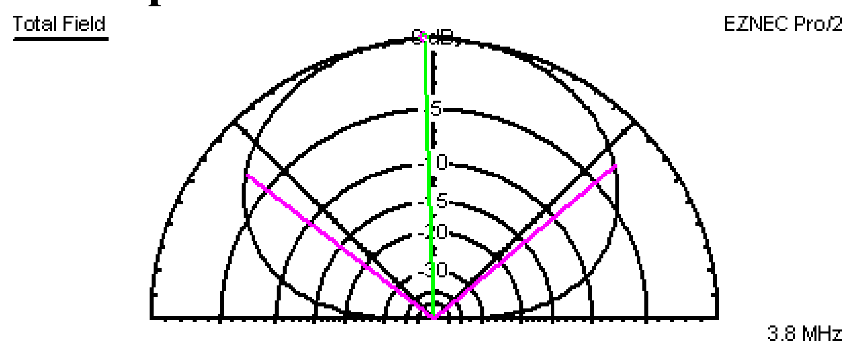
Slice Max Gain	3.52 dBi @ Az Angle = 225.0 deg.
Front/Back	0.43 dB
Beamwidth	126.5 deg.; -3dB @ 161.7, 288.2 deg.
Sidelobe Gain	3.09 dBi @ Az Angle = 45.0 deg.
Front/Sidelobe	0.43 dB

80-Meter Loop Feed on One Corner
Impedance = 149.9 - J 66.19 ohms



Elevation Plot		Cursor Elev	88.0 deg.
Azimuth Angle	272.0 deg.	Gain	6.82 dBi
Outer Ring	6.82 dBi		0.0 dBmax

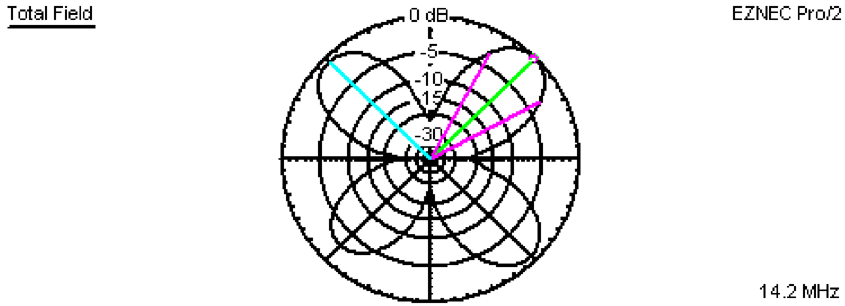
Slice Max Gain	6.82 dBi @ Elev Angle = 88.0 deg.
Beamwidth	103.1 deg.; -3dB @ 37.5, 140.6 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB



Elevation Plot		Cursor Elev	92.0 deg.
Azimuth Angle	25.0 deg.	Gain	6.73 dBi
Outer Ring	6.73 dBi		0.0 dBmax

Slice Max Gain	6.73 dBi @ Elev Angle = 92.0 deg.
Beamwidth	101.2 deg.; -3dB @ 40.7, 141.9 deg.
Sidelobe Gain	< -100 dBi
Front/Sidelobe	> 100 dB

Loop SkyWire Showing Different Feed Points



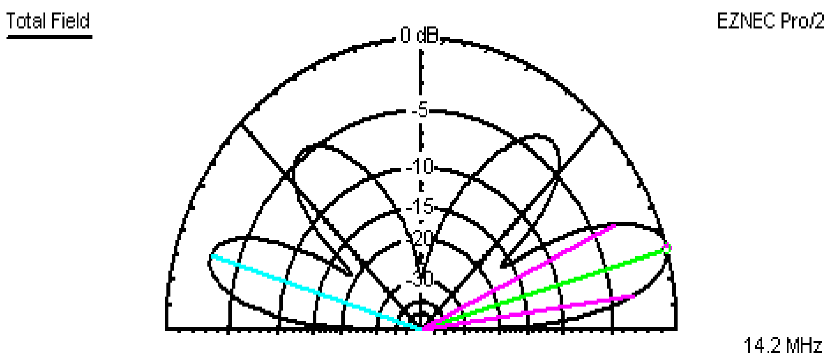
Azimuth Plot
Elevation Angle 16.0 deg.
Outer Ring 10.59 dBi

Cursor Az 45.0 deg.
Gain 10.59 dBi
0.0 dBmax

Slice Max Gain 10.59 dBi @ Az Angle = 45.0 deg.
Front/Back 2.65 dB
Beamwidth 33.6 deg.; -3dB @ 28.2, 61.8 deg.
Sidelobe Gain 9.95 dBi @ Az Angle = 135.0 deg.
Front/Sidelobe 0.64 dB

80-Meter Loop Corner Feed on 14.2 MHz

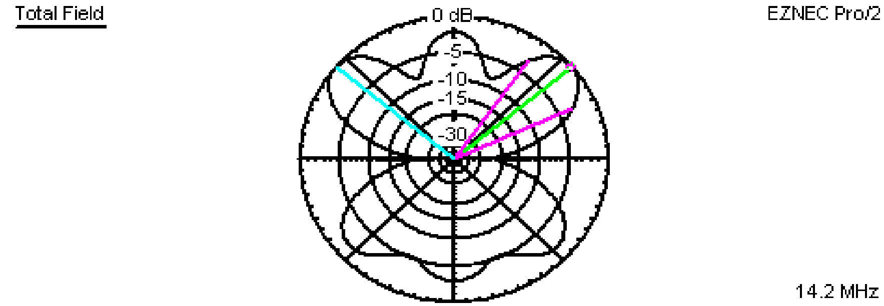
Impedance = 513.1 - J 938.9 ohms



Elevation Plot
Azimuth Angle 45.0 deg.
Outer Ring 10.59 dBi

Cursor Elev 16.0 deg.
Gain 10.59 dBi
0.0 dBmax

Slice Max Gain 10.59 dBi @ Elev Angle = 16.0 deg.
Beamwidth 17.2 deg.; -3dB @ 8.1, 25.3 deg.
Sidelobe Gain 7.95 dBi @ Elev Angle = 163.0 deg.
Front/Sidelobe 2.64 dB



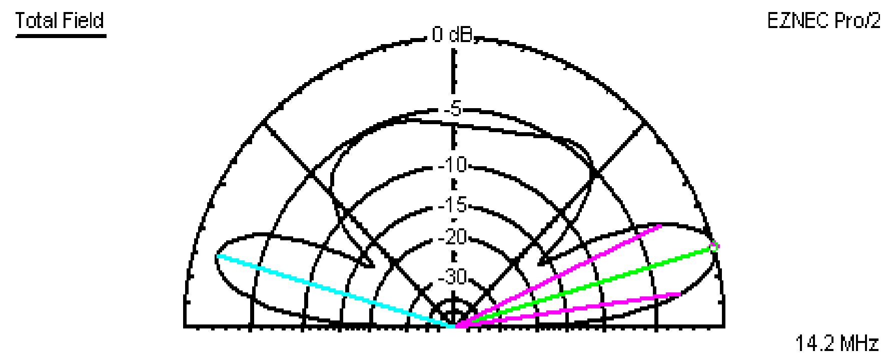
Azimuth Plot
Elevation Angle 16.0 deg.
Outer Ring 8.69 dBi

Cursor Az 40.0 deg.
Gain 8.69 dBi
0.0 dBmax

Slice Max Gain 8.69 dBi @ Az Angle = 40.0 deg.
Front/Back 1.7 dB
Beamwidth 30.3 deg.; -3dB @ 24.5, 54.8 deg.
Sidelobe Gain 8.69 dBi @ Az Angle = 140.0 deg.
Front/Sidelobe 0.0 dB

80-Meter Loop Center of Leg on 14.2 MHz

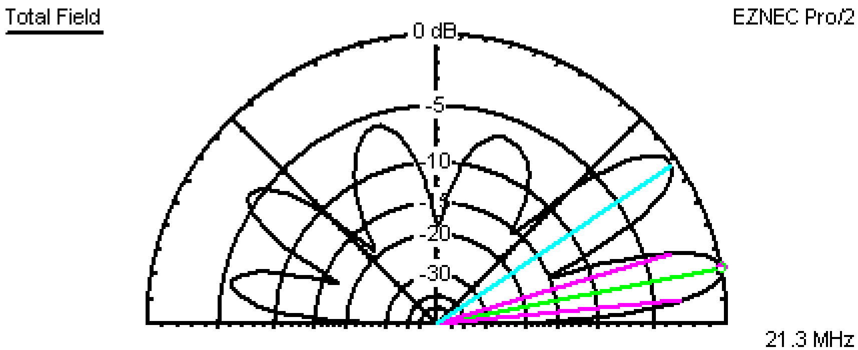
Impedance = 454.8 - J 994.8 ohms



Elevation Plot
Azimuth Angle 40.0 deg.
Outer Ring 8.69 dBi

Cursor Elev 16.0 deg.
Gain 8.69 dBi
0.0 dBmax

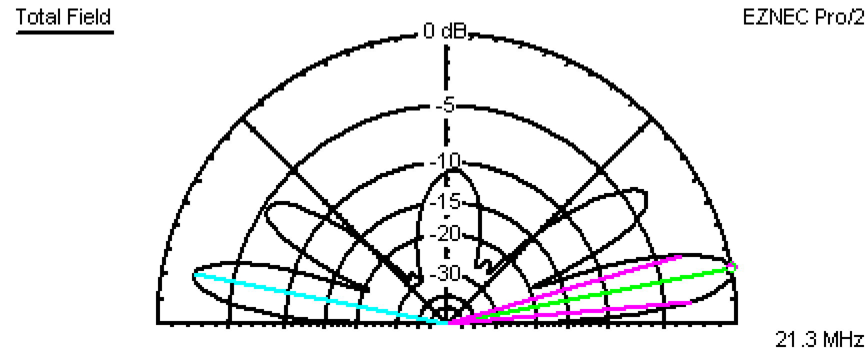
Slice Max Gain 8.69 dBi @ Elev Angle = 16.0 deg.
Beamwidth 16.9 deg.; -3dB @ 7.9, 24.8 deg.
Sidelobe Gain 6.99 dBi @ Elev Angle = 164.0 deg.
Front/Sidelobe 1.7 dB



Elevation Plot
Azimuth Angle 59.0 deg.
Outer Ring 10.58 dBi

Cursor Elev 11.0 deg.
Gain 10.58 dBi
0.0 dBmax

Slice Max Gain 10.58 dBi @ Elev Angle = 11.0 deg.
Beamwidth 11.3 deg.; -3dB @ 5.4, 16.7 deg.
Sidelobe Gain 10.11 dBi @ Elev Angle = 34.0 deg.
Front/Sidelobe 0.47 dB



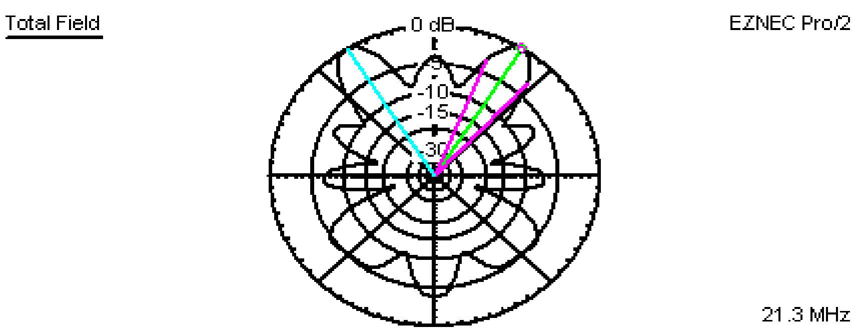
Elevation Plot
Azimuth Angle 45.0 deg.
Outer Ring 14.2 dBi

Cursor Elev 11.0 deg.
Gain 14.2 dBi
0.0 dBmax

Slice Max Gain 14.2 dBi @ Elev Angle = 11.0 deg.
Beamwidth 11.0 deg.; -3dB @ 5.3, 16.3 deg.
Sidelobe Gain 12.07 dBi @ Elev Angle = 169.0 deg.
Front/Sidelobe 2.13 dB

80-Meter Loop Center of Leg on 21.3 MHz
Impedance = 1277 - J 880.1 ohms

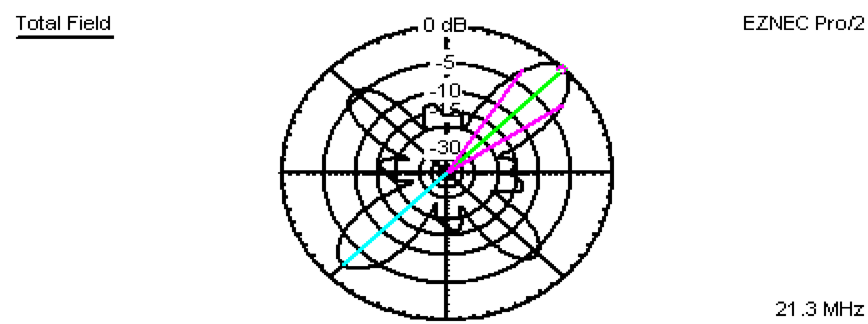
80-Meter Loop Corner Feed on 21.3 MHz
Impedance = 1263 - J 1245 ohms



Azimuth Plot
Elevation Angle 11.0 deg.
Outer Ring 10.63 dBi

Cursor Az 58.0 deg.
Gain 10.63 dBi
0.0 dBmax

Slice Max Gain 10.63 dBi @ Az Angle = 58.0 deg.
Front/Back 5.59 dB
Beamwidth 19.9 deg.; -3dB @ 47.8, 67.7 deg.
Sidelobe Gain 10.63 dBi @ Az Angle = 122.0 deg.
Front/Sidelobe 0.0 dB



Azimuth Plot
Elevation Angle 11.0 deg.
Outer Ring 14.2 dBi

Cursor Az 45.0 deg.
Gain 14.2 dBi
0.0 dBmax

Slice Max Gain 14.2 dBi @ Az Angle = 45.0 deg.
Front/Back 2.13 dB
Beamwidth 22.8 deg.; -3dB @ 33.6, 56.4 deg.
Sidelobe Gain 12.07 dBi @ Az Angle = 225.0 deg.
Front/Sidelobe 2.13 dB

Loop SkyWire Feed on 21.3 MHz