ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Receiving Antenna Metrics With Examples

Steps Beyond Gain and F/B

World Wide Radio Operators Foundation

Jukka Klemola OH6LI Feb 13th 2018

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Practical

- Presentation is longer than typically seen on WWROF
- We will have a short break at about 45 minutes
- All antenna model files and the Excel Workbook RX Ant Metrics will be availale via WWROF

- As you have questions, please write them down. Presentation is long
- Q&A at the end

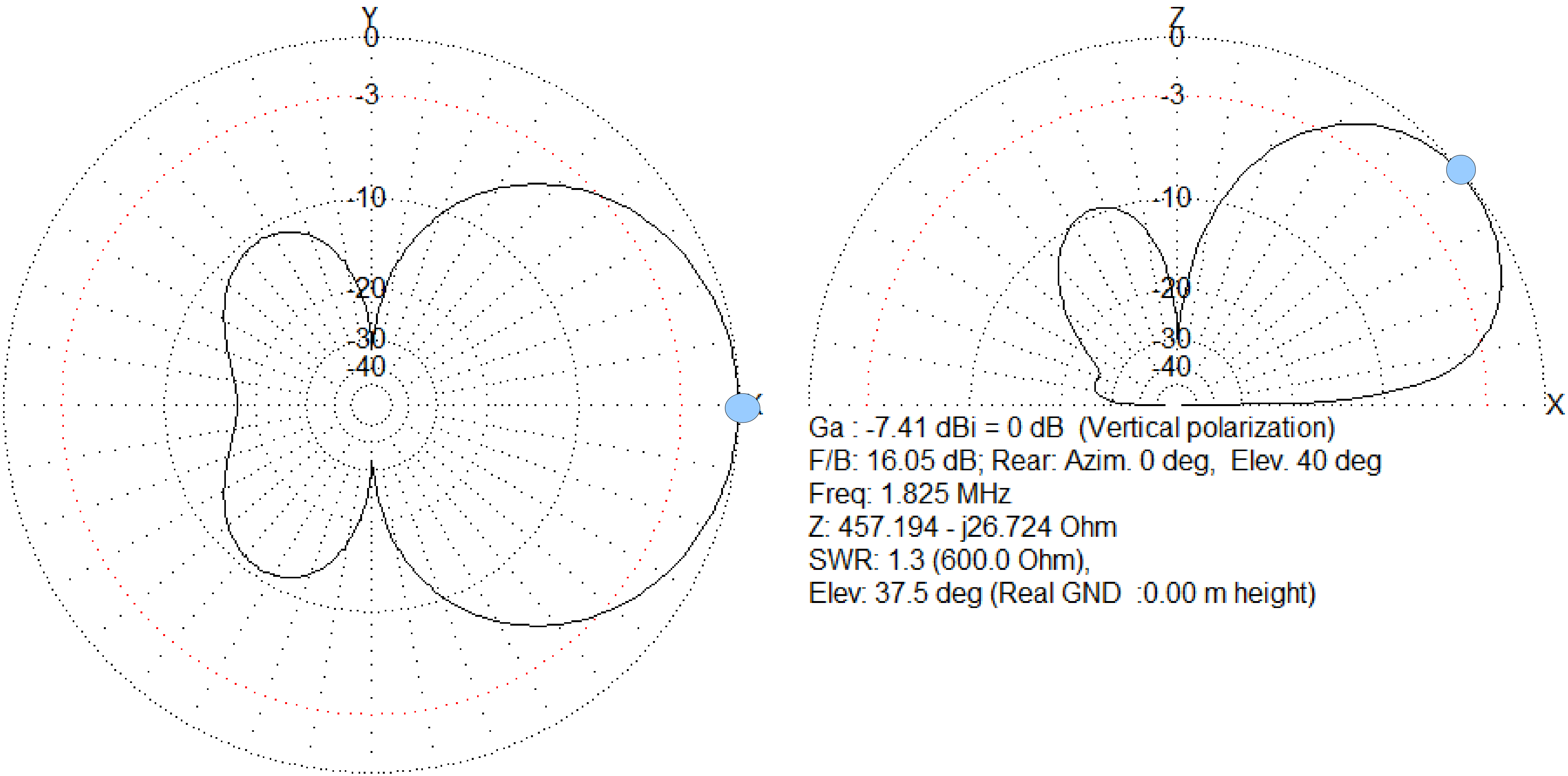
Contributors

- Markku OH2RA
- Dan AC6LA
- Frank W3LPL
- Reino OH3MA
- Maik DJ2QV
- Ward N0AX

Contents

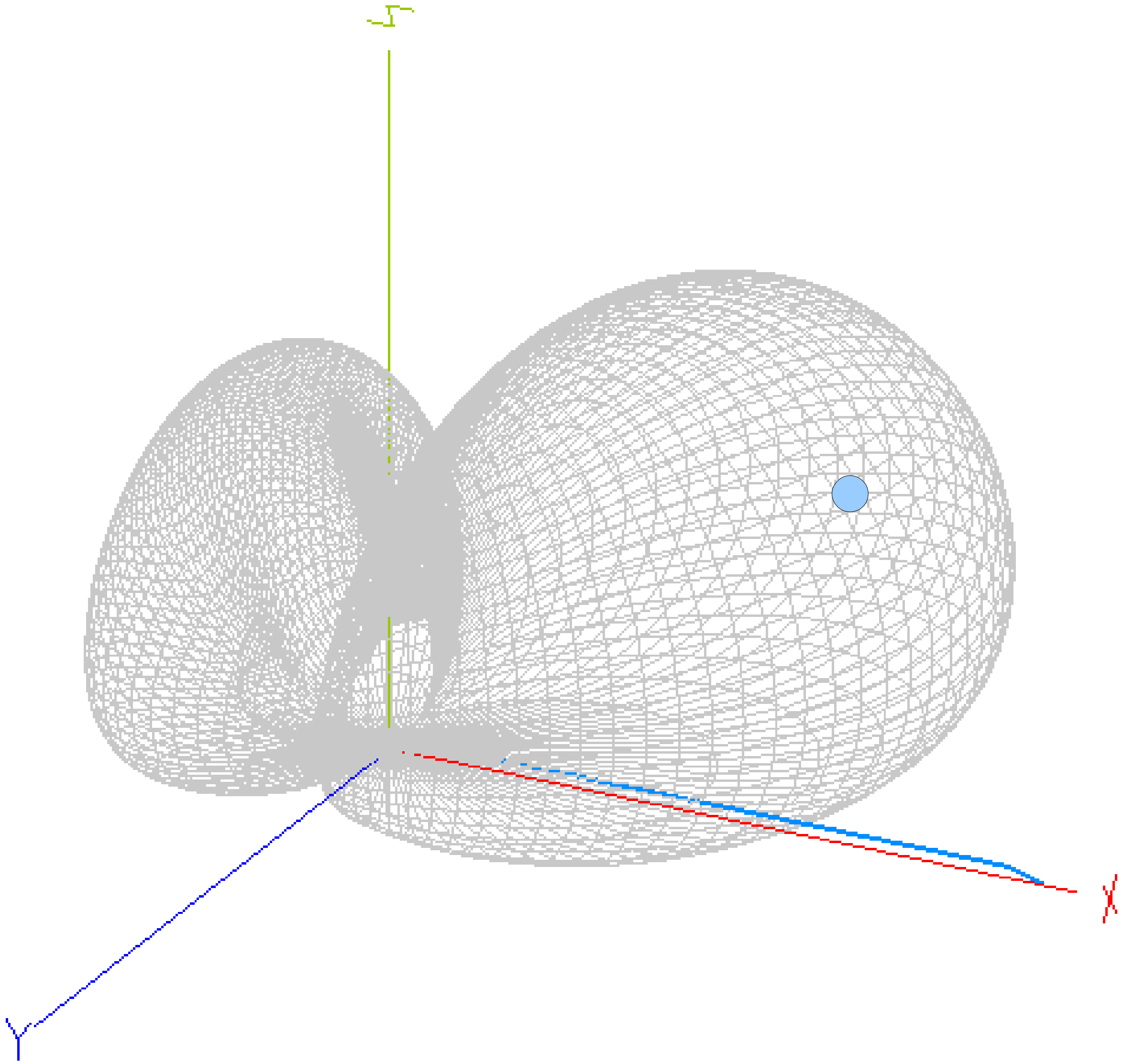
- Traditional Metrics G_{max}, F/B
- Receiving Directivity Factor
- Directivity Merit Figure
- Noise Margin
- Leaking Index
- Receiving antennas for residential locations
- Better decent size antennas for rural locations
  - Linear Inline Receiving Array

Antenna Gain Maximum



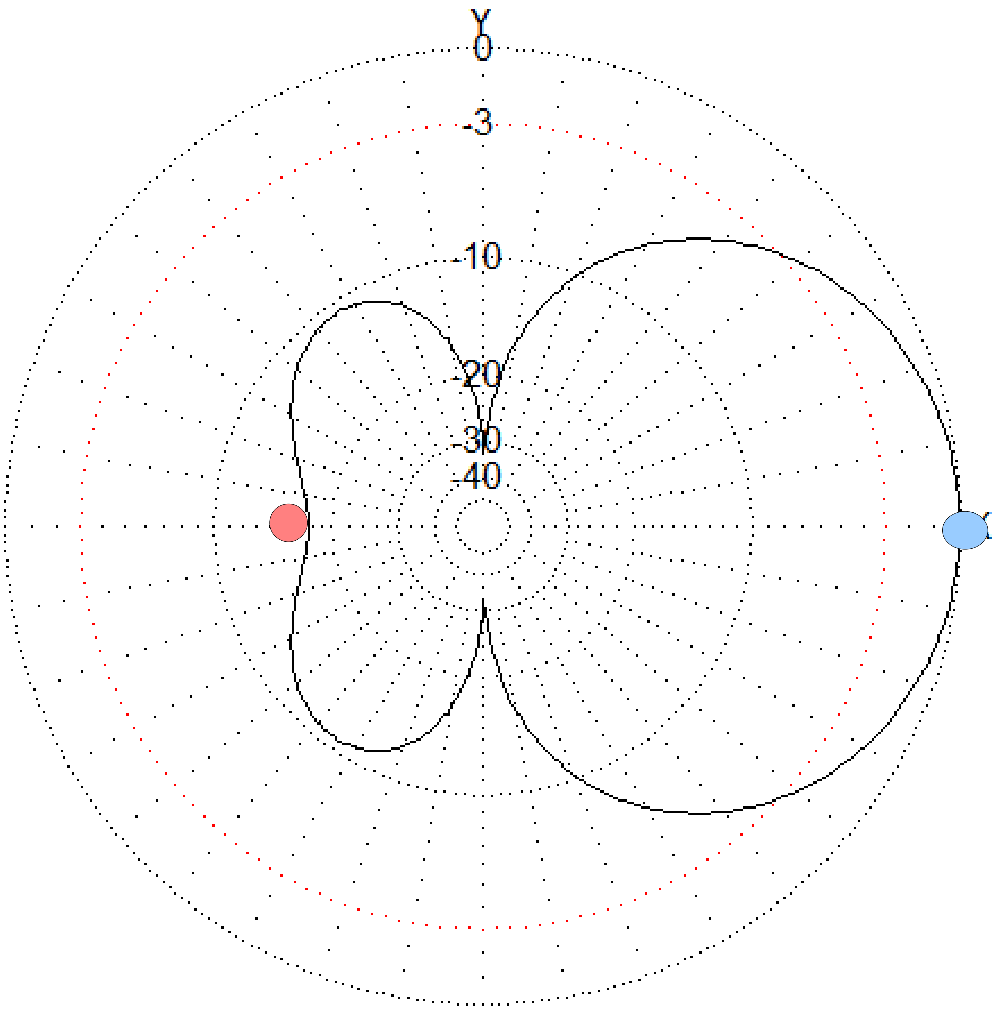
Ga : -7.41 dBi = 0 dB (Vertical polarization)
F/B: 16.05 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 457.194 - j26.724 Ohm
SWR: 1.3 (600.0 Ohm),
Elev: 37.5 deg (Real GND :0.00 m height)

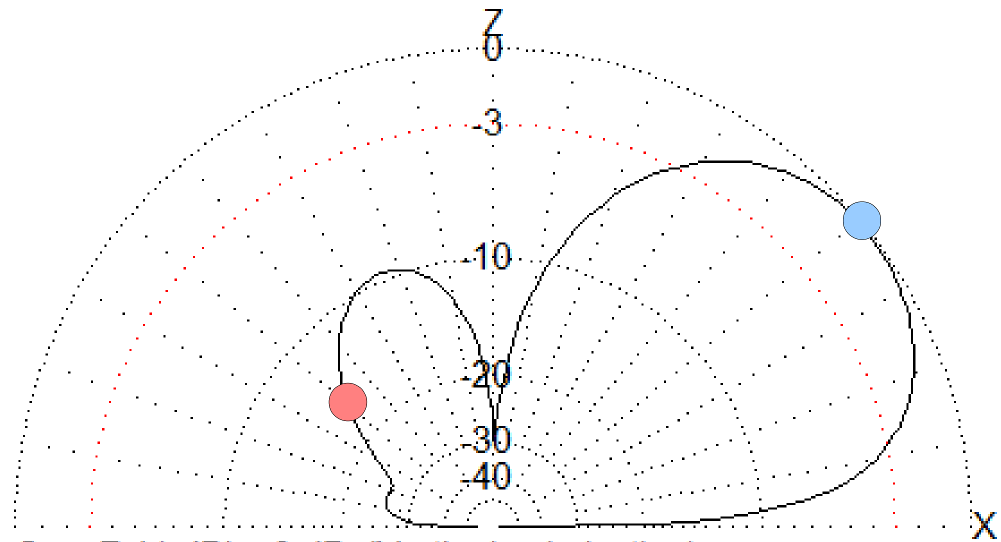
Antenna Gain Maximum



ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Antenna Front-to-Back





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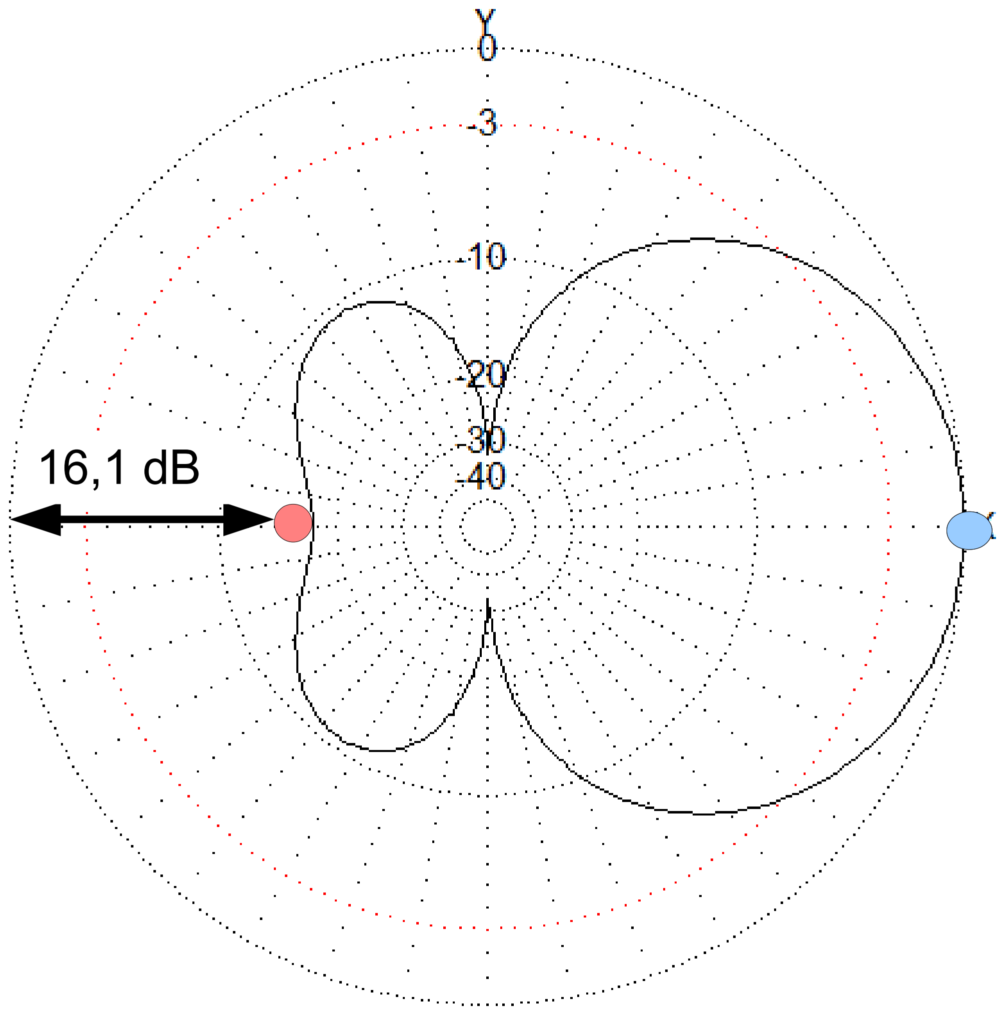

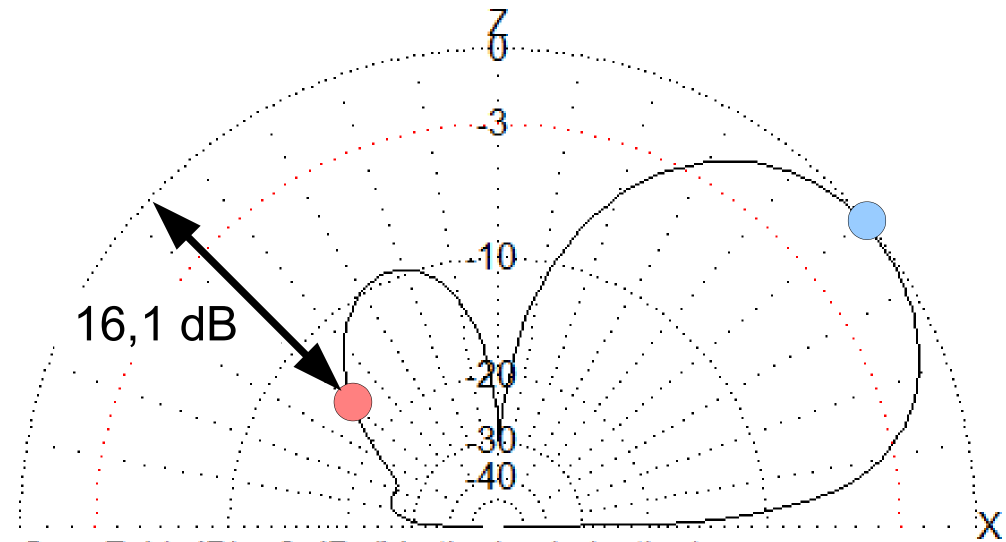

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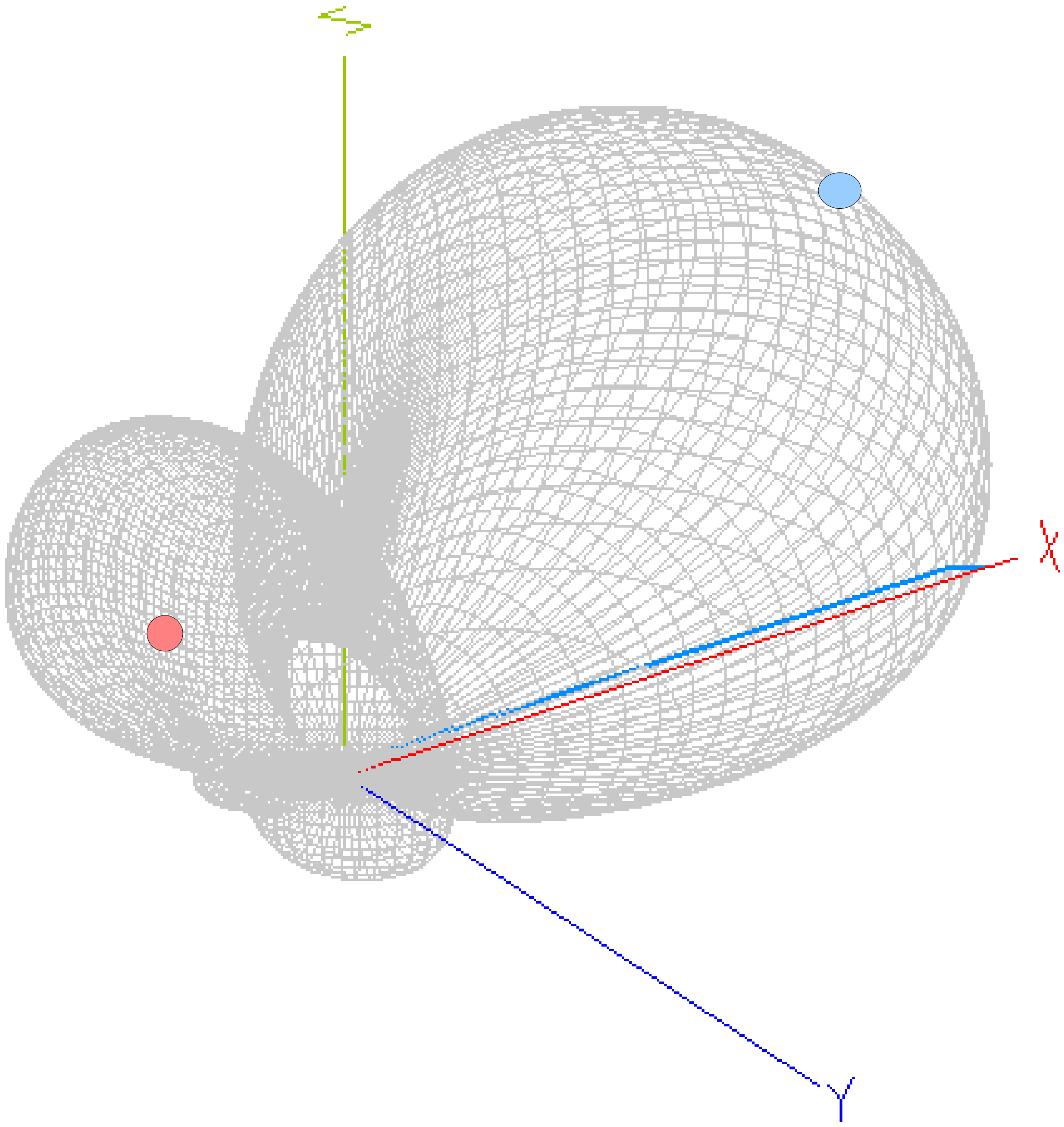
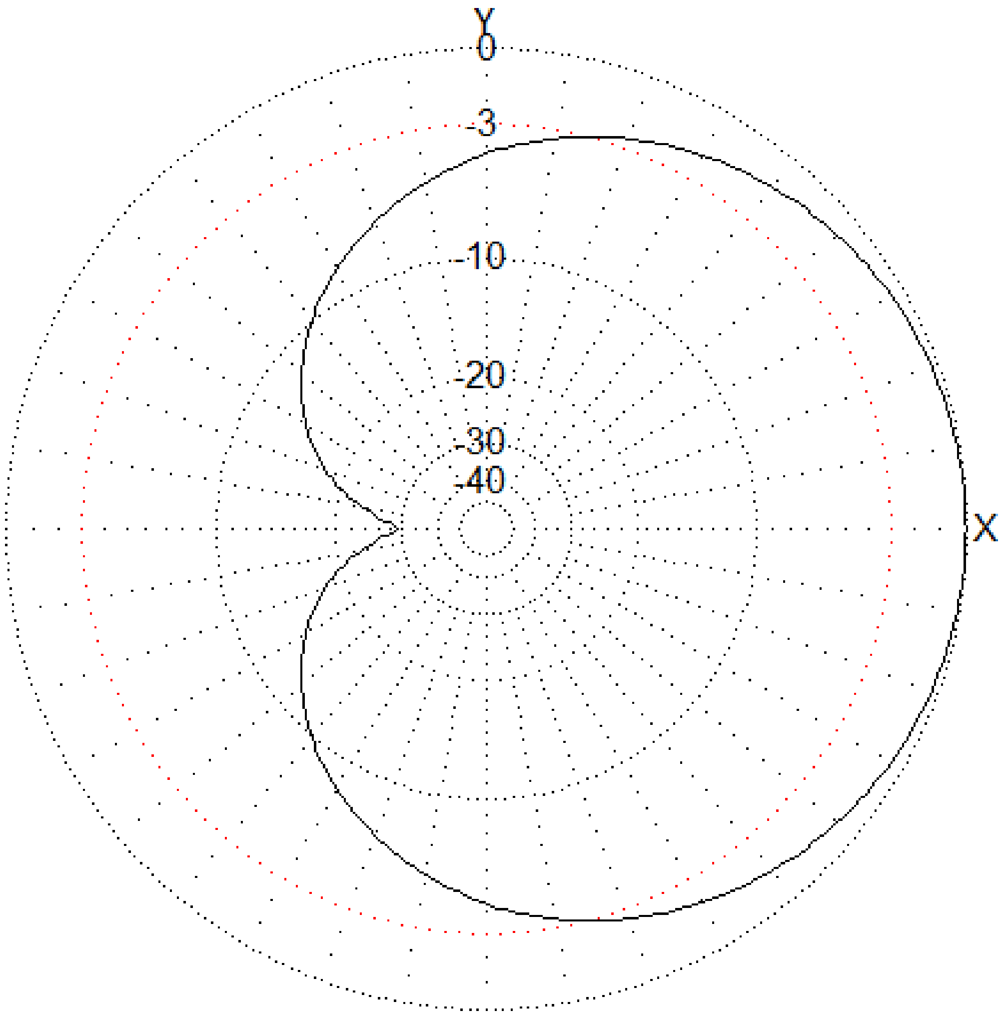
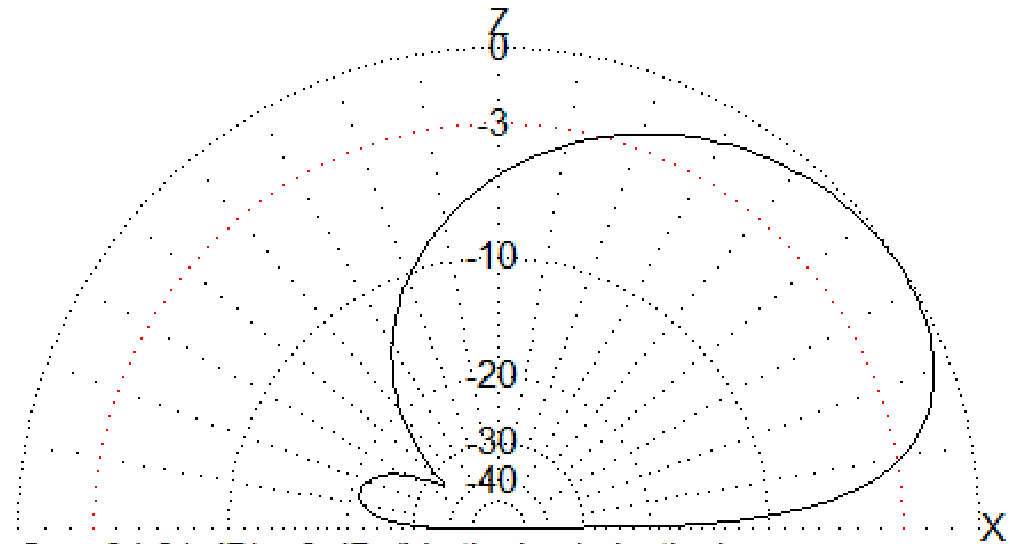


ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Cardioid Pattern Antenna

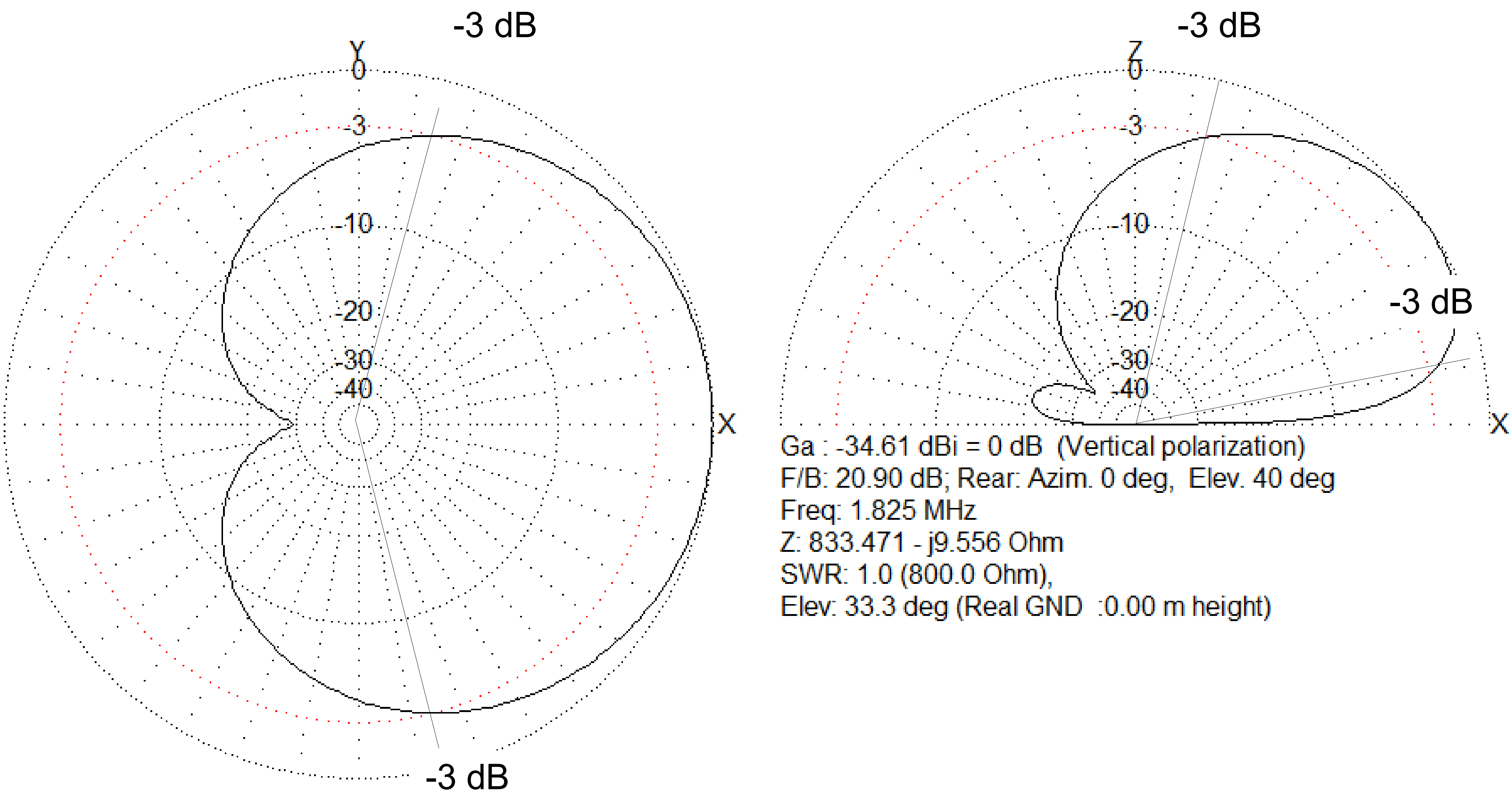
0.5wl BOG, Flag, 2xGP



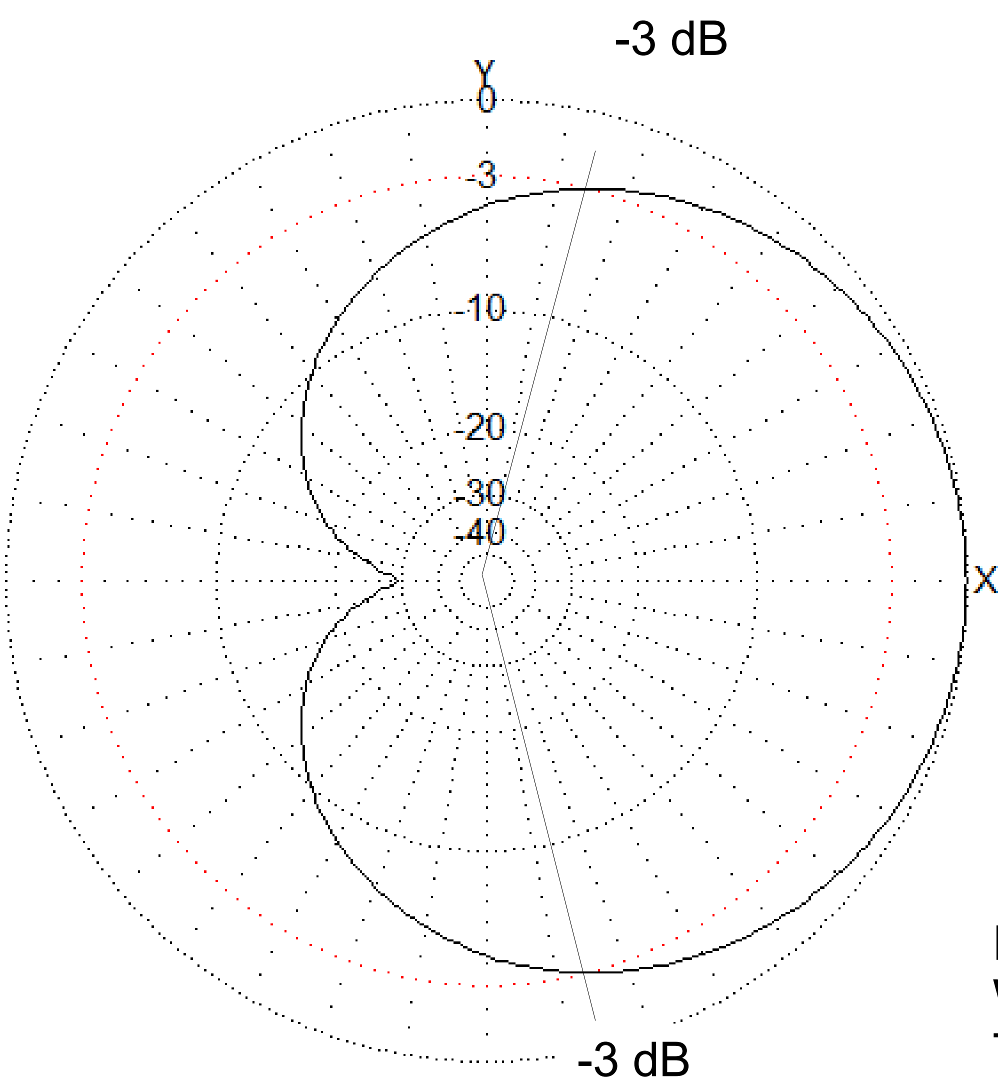


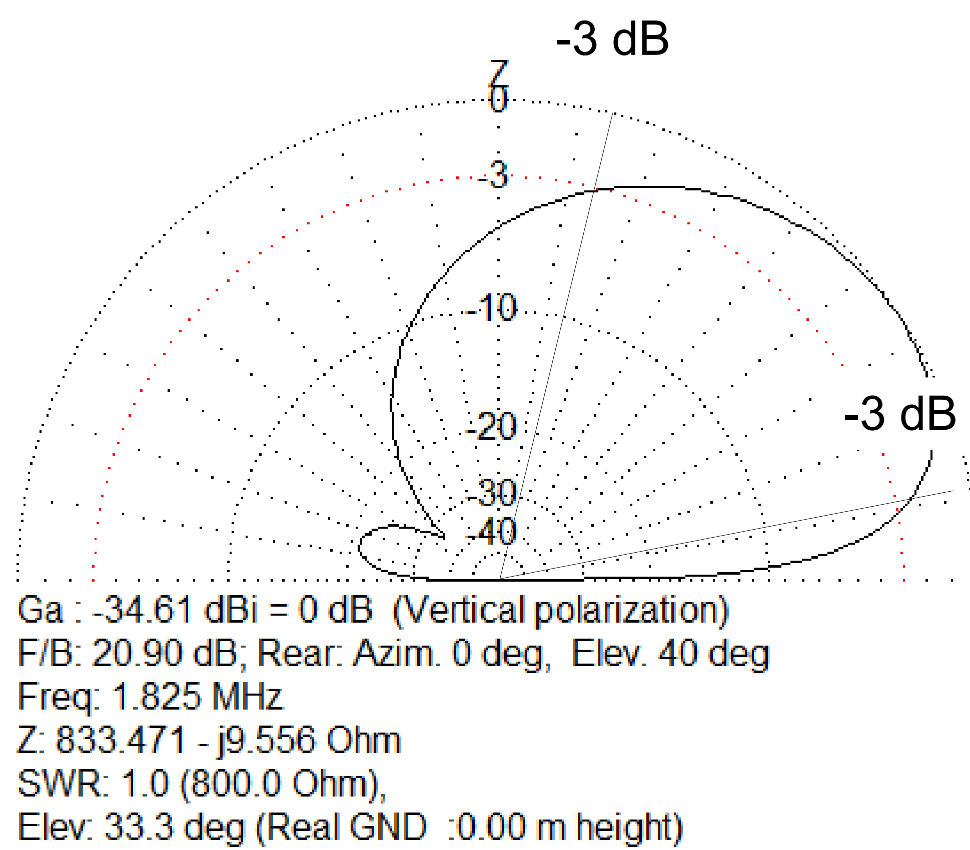
Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

Cardioid Pattern Antenna



Cardioid Pattern Antenna

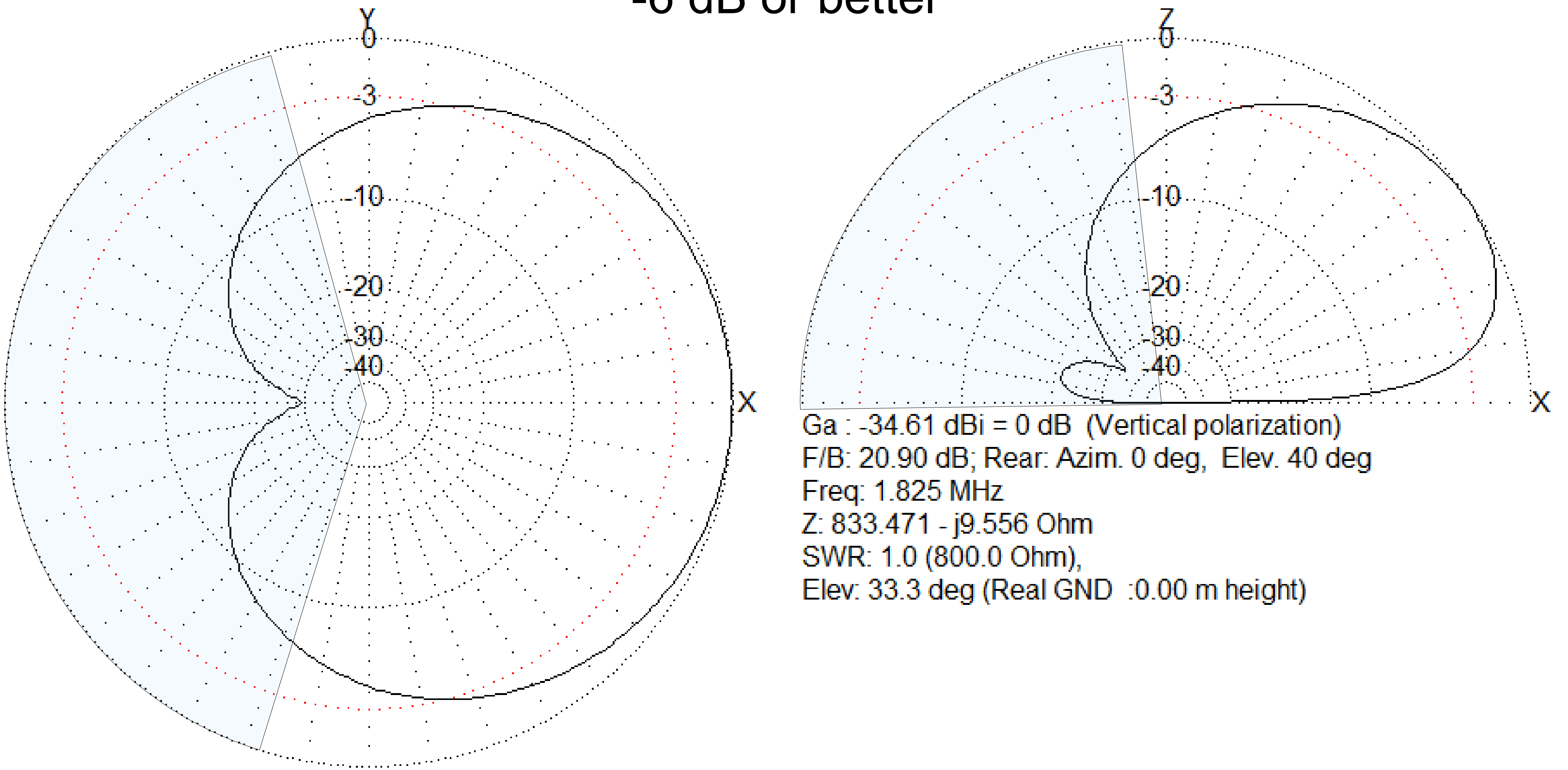




For a receiving antenna
Which is considered the 'Better' direction
The receiving sector on right or
The attenuated sector on the left?

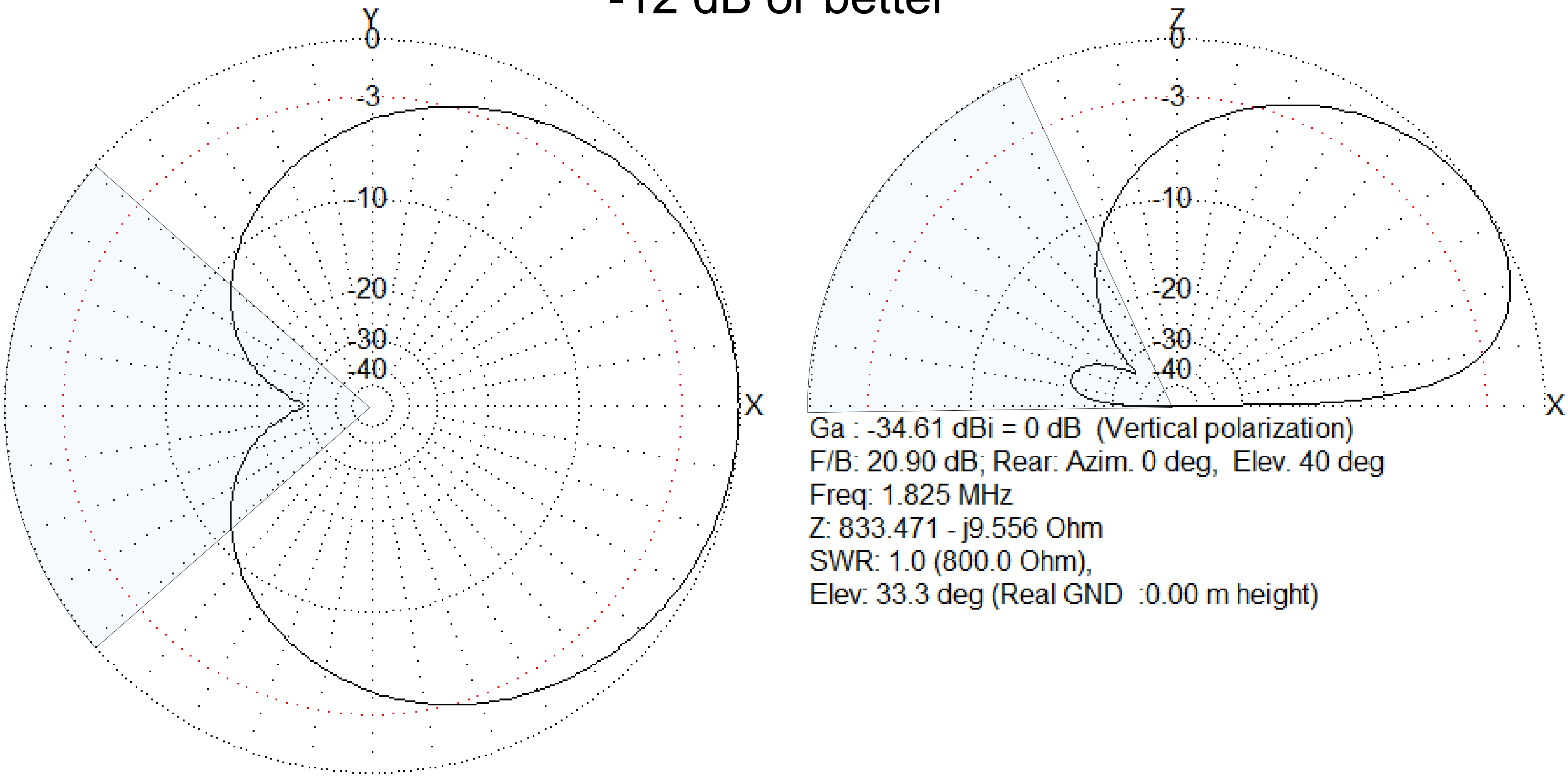
Cardioid Pattern Antenna

-6 dB or better



Cardioid Pattern Antenna

-12 dB or better

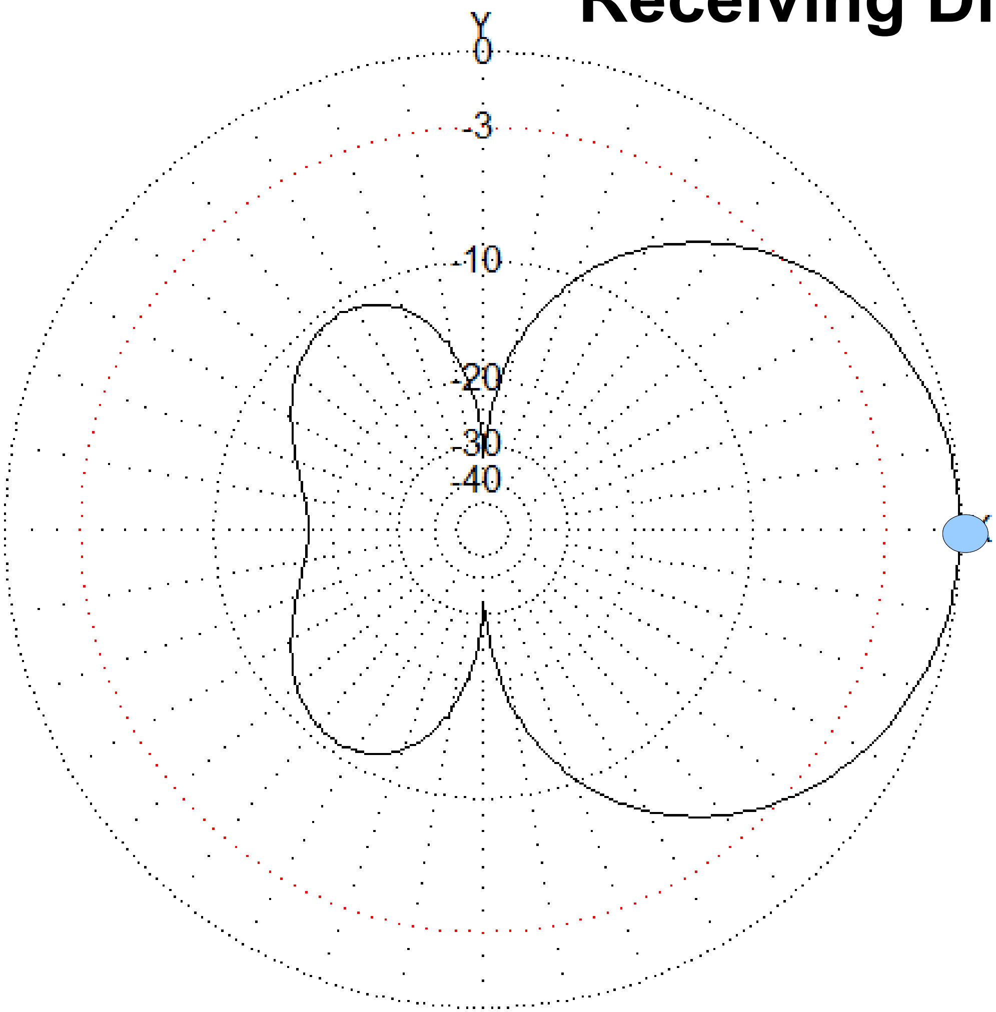


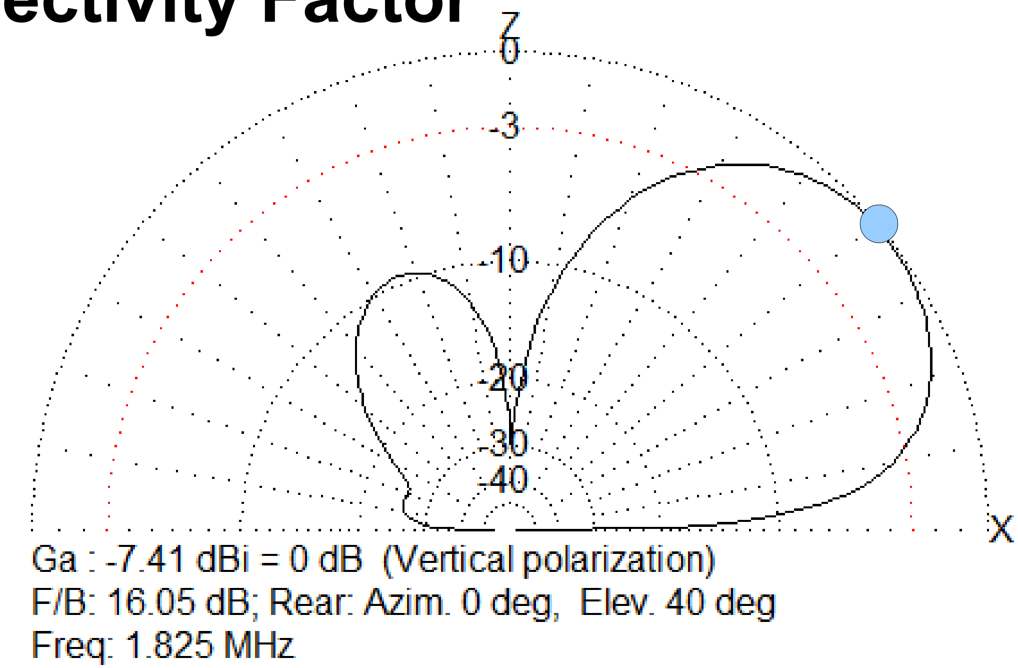
Modern Metrics

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Receiving Antenna RDF

Receiving Directivity Factor



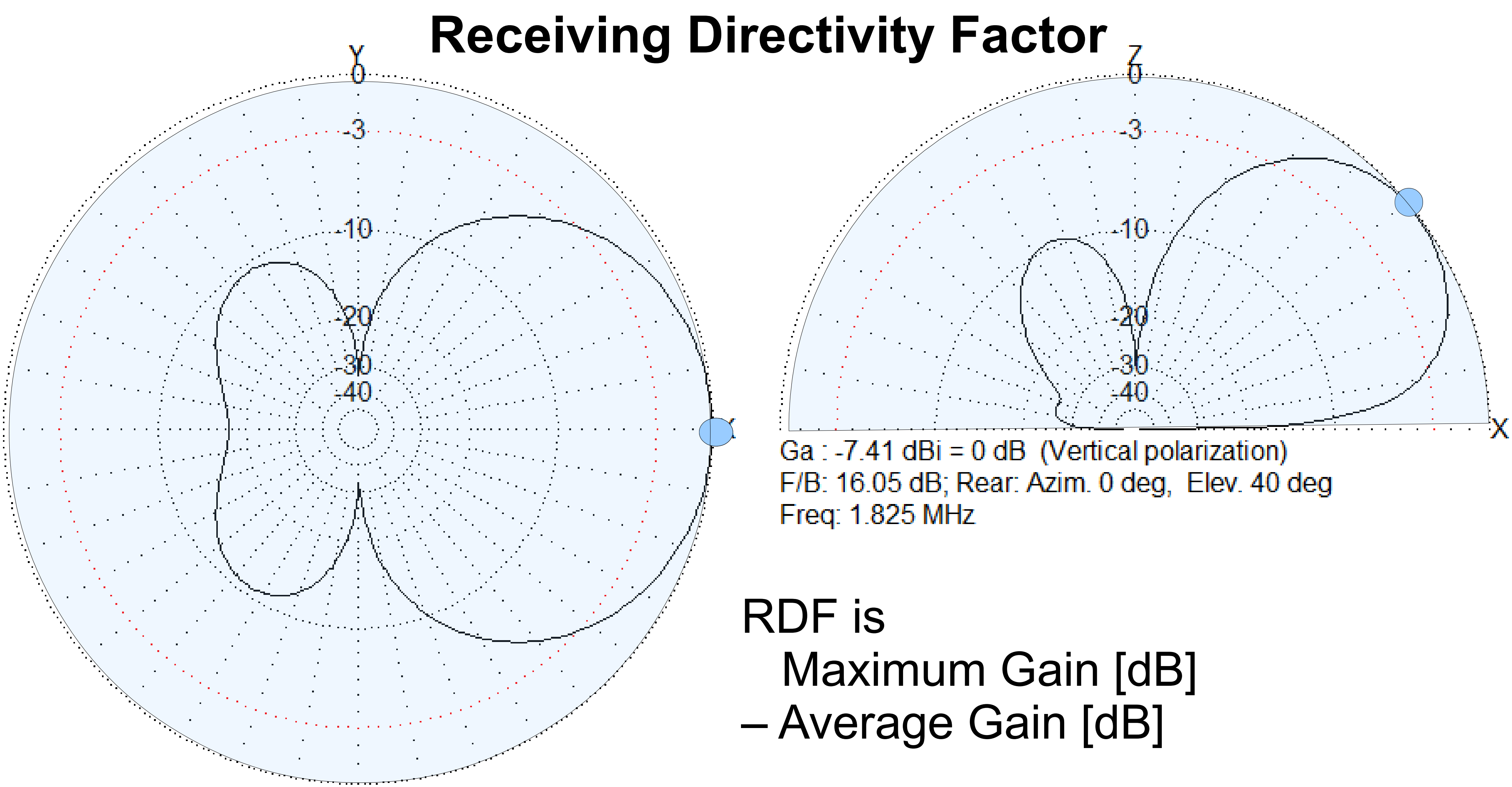


RDF is

$$\frac{\text{Maximum Gain}}{\text{Average Gain}}$$

Calculated through full hemisphere

Receiving Antenna RDF

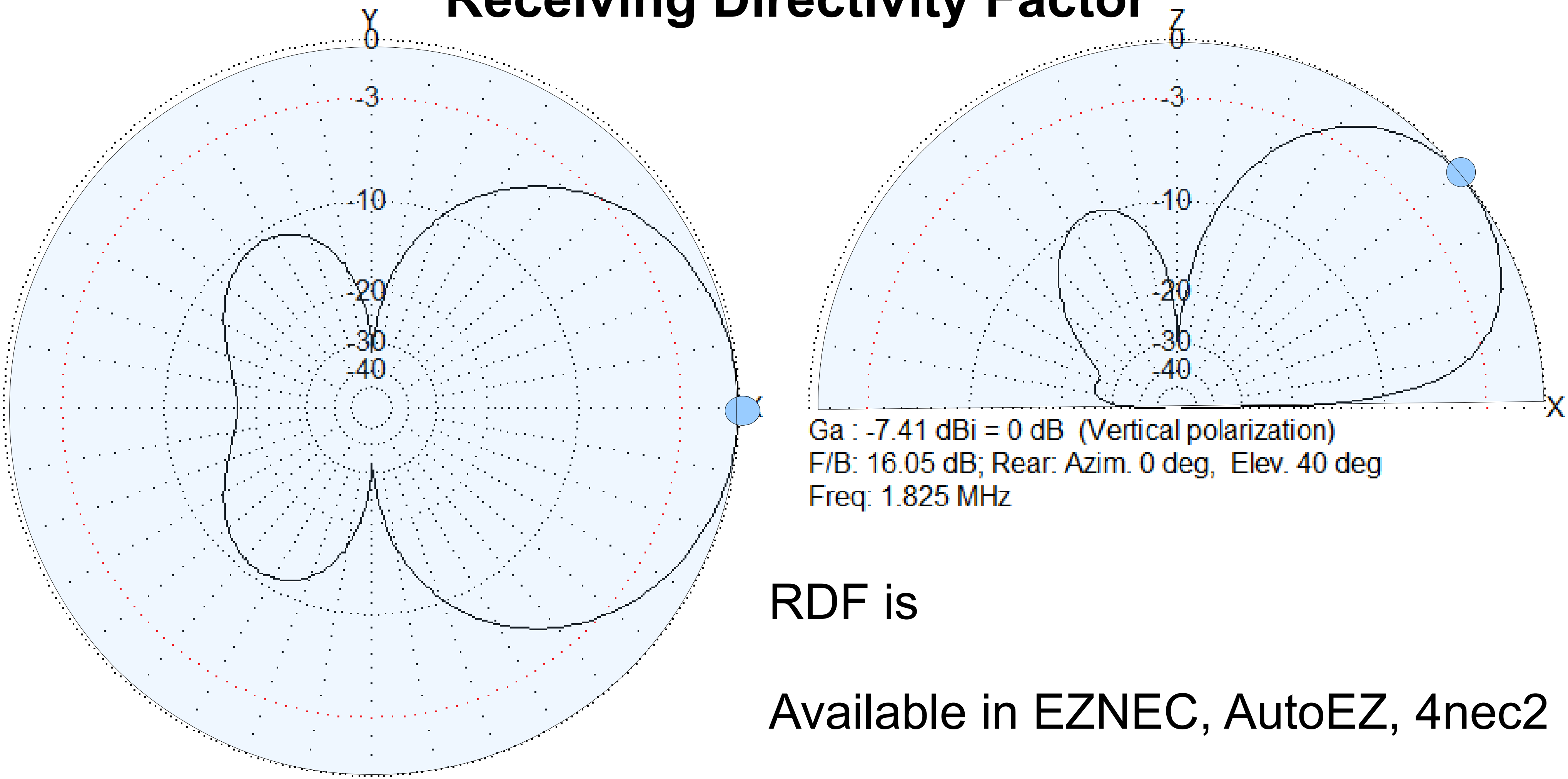


RDF is
Maximum Gain [dB]
– Average Gain [dB]

Calculated through full hemisphere

Receiving Antenna RDF

Receiving Directivity Factor

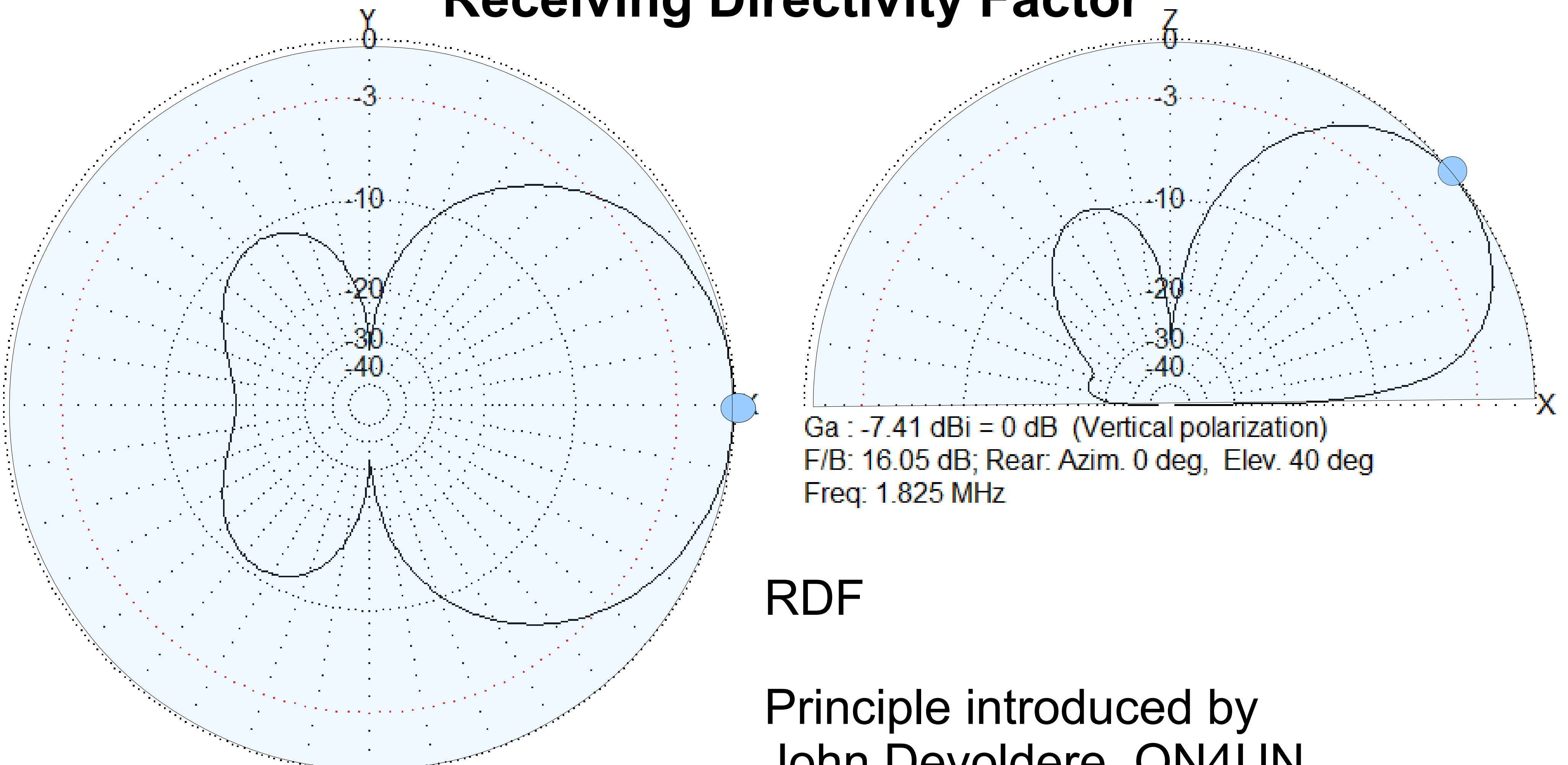


RDF is

Available in EZNEC, AutoEZ, 4nec2

Receiving Antenna RDF

Receiving Directivity Factor

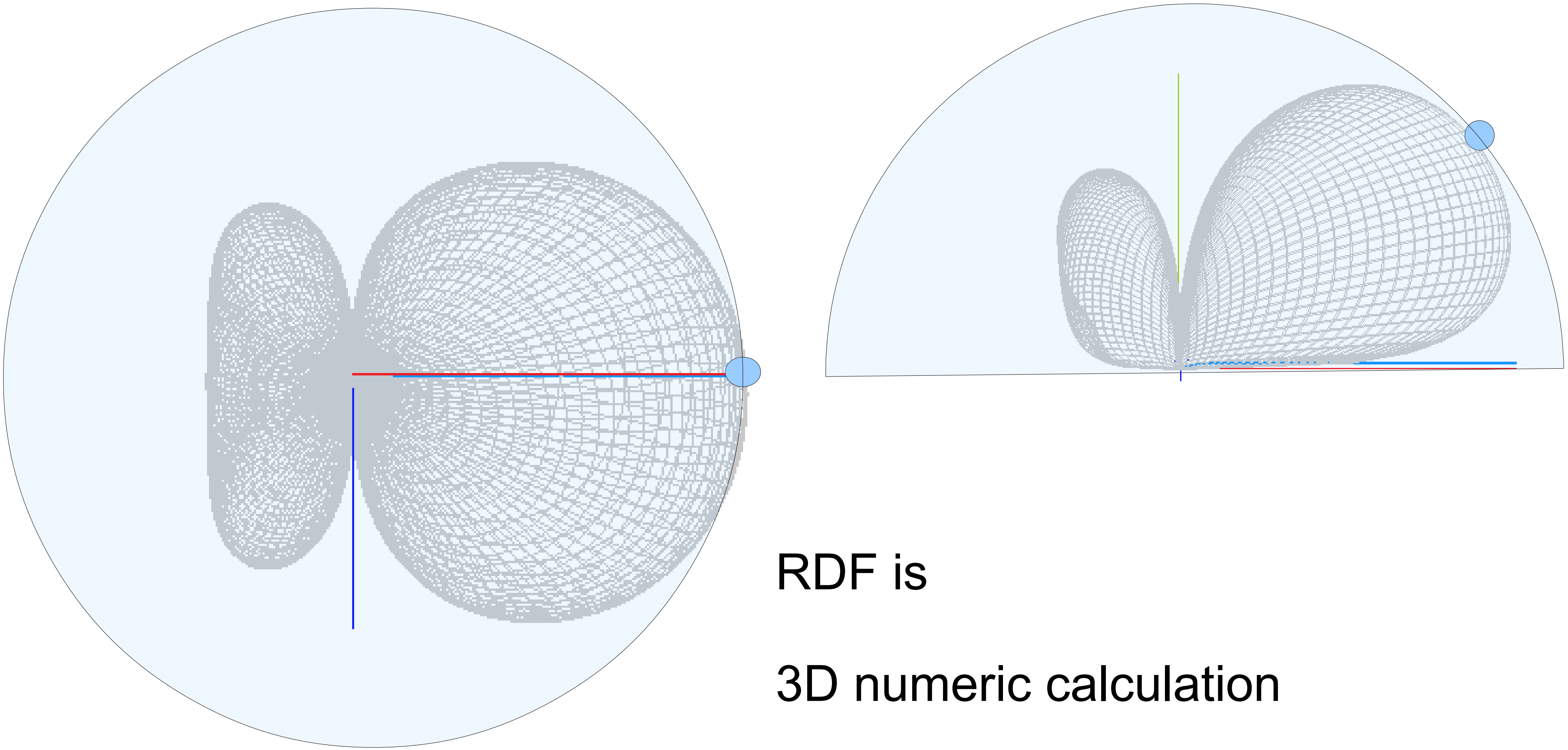


RDF

Principle introduced by John Devoldere, ON4UN, Low Band DXing, Chapter 7

Receiving Antenna RDF

Receiving Directivity Factor

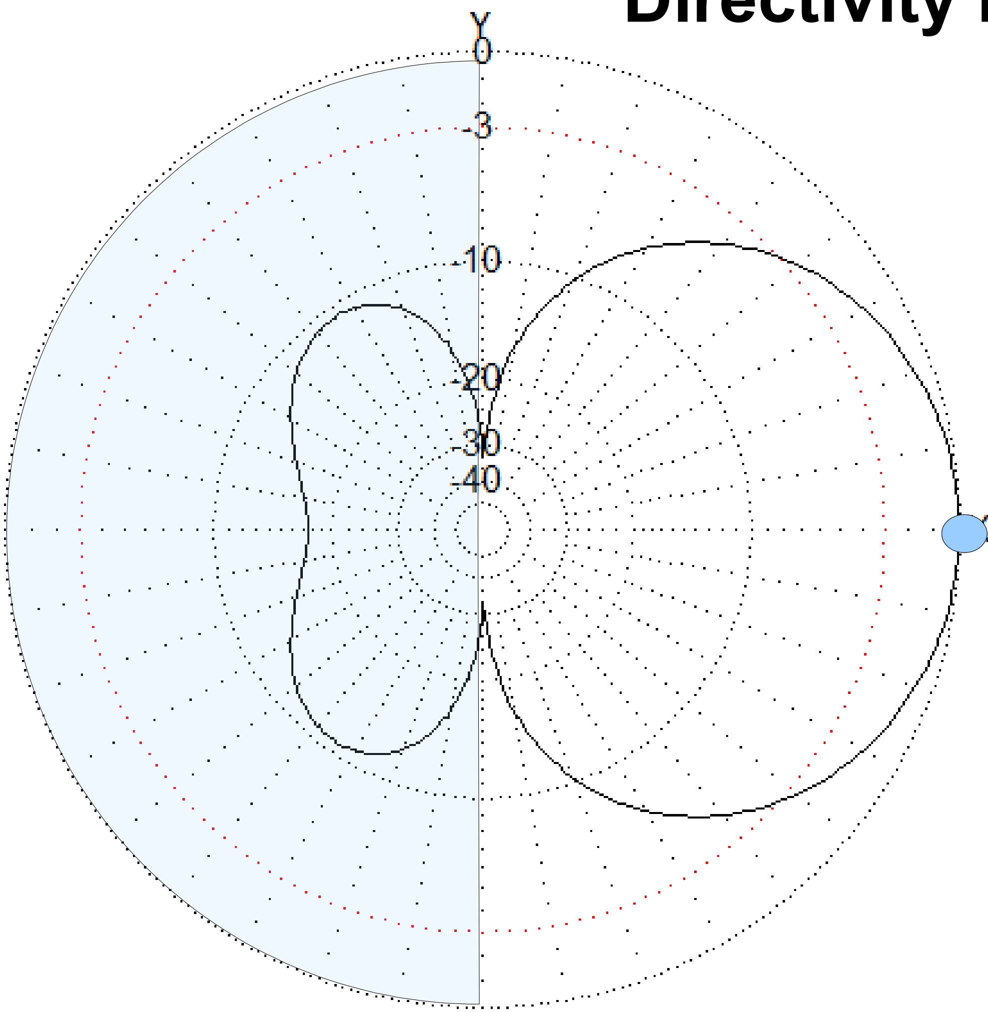


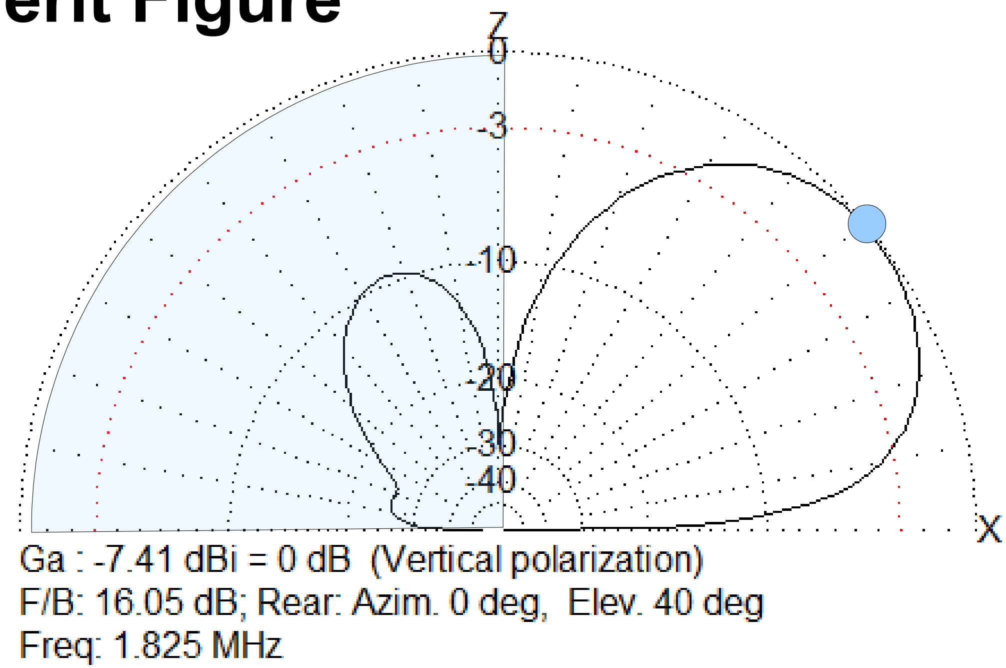
RDF is

3D numeric calculation

Receiving Antenna DMF

Directivity Merit Figure



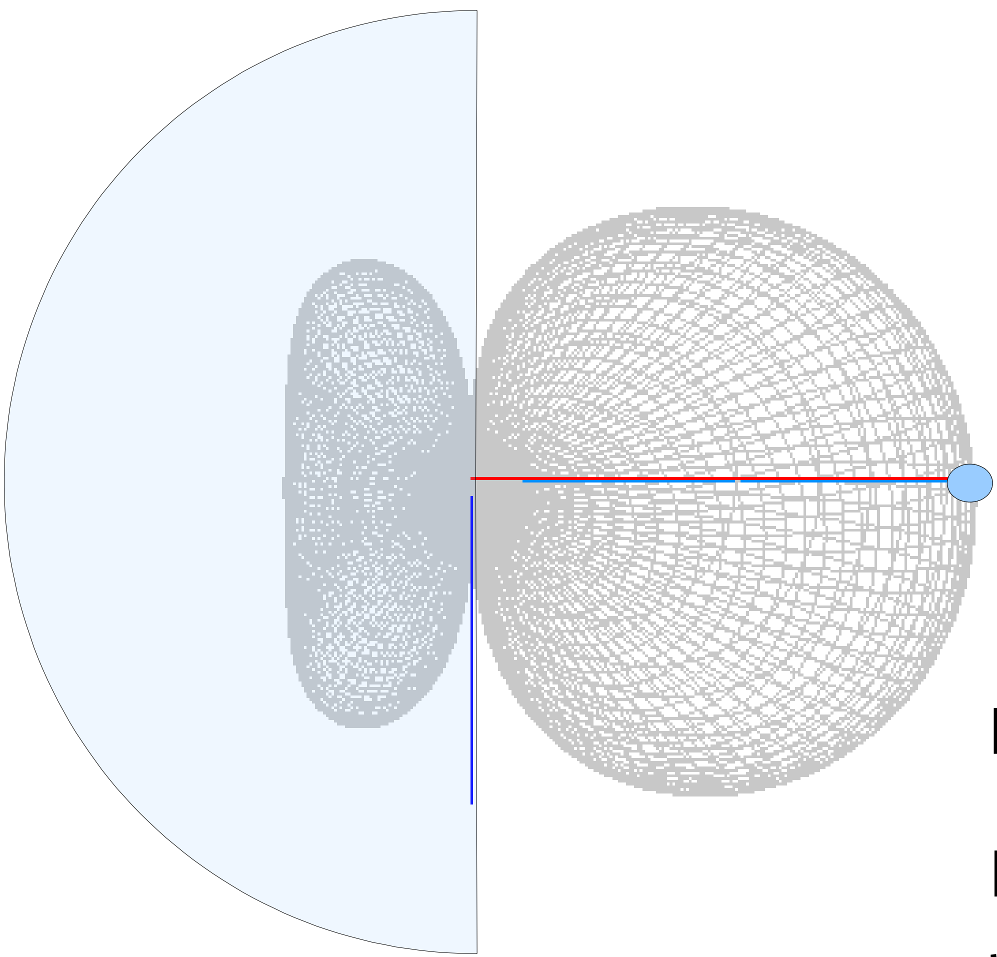


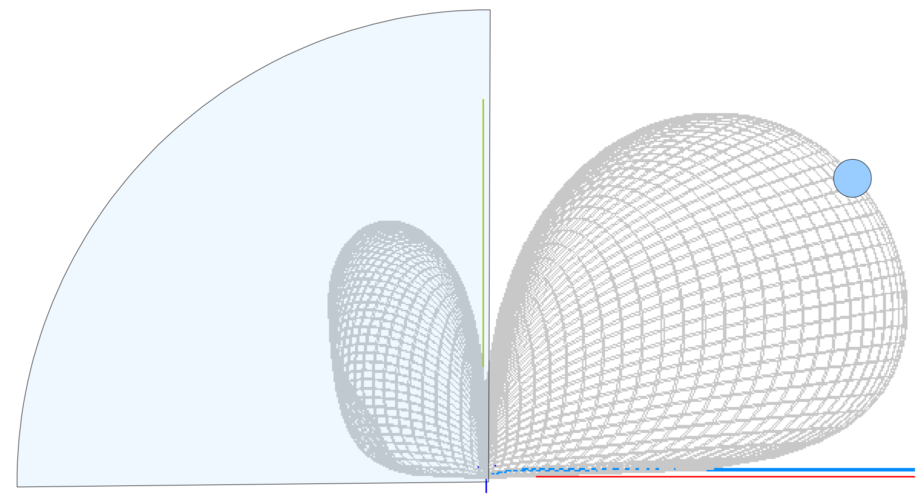
DMF is
  Maximum Gain [dB]
– Back Half Average Gain [dB]

Calculated through back half hemisphere

Receiving Antenna DMF

Directivity Merit Figure



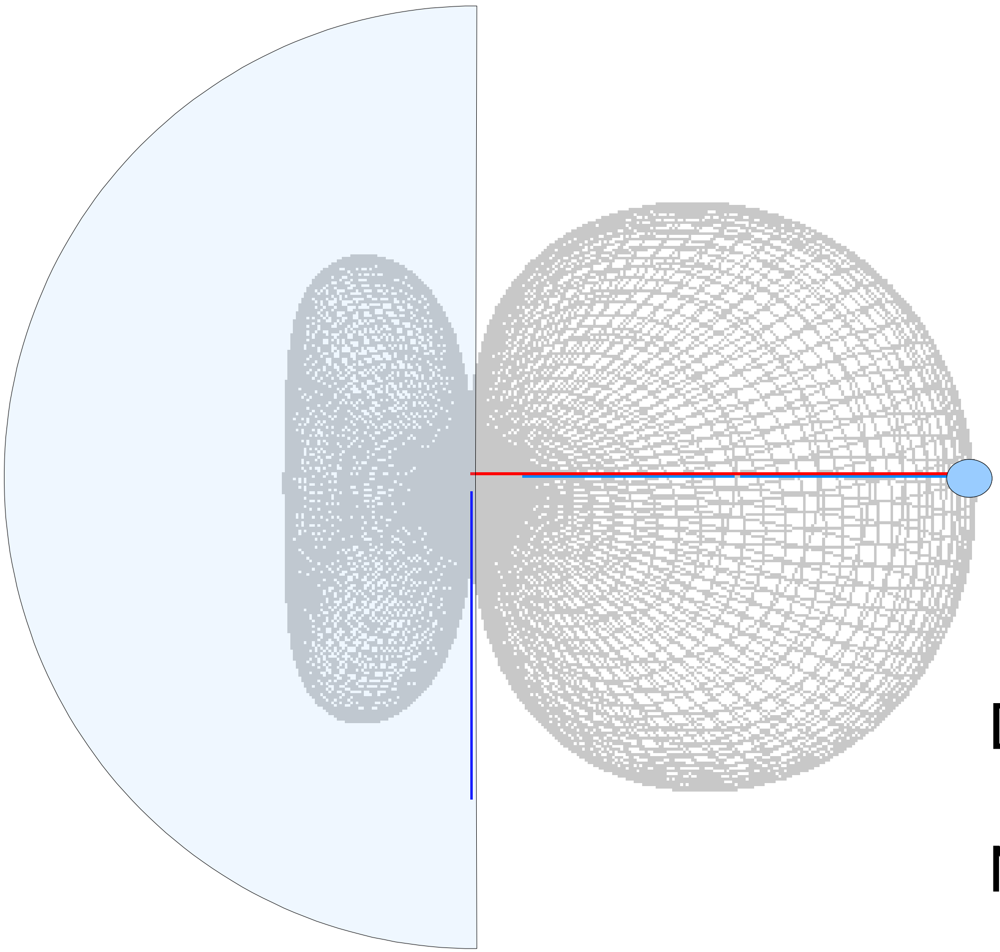


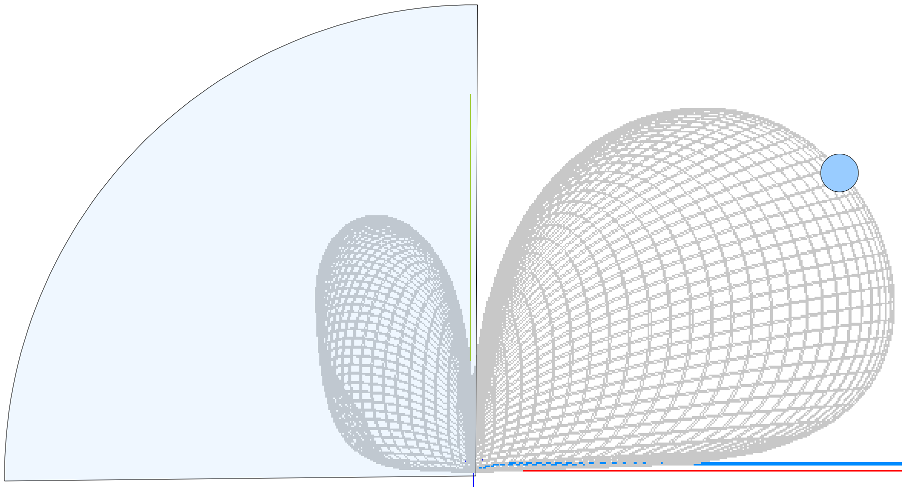
DMF is

Introduced as a 3D item
John Devoldere, ON4UN
Low Band DXing, Chapter 7

Receiving Antenna DMF

Directivity Merit Figure



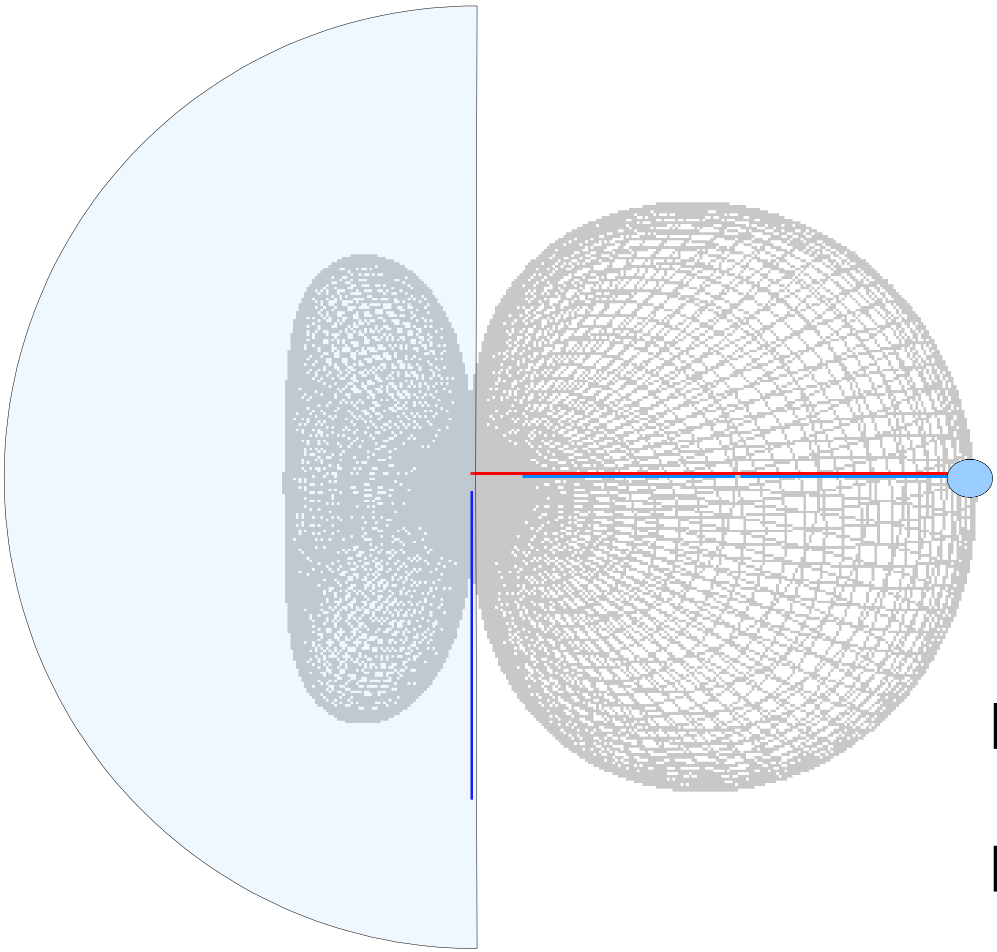


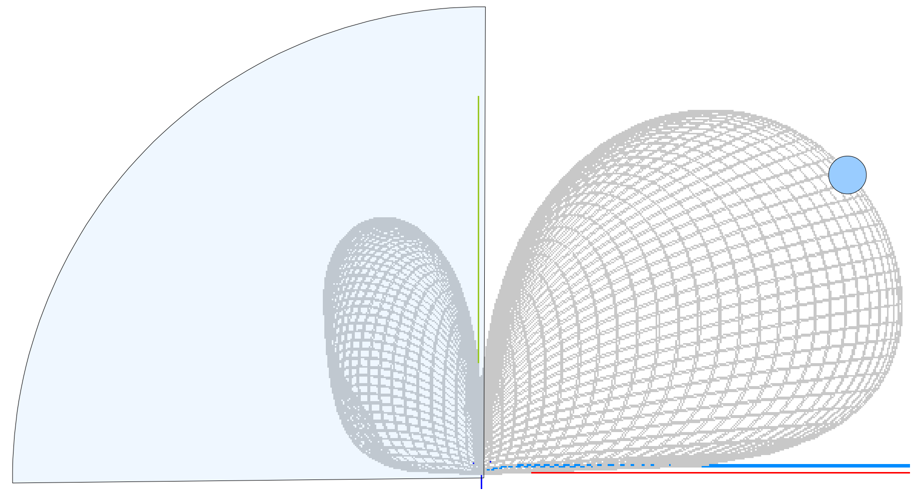
DMF is

Not available

Receiving Antenna DMF

Directivity Merit Figure





DMF is

Not available

Solution release in this presentation

What are the Metrics Good For?

- Previously unanswered questions:

- Does my system hear noise from the band or am I limited by electronics thermal noise?

What are the Metrics Good For?

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- Does my system hear noise from the band or am I limited by electronics thermal noise?

- How small my directional antenna can be and still receive the noise from the band?

What are the Metrics Good For?

- Previously unanswered questions:

- Does my system hear noise from the band or am I limited by electronics thermal noise?

- How small my directional antenna can be and still receive the noise from the band?

- Which antenna pattern is better?

RX Antenna Development

- Small antennas

RX Antenna Development

- Small antennas
  - Flag, FO0AAA, DoubleKAZ, phased antennas
- Optimize the antenna size
- Solution proposal in this presentation

- Most antennas produce side lobes
  - Pattern may leak despite overall average is good
- Solution proposal in this presentation

RX Antenna Development

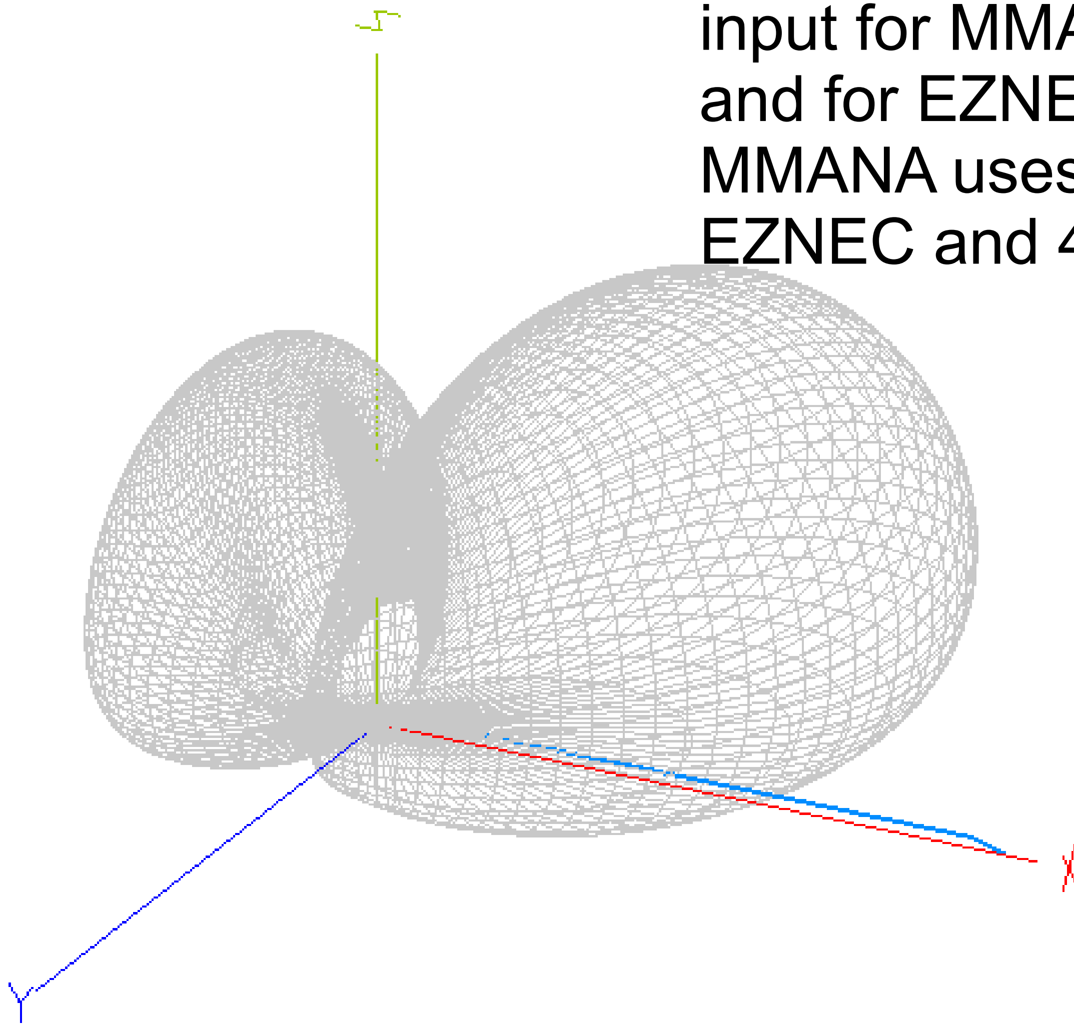
- New small antennas use a load to form the pattern
- Antenna's gain is typically negative in dBi
- Need to design antenna system level sensitivity
- Best S/N by cleanest pattern
  + adequate amplification

- Transmit antennas integrate all noise
  - Transmit antennas' receiving S/N grows by G_{max}

Antenna Metrics Development

- Computers bring opportunities
- True 3D pattern data available
- Idea to Need to Requirement to Specification
- Calculating is easy

Antenna Pattern Data



Sample based 3D pattern into Excel
Dan, AC6LA, made an automated input for MMANA Table Angle / Gain and for EZNEC and 4nec2 .pf3 files
MMANA uses MININEC
EZNEC and 4nec2 use NEC

Antenna Pattern Data

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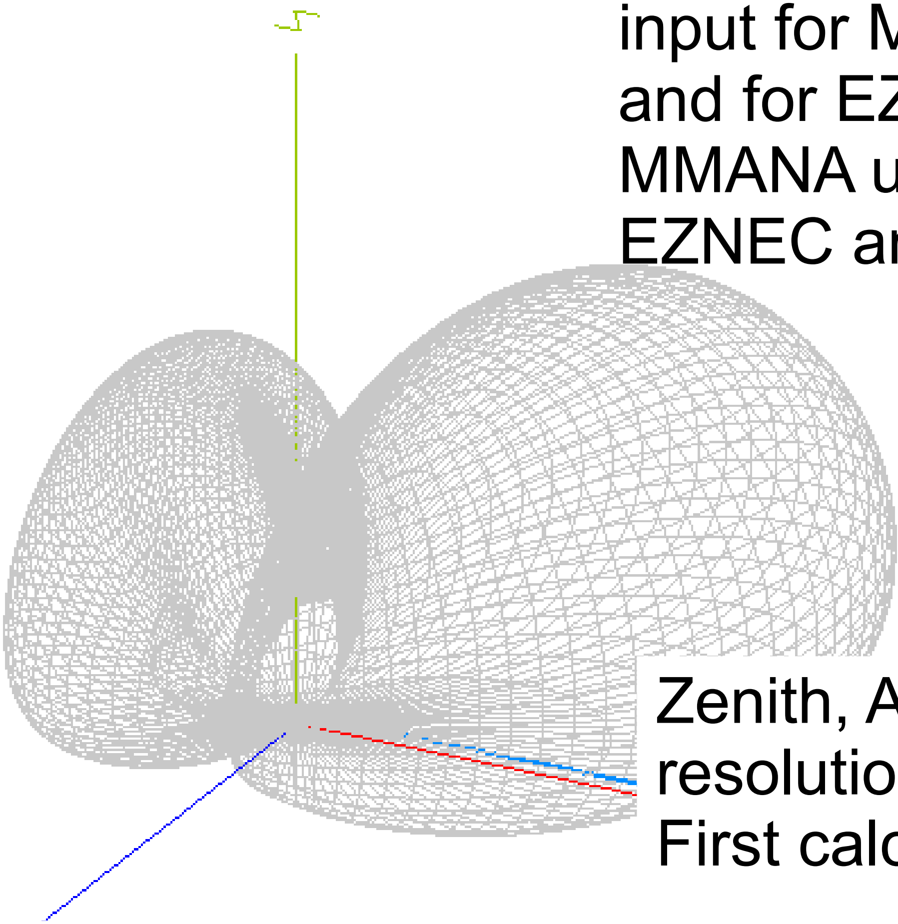
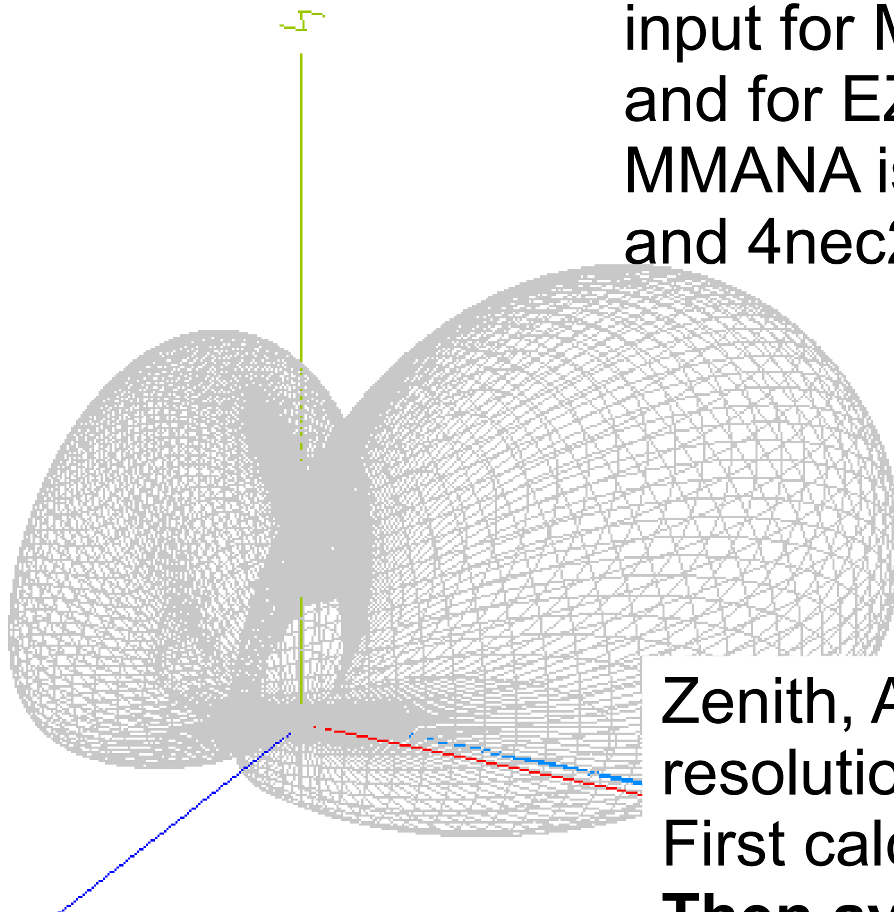


Zenith, Azimuth, Gain at 1 degree resolution
First calculus to steradians

Math basics:
hemisphere surface is 2 Pi

Data to Metrics

Sample based 3D pattern into Excel
Dan, AC6LA, made an automated input for MMANA Table Angle / Gain and for EZNEC and 4nec2 .pf3 files
MMANA is MININEC while EZNEC and 4nec2 use NEC engine



Zenith, Azimuth, Gain at 1 degree resolution
First calculus to steradians
Then average gain to get RDF and back half average to get DMF

Math basics:
hemisphere surface is 2 Pi

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

RX Ant Metrics Workbook

Read MMANA .csv File

RX Ant Metrics v16.xlsm

	A	B	C	D	E	F	G	H	I	J
1	ZENITH(DI	AZIMUTH(	VERT(d	HORI(d	TOTAL(dB	Pwr	Th1	Th2	dA(sr)	Pwr*dA
2	0	0	-93,03	-999	-93,03	4,98E-10	0	0,5	3,32E-07	1,65E-16
3	1	0	-81,29	-999	-81,29	7,43E-09	0,5	1,5	2,66E-06	1,98E-14
4	2	0	-76,33	-999	-76,33	2,33E-08	1,5	2,5	5,32E-06	1,24E-13
5	3	0	-73,1	-999	-73,1	4,9E-08	2,5	3,5	7,97E-06	3,9E-13
6	4	0	-70,68	-999	-70,68	8,55E-08	3,5	4,5	1,06E-05	9,08E-13
7	5	0	-68,73	-999	-68,73	1,34E-07	4,5	5,5	1,33E-05	1,78E-12
8	6	0	-67,1	-999	-67,1	1,95E-07	5,5	6,5	1,59E-05	3,1E-12
9	7	0	-65,68	-999	-65,68	2,7E-07	6,5	7,5	1,86E-05	5,02E-12
10	8	0	-64,44	-999	-64,44	3,6E-07	7,5	8,5	2,12E-05	7,63E-12
11	9	0	-63,32	-999	-63,32	4,66E-07	8,5	9,5	2,38E-05	1,11E-11
12	10	0	-62,31	-999	-62,31	5,87E-07	9,5	10,5	2,64E-05	1,55E-11
13	11	0	-61,38	-999	-61,38	7,28E-07	10,5	11,5	2,91E-05	2,12E-11
14	12	0	-60,52	-999	-60,52	8,87E-07	11,5	12,5	3,17E-05	2,81E-11
15	13	0	-59,73	-999	-59,73	1,06E-06	12,5	13,5	3,43E-05	3,65E-11
16	14	0	-58,99	-999	-58,99	1,26E-06	13,5	14,5	3,68E-05	4,65E-11

M N O P Q R

(•) MMANA csv ( ) EZNEC/4nec2 pf3 Source Type

User input	
1	Step size, deg
EPÄTOSI	Free space ?

(Make changes to these two cells only.)

1) Set the values above as desired.

2) In MMANA, click File > Table of Angle/Gain then use these parameters ***in the dialog window*** (not here).

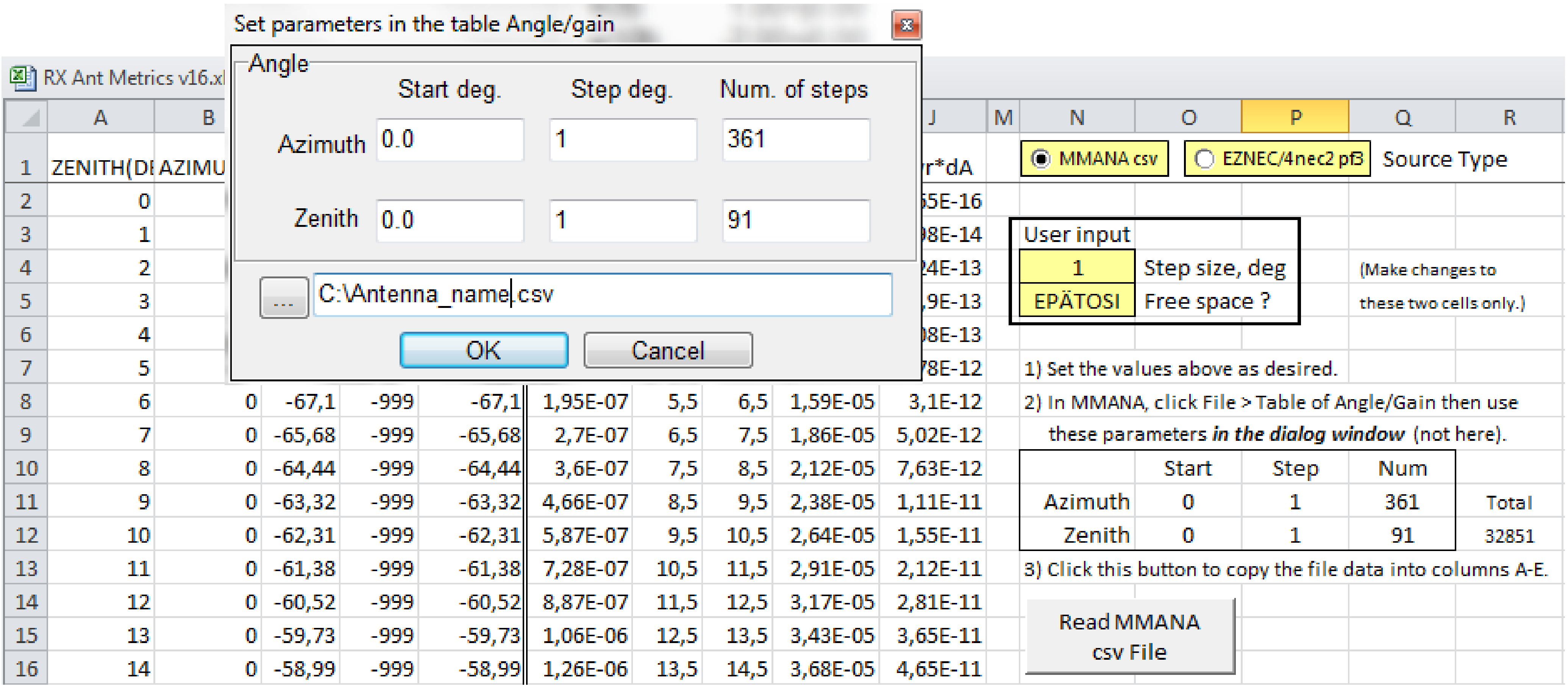
	Start	Step	Num	
Azimuth	0	1	361	Total
Zenith	0	1	91	32851

3) Click this button to copy the file data into columns A-E.

[Read MMANA csv File]

RX Ant Metrics Workbook

Read MMANA .csv File



ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

RX Ant Metrics Workbook

Read EZNEC or 4nec2 pf3 File

RX Ant Metrics v16.xlsm

	A	B	C	D	E	F	G	H	I	J
1	ZENITH(DI	AZIMUTH(	VERT(d	HORI(d	TOTAL(dB	Pwr	Th1	Th2	dA(sr)	Pwr*dA
2	0	0	-93,03	-999	-93,03	4,98E-10	0	0,5	3,32E-07	1,65E-16
3	1	0	-81,29	-999	-81,29	7,43E-09	0,5	1,5	2,66E-06	1,98E-14
4	2	0	-76,33	-999	-76,33	2,33E-08	1,5	2,5	5,32E-06	1,24E-13
5	3	0	-73,1	-999	-73,1	4,9E-08	2,5	3,5	7,97E-06	3,9E-13
6	4	0	-70,68	-999	-70,68	8,55E-08	3,5	4,5	1,06E-05	9,08E-13
7	5	0	-68,73	-999	-68,73	1,34E-07	4,5	5,5	1,33E-05	1,78E-12
8	6	0	-67,1	-999	-67,1	1,95E-07	5,5	6,5	1,59E-05	3,1E-12
9	7	0	-65,68	-999	-65,68	2,7E-07	6,5	7,5	1,86E-05	5,02E-12
10	8	0	-64,44	-999	-64,44	3,6E-07	7,5	8,5	2,12E-05	7,63E-12
11	9	0	-63,32	-999	-63,32	4,66E-07	8,5	9,5	2,38E-05	1,11E-11
12	10	0	-62,31	-999	-62,31	5,87E-07	9,5	10,5	2,64E-05	1,55E-11
13	11	0	-61,38	-999	-61,38	7,28E-07	10,5	11,5	2,91E-05	2,12E-11
14	12	0	-60,52	-999	-60,52	8,87E-07	11,5	12,5	3,17E-05	2,81E-11
15	13	0	-59,73	-999	-59,73	1,06E-06	12,5	13,5	3,43E-05	3,65E-11
16	14	0	-58,99	-999	-58,99	1,26E-06	13,5	14,5	3,68E-05	4,65E-11

MMANA csv | EZNEC/4nec2 pf3 | Source Type

With EZNEC: On the 3D Plot window click File > Save 3D Plot. Enter a file name then click Save.

With AutoEZ: Enable the "Include 3D Data in Calculations" option. A file named $AutoEZ$n.PF3, where "n" is the test case number, will be written to the AutoEZ home folder.

With 4nec2: Click Calculate > Far Field pattern > Full. On the Pattern window, Transfer > Export > Full/3D.

Step size and Free space are deduced from the file.

Read EZNEC/4nec2 pf3 File

RX Ant Metrics Outputs

RX Ant Metrics v16.xlsm

	A	B	C	D	E	F	G	H	I	J	M	N	O	P	Q	R
1	ZENITH(DE	AZIMUTH(	VERT(d	HORI(d	TOTAL(dB	Pwr	Th1	Th2	dA(sr)	Pwr*dA		MMANA csv	EZNEC/4nec2 pf3		Source Type	
17	15	0	-21,08	-999	-21,08	0,007798	14,5	15,5	3,94E-05	3,07E-07		**06 Beverage 250m.csv**				
18	16	0	-22,91	-999	-22,91	0,005117	15,5	16,5	4,2E-05	2,15E-07						
19	17	0	-25,37	-999	-25,37	0,002904	16,5	17,5	4,45E-05	1,29E-07		-4,6	Max 3D Gain, dBi		(at Az = 0°, El = 31°)	
20	18	0	-28,93	-999	-28,93	0,001279	17,5	18,5	4,71E-05	6,02E-08		**-16,8**	Avg Gain, dB			
21	19	0	-34,69	-999	-34,69	0,00034	18,5	19,5	4,96E-05	1,68E-08		**12,2**	RDF, dB (Max - Avg)			
22	20	0	-37,49	-999	-37,49	0,000178	19,5	20,5	5,21E-05	9,28E-09		RDF: Receiving Directivity Factor				
23	21	0	-30,56	-999	-30,56	0,000879	20,5	21,5	5,46E-05	4,8E-08						
24	22	0	-26	-999	-26	0,002512	21,5	22,5	5,71E-05	1,43E-07		**-24,7**	Back Half Avg Gain, dB			
25	23	0	-22,89	-999	-22,89	0,00514	22,5	23,5	5,95E-05	3,06E-07		**20,1**	DMF, dB (Max - Back Half Avg)			
26	24	0	-20,56	-999	-20,56	0,00879	23,5	24,5	6,19E-05	5,45E-07		DMF: Directivity Merit Figure				

Avg Gain RDF DMF | Noise Margin | Leaking Index | Summary of Metrics

Front sheet - Avg Gain RDF DMF

RDF algorithm same as EZNEC
DMF available as a new item

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

RX Ant Metrics Outputs

RX Ant Metrics v16.xlsm

	User input			Result:	
Noise Level P.372-13	46	dB			
Feed System Losses	2	dB			
RX Noise Figure	4	dB	Noise Margin	**0,5 dB**	above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-I

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

38 dB on 80 at a quiet rural site, minimum noise level expected

56 dB on 80 at a residential site, median value

The distribution around the median value curves is described in Radio Noise document Table 2

The Noise Margin should be several dB to achieve good antenna system performance in all conditions

Avg Gain RDF DMF | Noise Margin | Leaking Index | Summary of Metrics

Noise Margin estimates if the receiving system is limited by electronics thermal noise

That is, if antenna's Average Gain is big enough to hear the band noise over the receiver's thermal electronics noise

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

RX Ant Metrics Outputs

RX Ant Metrics v16.xlsm

Result:

dB below Max Gain	3 level analysis
12	8,4%
18	48,3%
24	73,0%
Leaking Index	**43,2 %**

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

--- Notes ---

Leaking Index tells how much the antenna pattern leaks to unwanted directions
User can set the azimuth range, default is 80 to 280 degrees
Zenith range is fixed 0 to 90 degrees

The antenna is better when
-smaller proportion of pattern leaks
-any leaking is attenuated more

Avg Gain RDF DMF | Noise Margin | Leaking Index | Summary of Metrics

Leaking Index tells if the antenna pattern leaks outside the Main Lobe

RX Ant Metrics Outputs

RX Ant Metrics v17p.xlsm

	A	B	C	D	E	F	G	H	I	J	K	M	N	O
1	Summary of Metrics									RX Ant Metrics v17p.xlsm				
2														
3	A new summary row is automatically added each time a data file is read.													
4	Copy/paste data below as desired to a new workbook.													
5	Delete any rows that are no longer needed.													
6	Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
7	05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
8	06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
9	07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5

Read MMANA csv File

Avg Gain RDF DMF | Noise Margin | Leaking Index | Summary of Metrics

Summary of Metrics gives an easy to copypaste data set to a collection workbook

New Antenna Metrics Explained

Noise Margin

- The Sky provides noise to antenna
- Noise is mostly man-made or atmospheric
- Directional antenna receives noise by calculated average gain in relation to full hemisphere noise
- Smaller antenna with smaller amplification receives less noise

Noise Margin

- The Sky provides noise to antenna
- Noise is mostly man-made or atmospheric
- Directional antenna receives noise by calculated average gain in relation to full hemisphere noise
- Smaller antenna with smaller amplification receives less noise
- To hear the weak signals, the noise level received from the Sky must exceed the noise of electronics, the thermal noise, by a margin

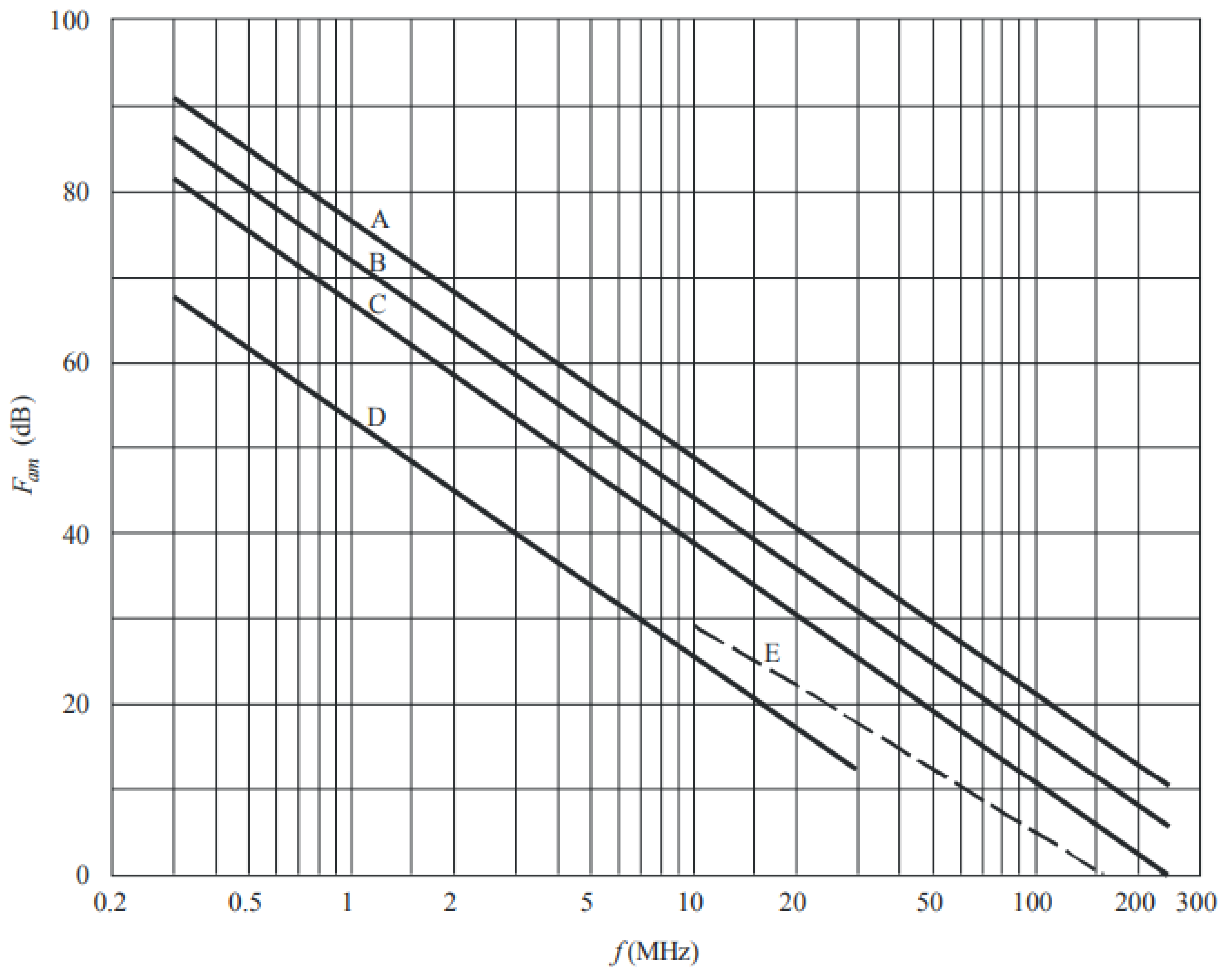
Noise Margin

- We can calculate the noise power we receive
- Thermal electronics noise equals Noise Figure
- We want to have a small, yet highly directive antenna and receive the smallest possible signals
- That is, we want to hear the band noise at main lobe -3dB points and have the smallest feasible antenna
- We need to understand and evaluate the antenna system Noise Margin

Noise Level

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna



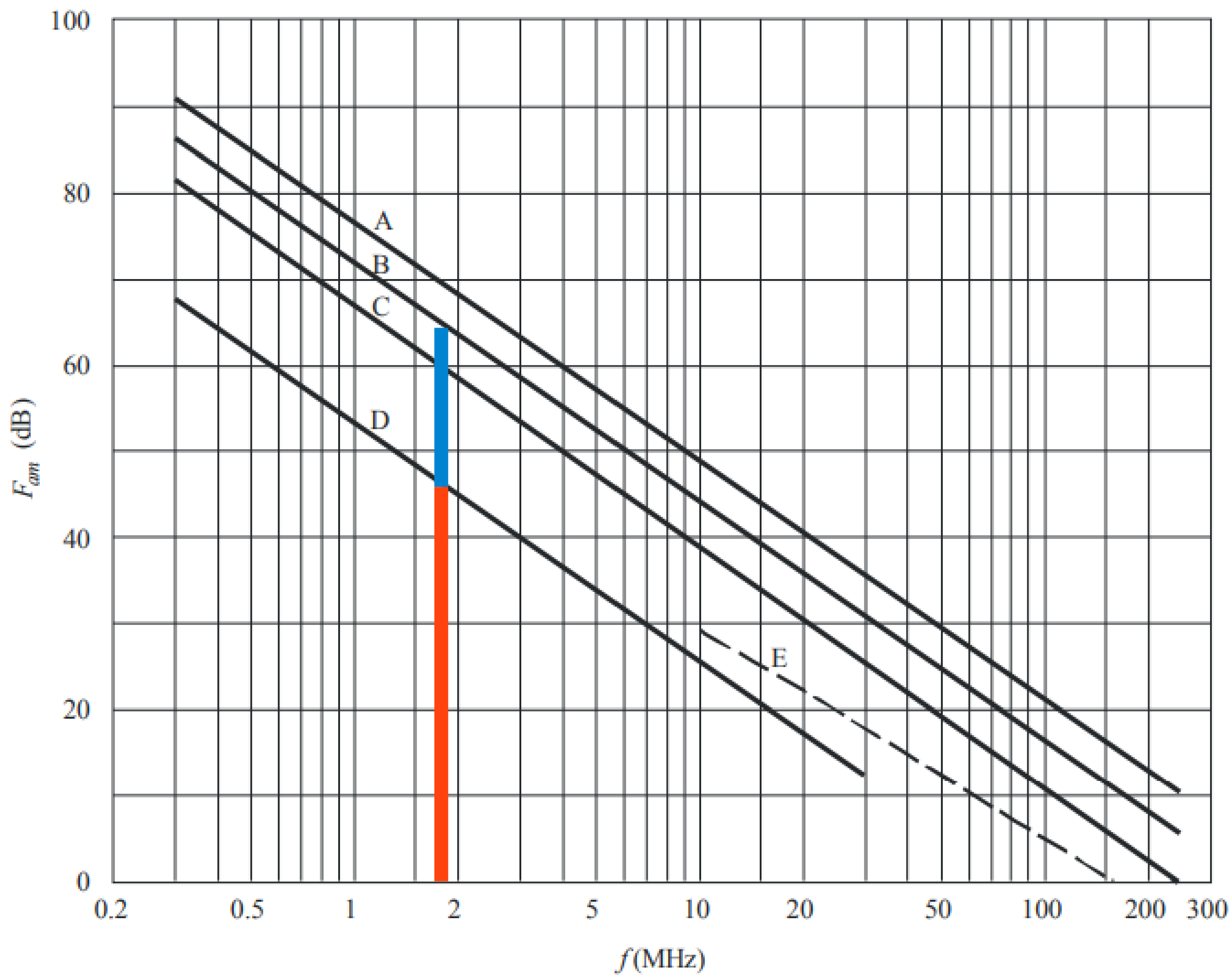
ITU-R P.372-13

Curves A: city
B: residential
C: rural
D: quiet rural
E: galactic (see § 6)

Noise Level

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna



ITU-R P.372-13

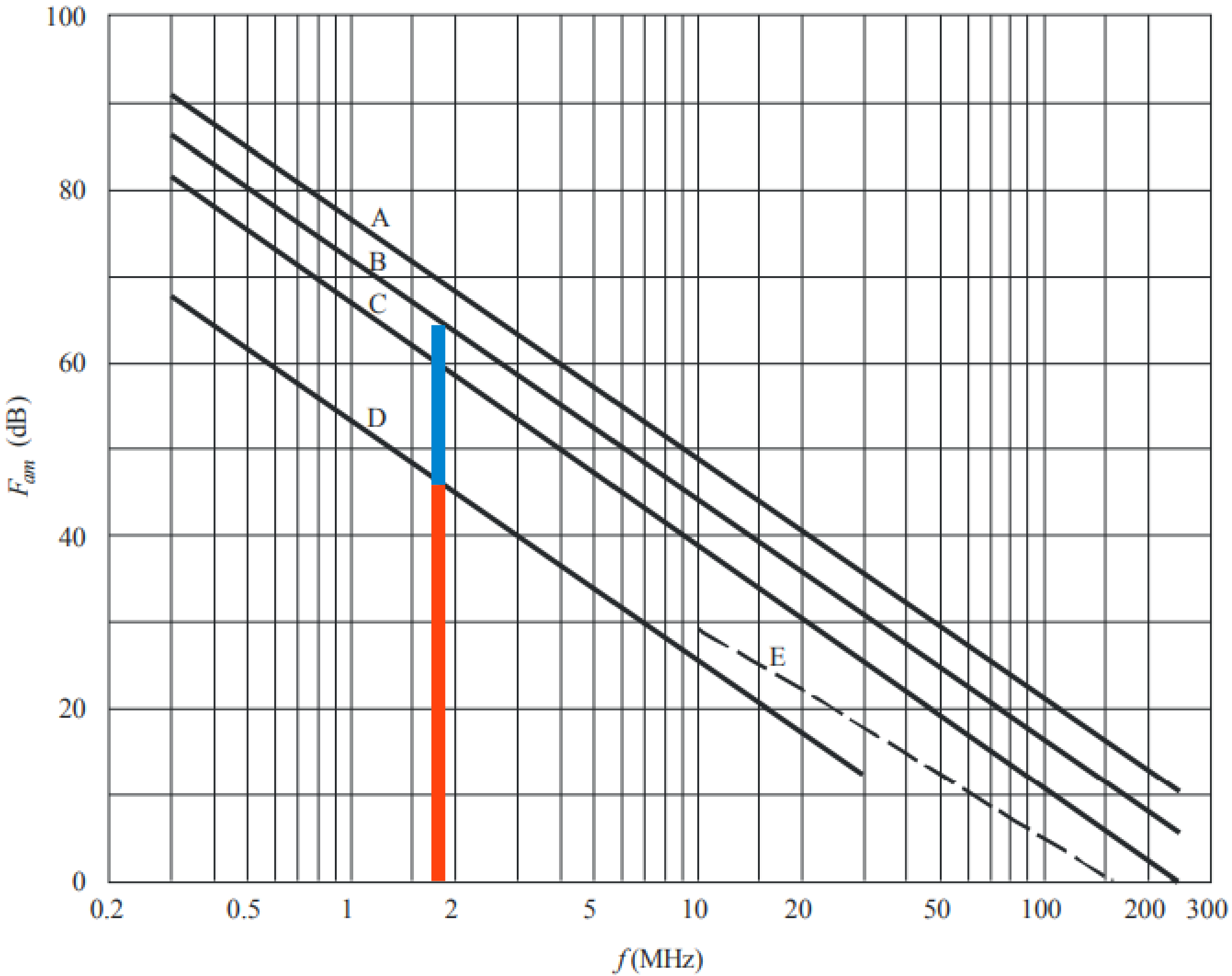
Shows 46 dB noise on 160 at 1Hz bandwidth for a quiet rural receiving site

64dB for a residential area receiving site

Noise Level

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna



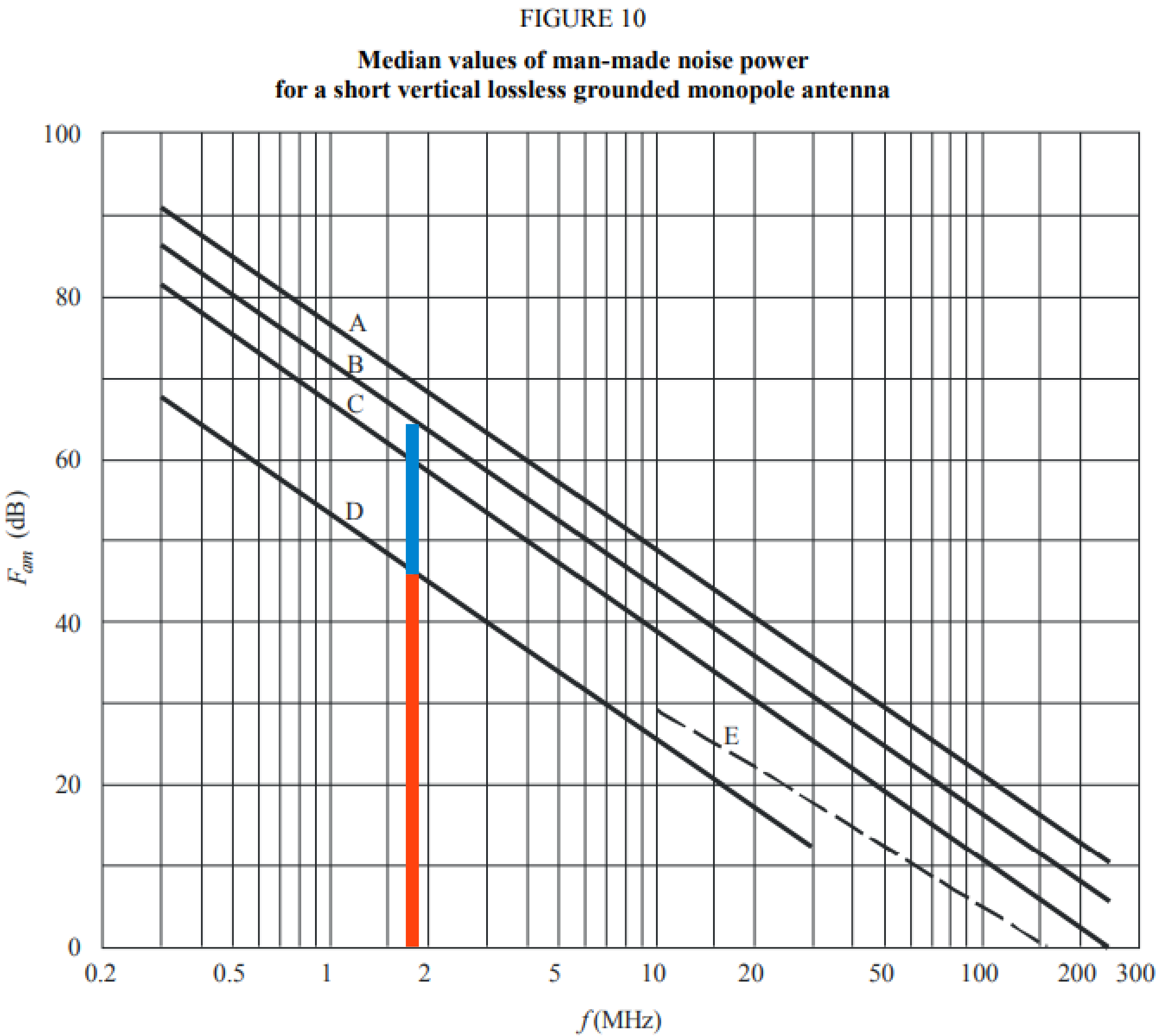
ITU-R P.372-13

Shows 46 dB noise on 160 at 1Hz bandwidth for a quiet rural receiving site

64dB for a residential area receiving site

Validation for Noise Level comes from ITU

Noise Level



ITU-R P.372-13

Shows 46 dB noise on 160 at 1Hz bandwidth for a quiet rural receiving site

64dB for a residential area receiving site

A B C Noise Levels are statistical median

D is minimum noise level expected

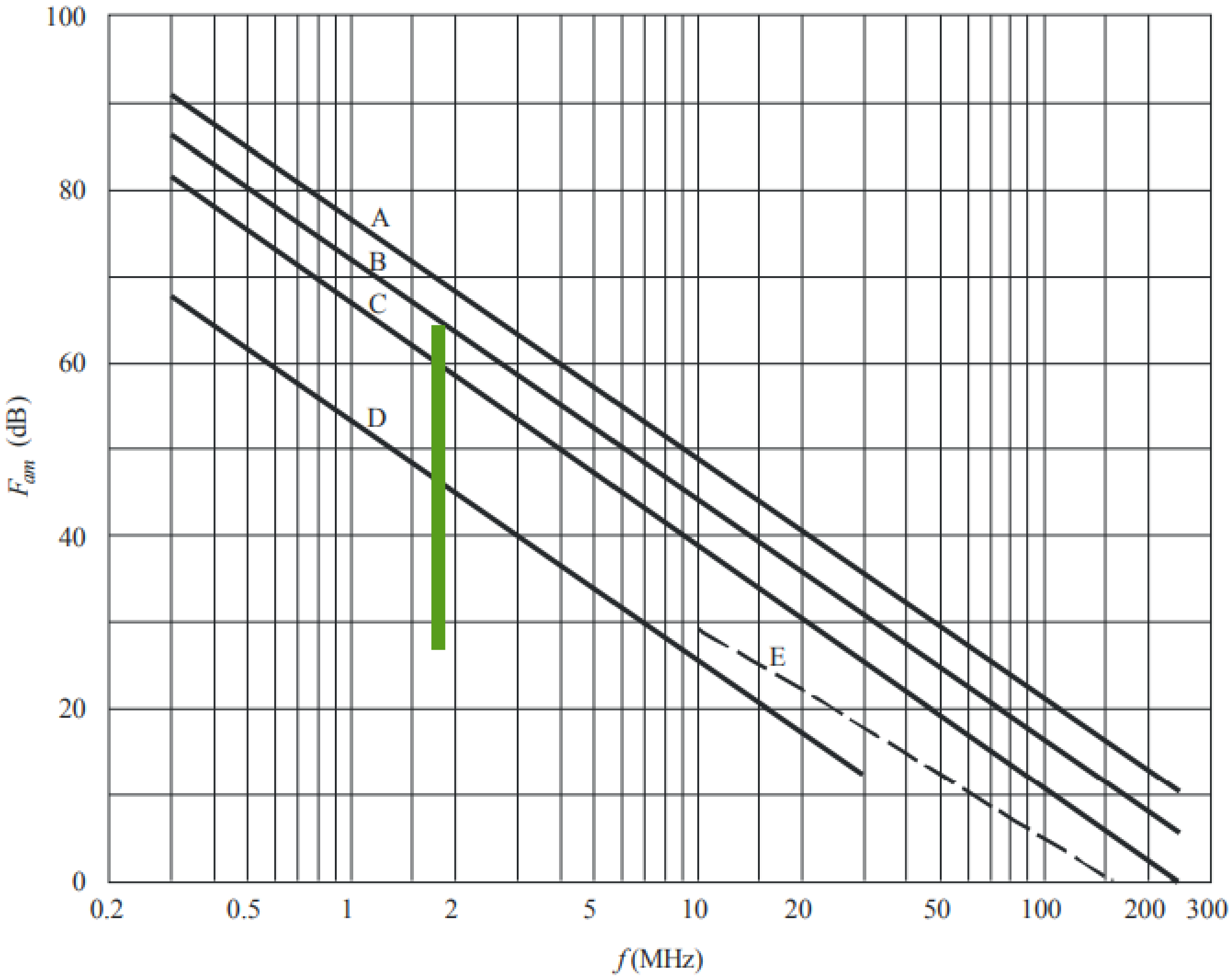
Noise Distribution

- Noise distribution is even for dA(sr) steradian surface elements through the hemisphere
- Noise Mask can be used but Excel file size grows from 5MB level to 8M+
- Low angle man-made noise likely dominates
- 0 to 2 degrees elevation gain is small, attenuates the low angle noise, lowers importance
- Low angle emphasizing noise mask algorithm prototyping showed less than 1 dB difference
- Noise Margin algorithm can be improved

Noise Level

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna



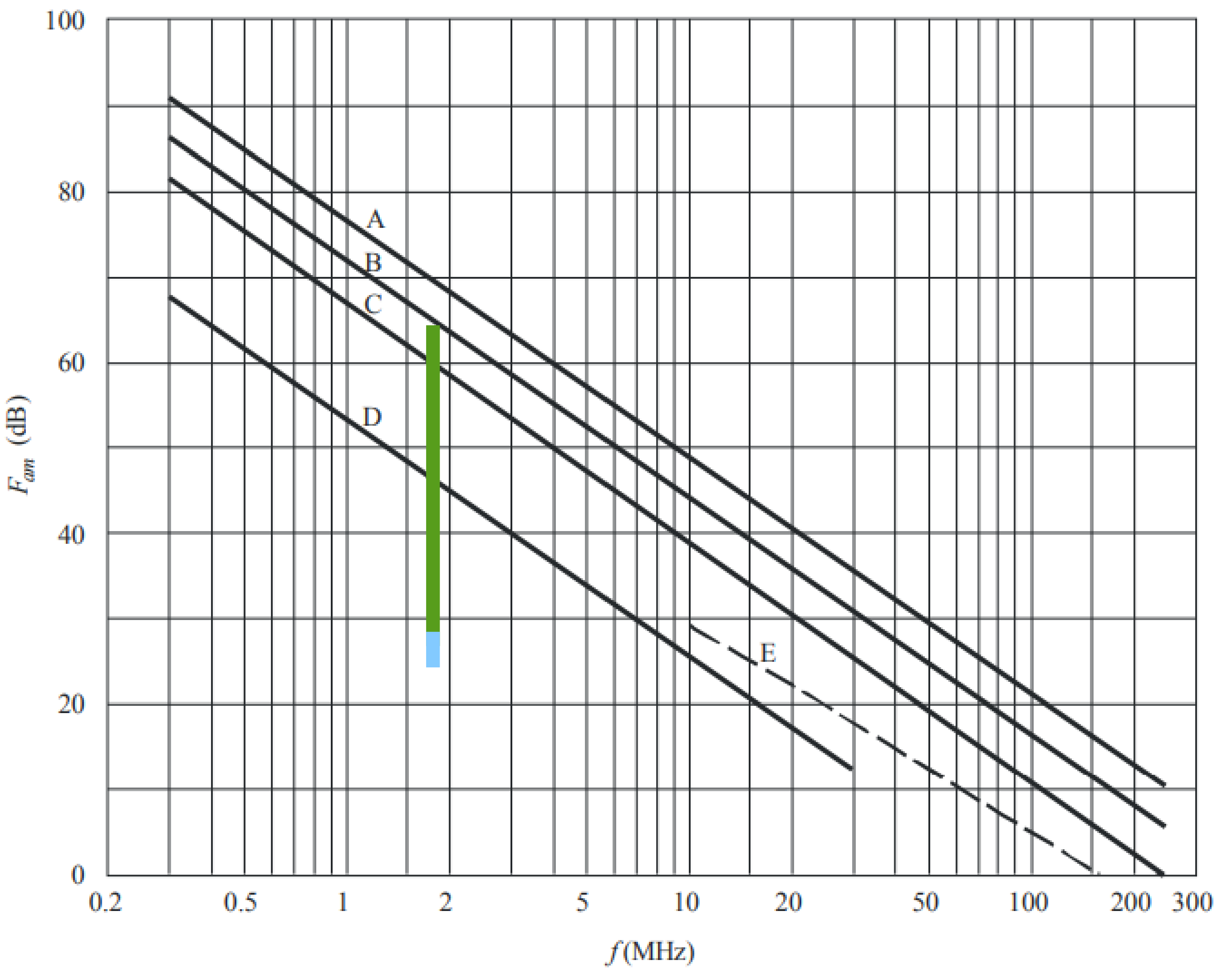
Calculate in dB:

Noise Level
+ Antenna Gaverage

Noise Level at Connector

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna

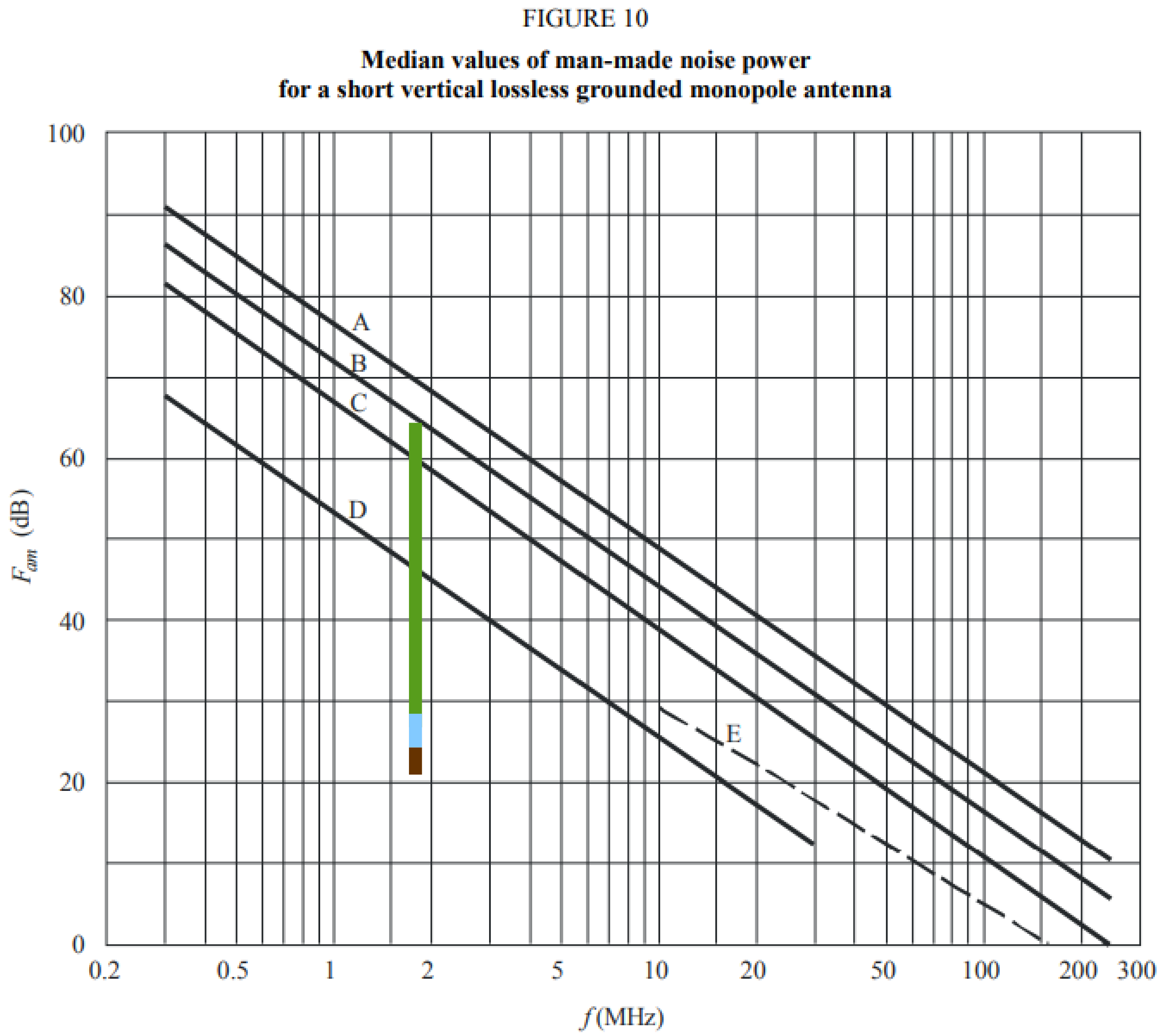


Calculate in dB:

Noise Level
\+ Antenna Gaverage
\- Feed System Losses

= Noise Level at antenna system output connector at Main Lobe Gmax

Noise Level at -3dB points



Calculate in dB:

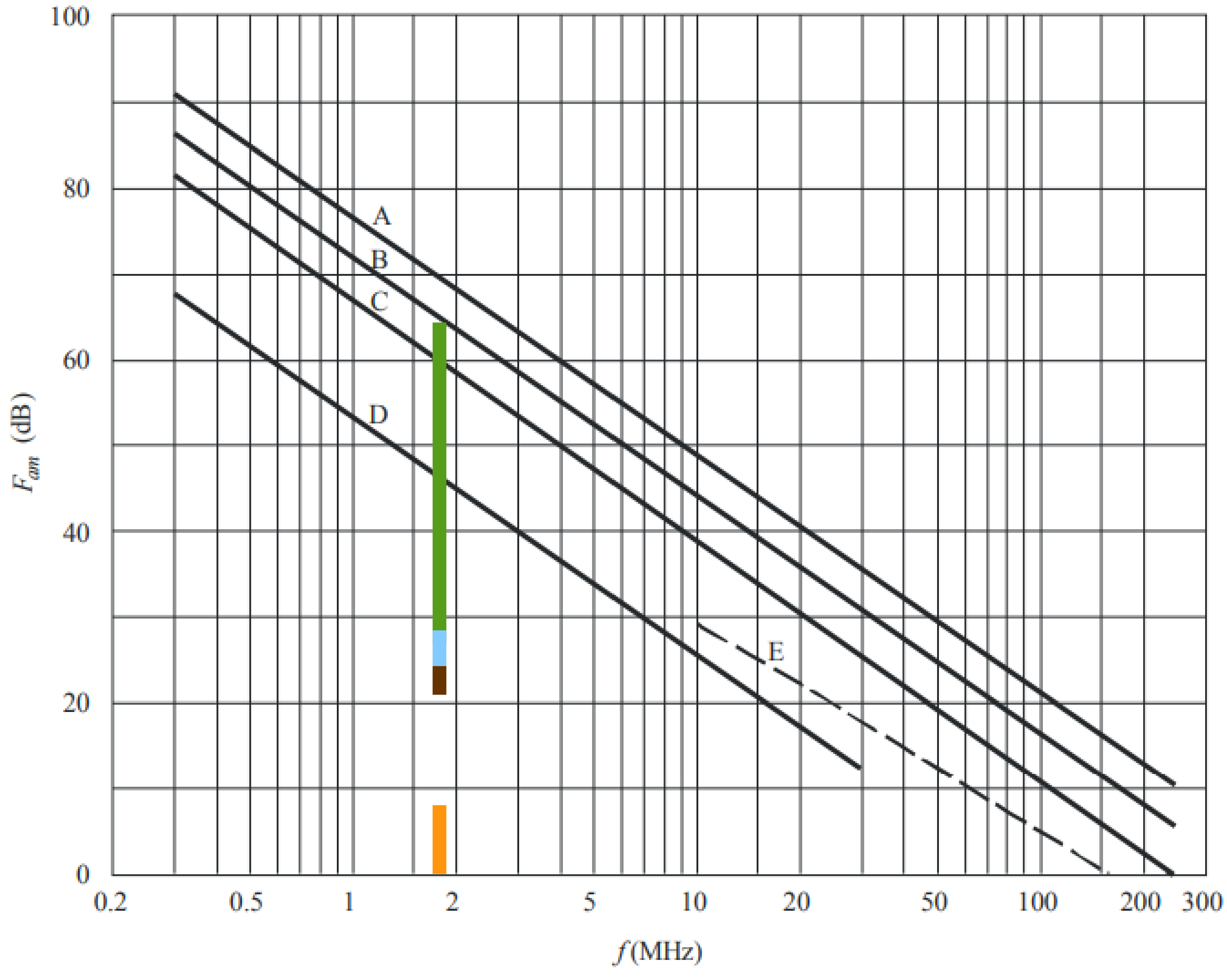
Noise Level
+ Antenna Gaverage
- Feed System Losses
- 3 dB

= Noise Level at antenna system output connector at Main Lobe – 3 dB points

Receiver Noise Figure

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna



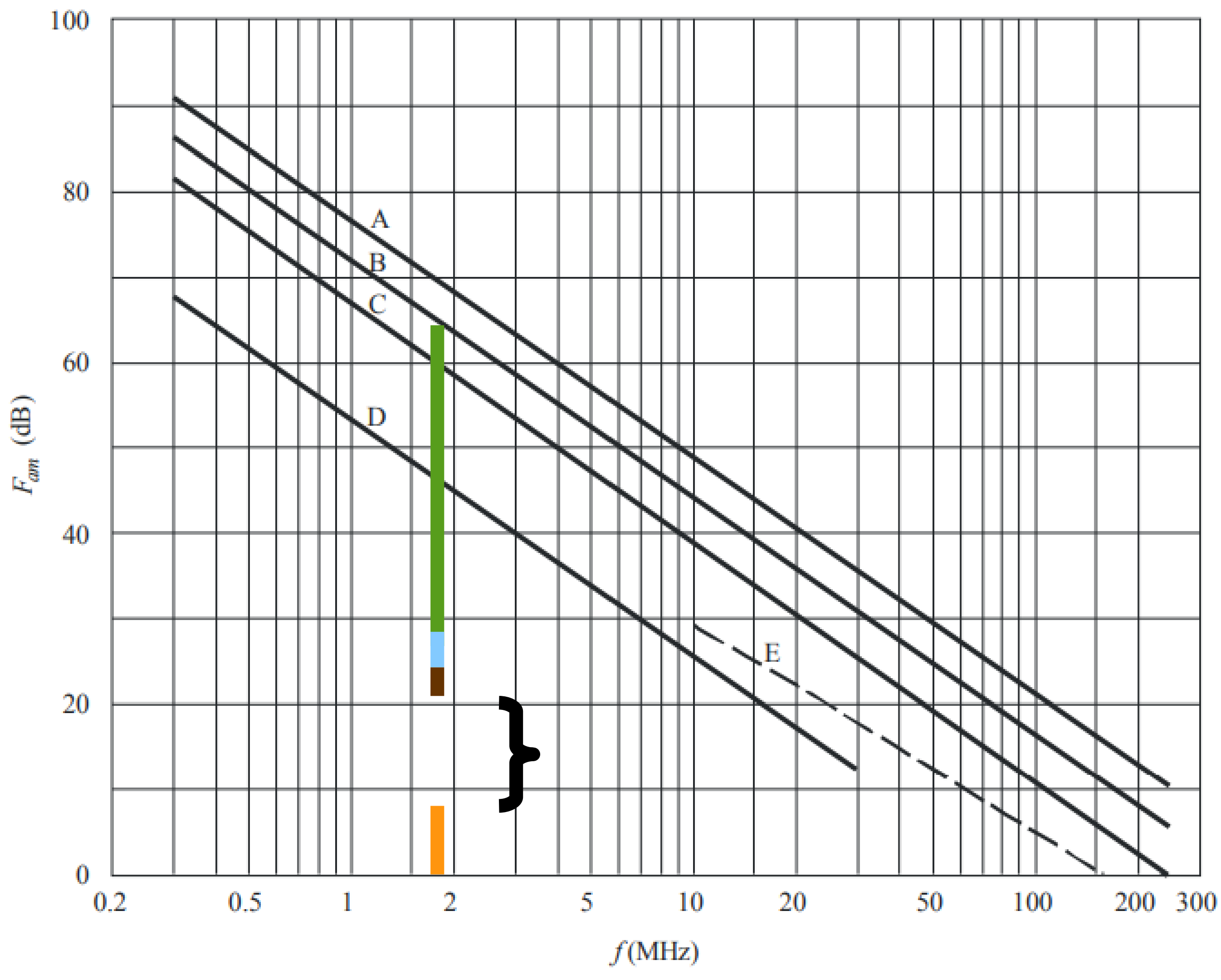
RX Noise Figure

Receiver Noise Figure stands on the bottom, limiting the receiving system sensitivity

Noise Margin

FIGURE 10

Median values of man-made noise power for a short vertical lossless grounded monopole antenna

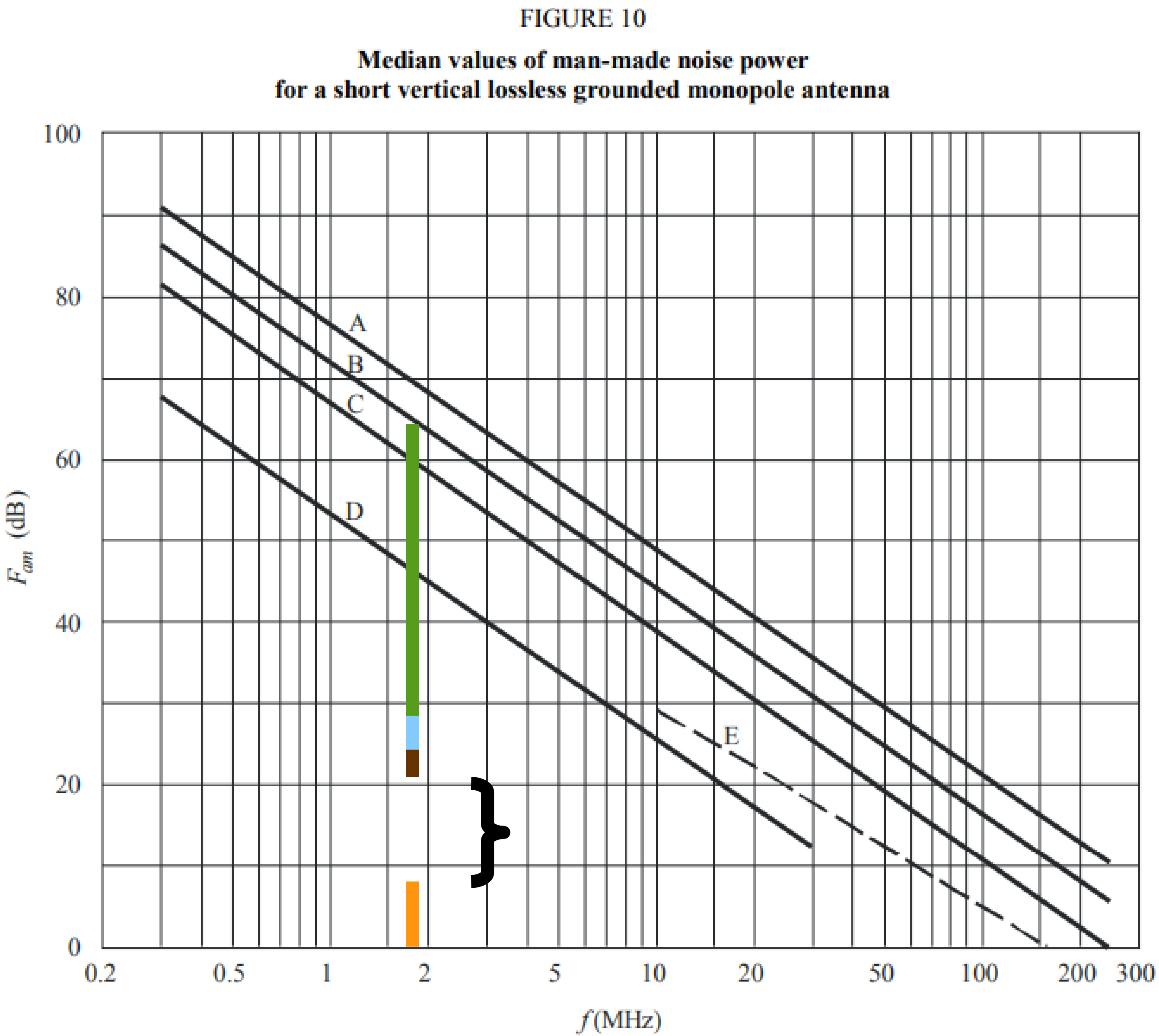


Calculate in dB:

Noise Level
+ Antenna Gaverage
- Feed System Losses
- 3 dB
- RX Noise Figure

= **Noise Margin**

Noise Margin



Calculate in dB:

Noise Level
\+ Antenna Gaverage
\- Feed System Losses
\- 3 dB
\- RX Noise Figure

= **Noise Margin**

Noise Margin gives room for Noise Level changes

Noise Margin in RX Ant Metrics

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

RX Ant Metrics v16.xlsm

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **0,5 dB** above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-13-

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

38 dB on 80 at a quiet rural site, minimum noise level expected

56 dB on 80 at a residential site, median value

The distribution around the median value curves is described in Radio Noise document Table 2

The Noise Margin should be several dB to achieve good antenna system performance in all conditions

Noise Margin in RX Ant Metrics

21	RX Noise Figure is typically 3 to 5 dB. Specific preamplifiers may have smaller numbers
22	Feed System Losses is all losses from all transformers, cables, possible relays and
23	filtering before radio or preamplifier
24	
25	-3 dB comes from requirement to receive Main Lobe's Gmax - 3 dB points

Avg Gain RDF DMF | **Noise Margin** | Leaking Index | Summary of Metrics

Leaking Index

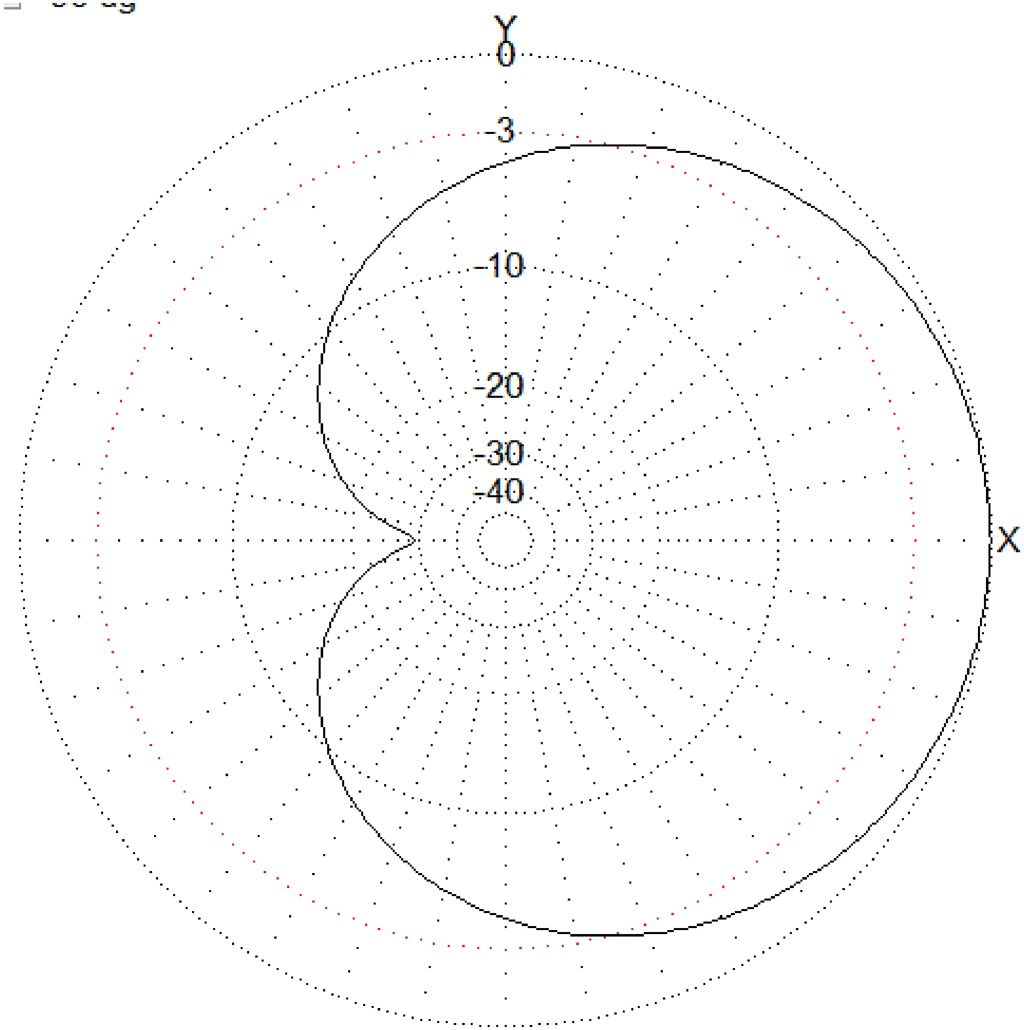
Leaking Index

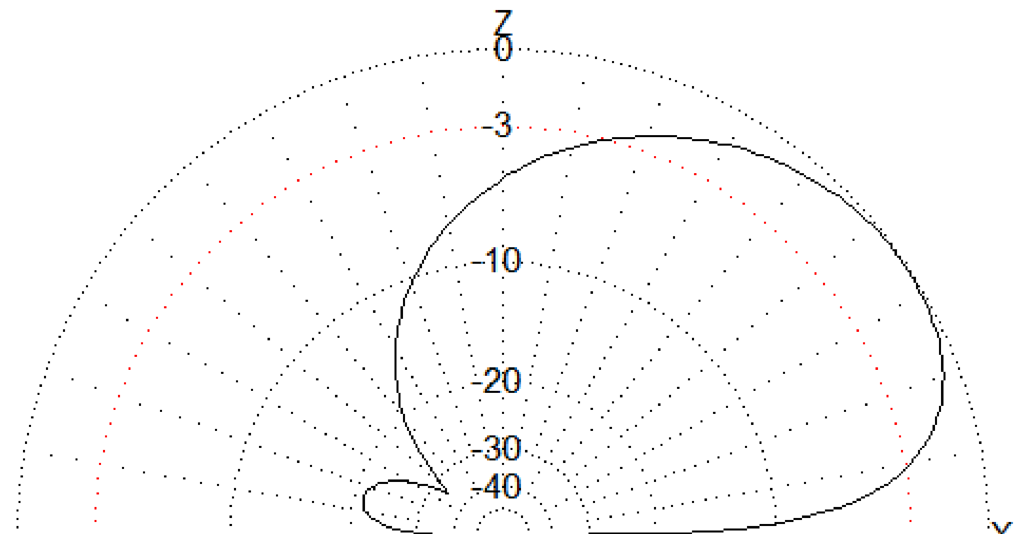
- Leaking Index tells how much the antenna pattern leaks to unwanted directions

Leaking Index

- Leaking Index tells how much the antenna pattern leaks to unwanted directions
  - Default 80 to 280 degrees Azimuth
- The antenna is better when
  - Smaller proportion of pattern leaks
  - Any leaking is attenuated more
- The percentage of leaking is calculated at three levels; G_{max} -12 dB, -18 dB and -24 dB.
- Leaking Index is the average percentage of leaking at these three levels

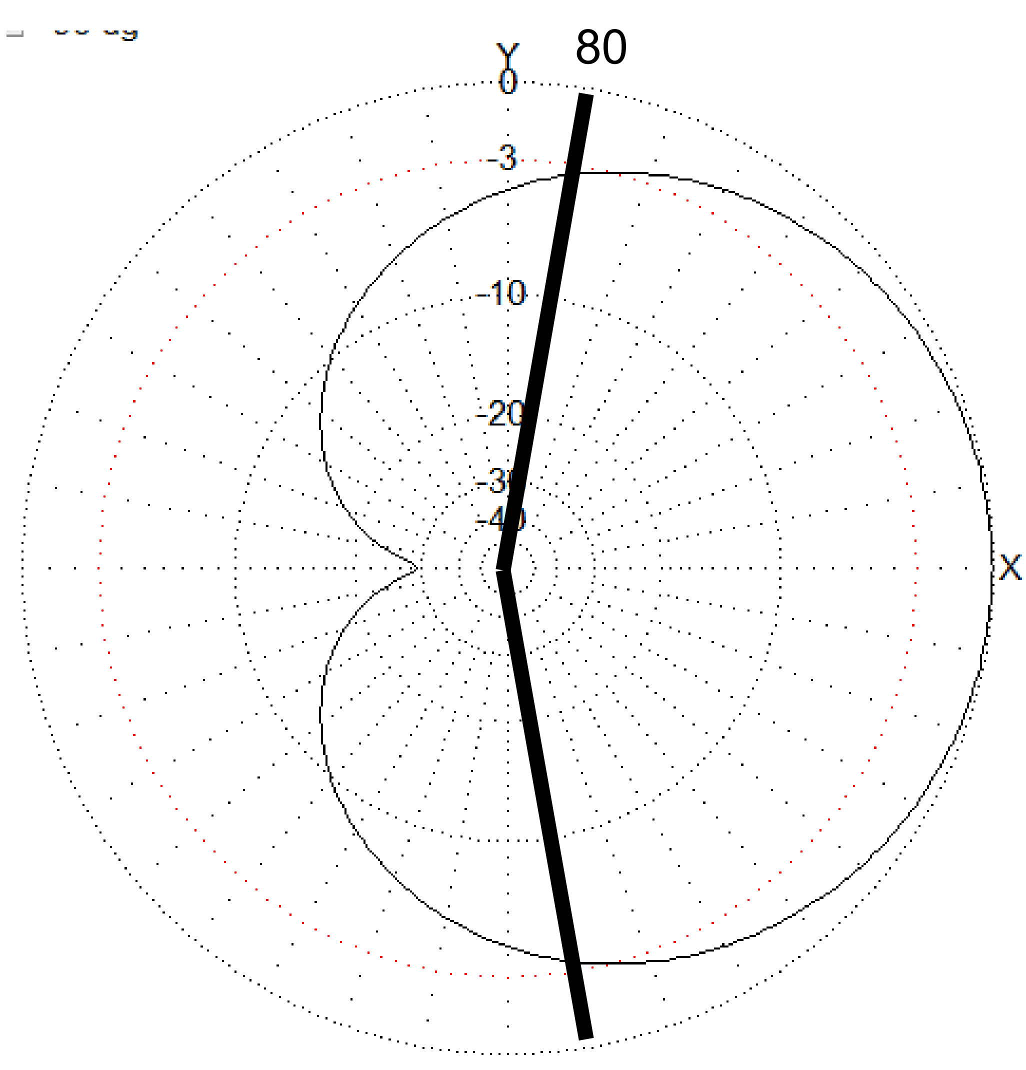
Leaking Index

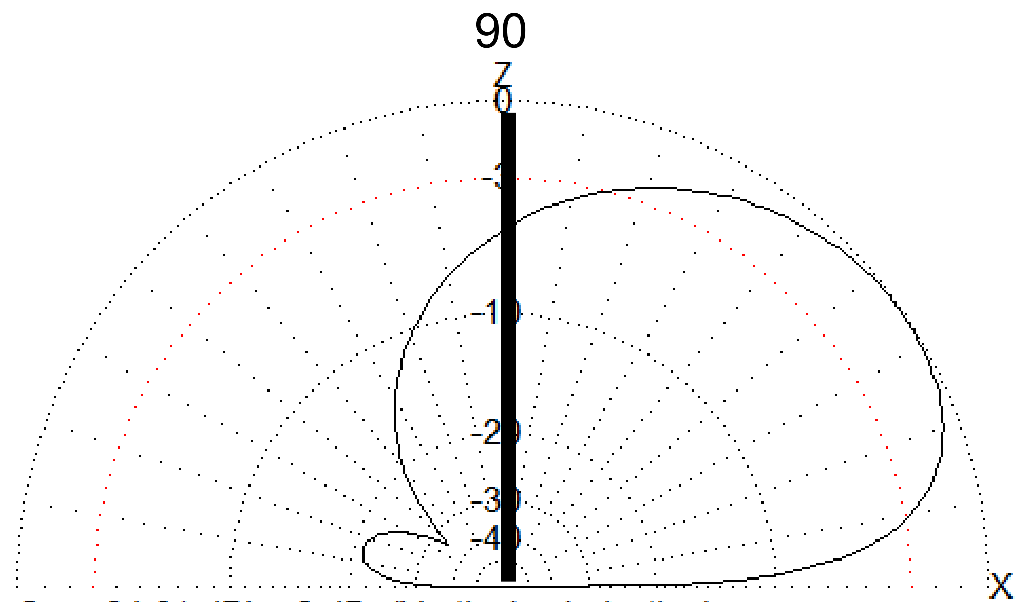




Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

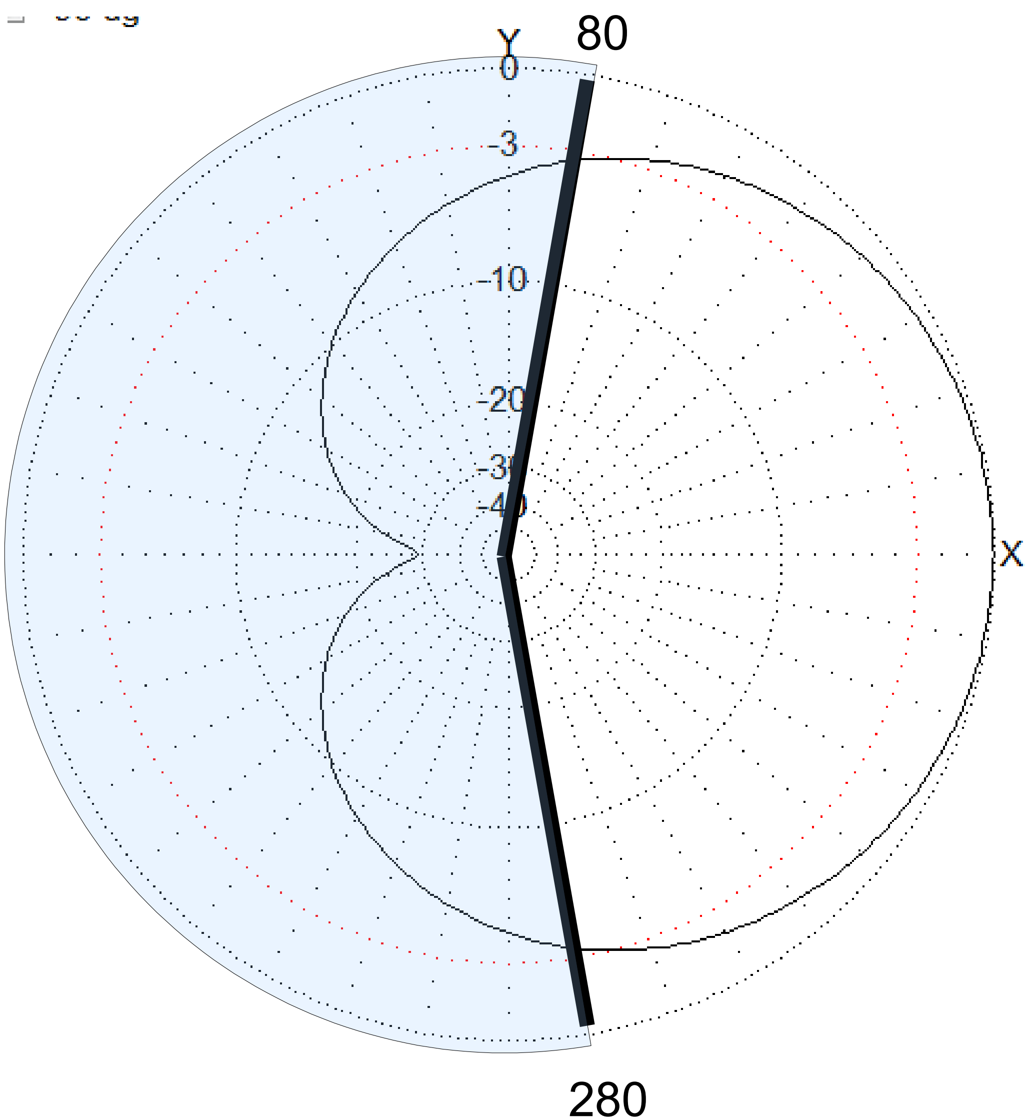
Leaking Index

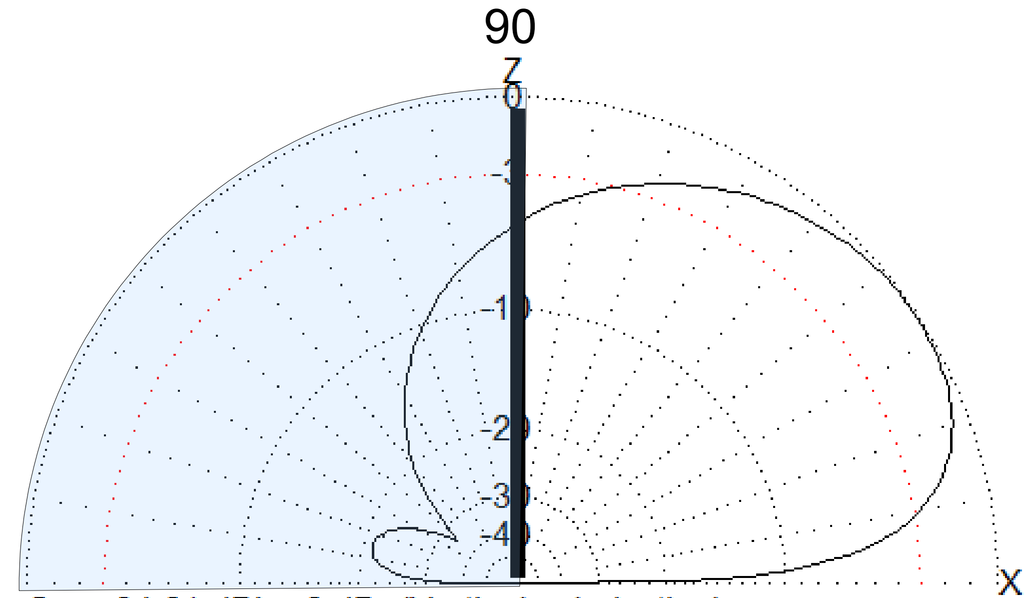




Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

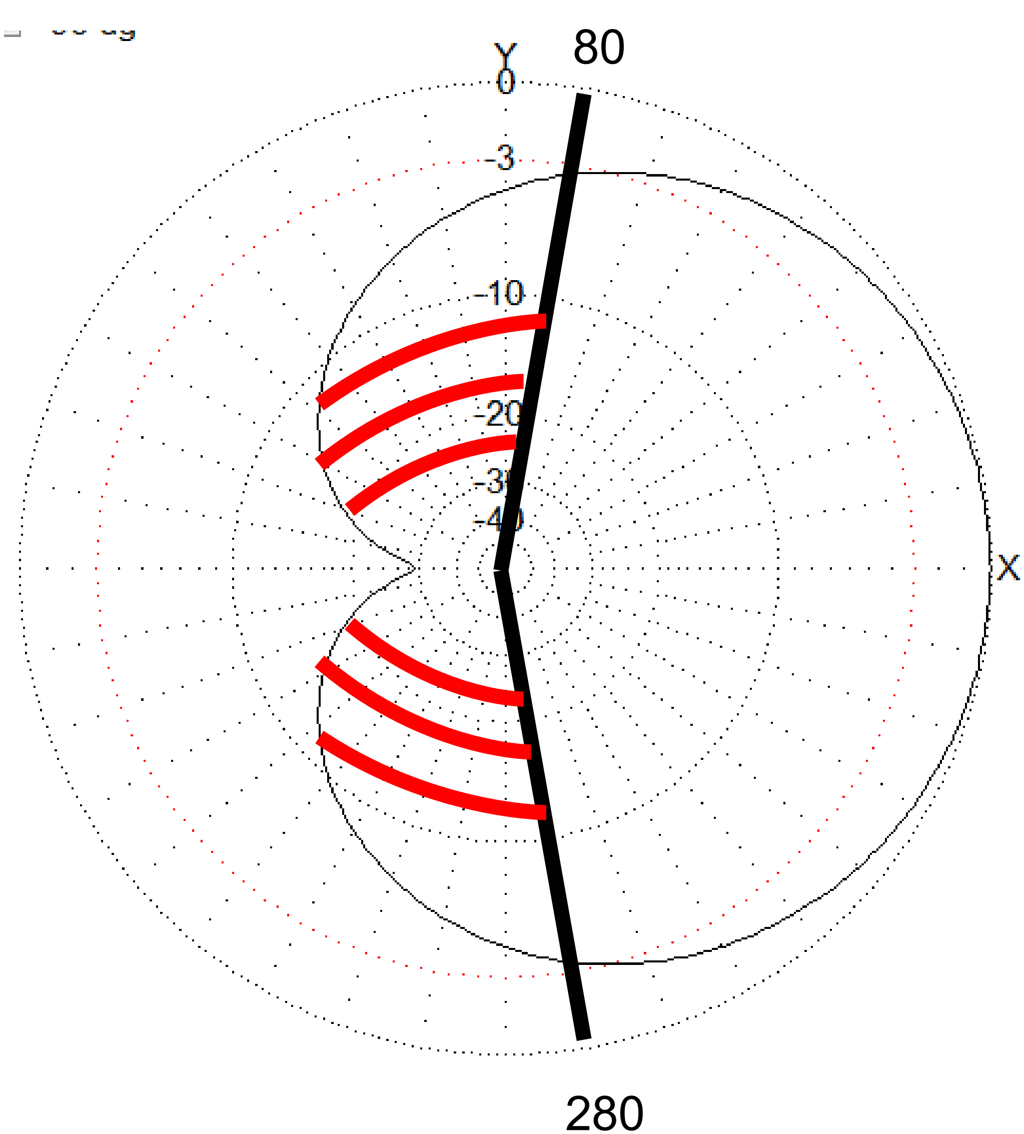
Leaking Index

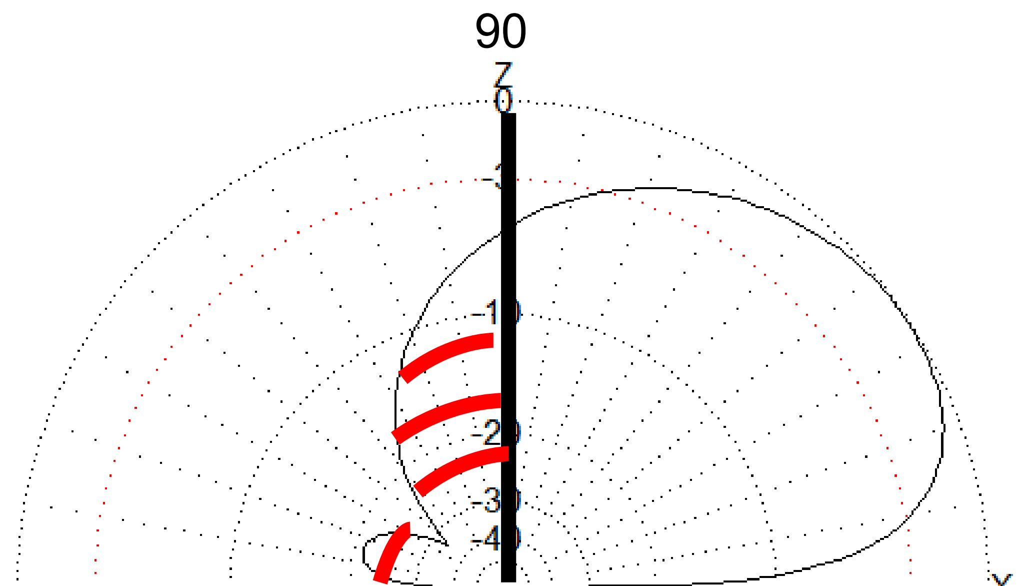




Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

Leaking Index

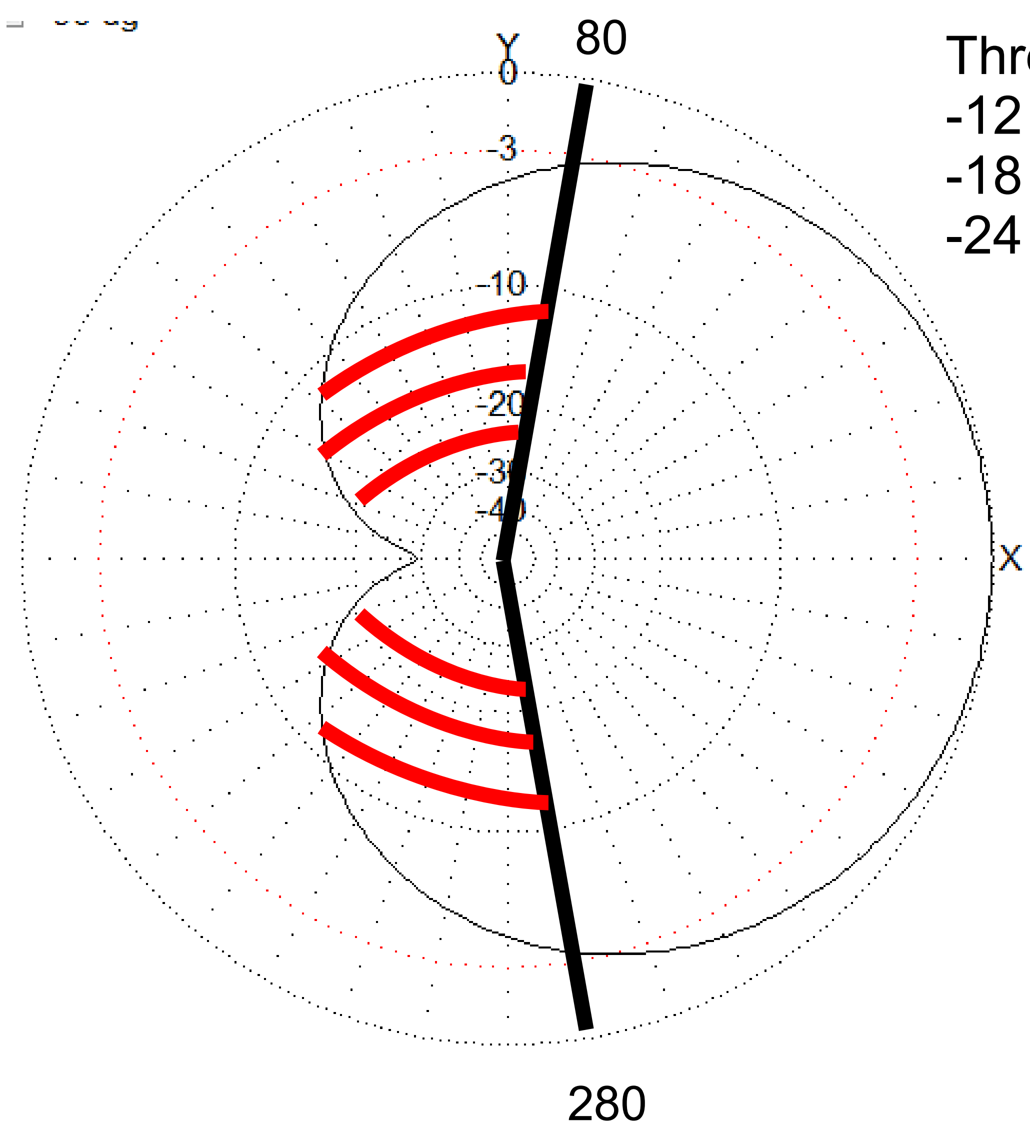




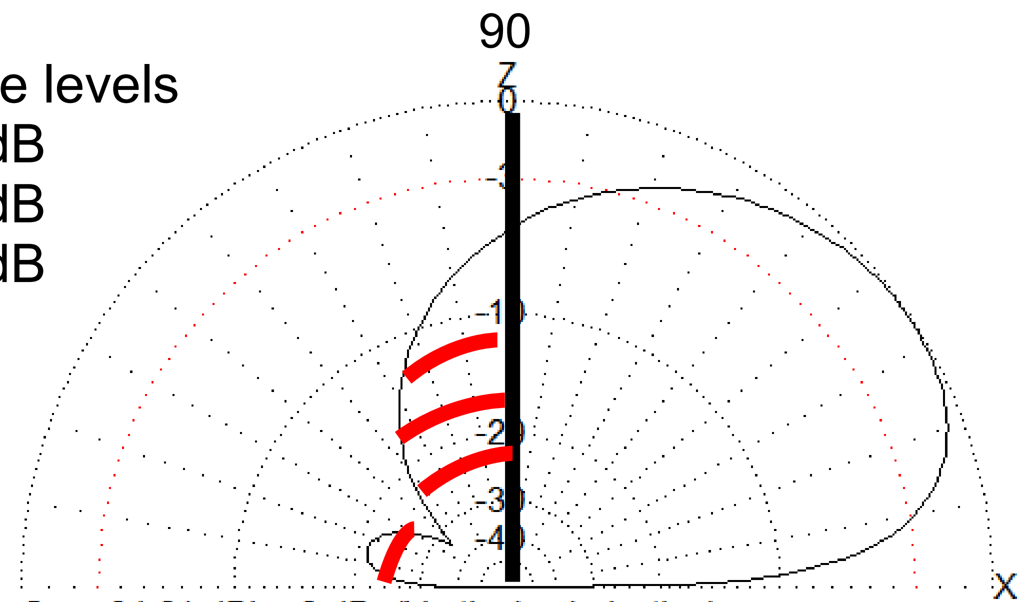
Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Leaking Index



Three levels
-12 dB
-18 dB
-24 dB



Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Leaking Index in RX Ant Metrics

RX Ant Metrics v16.xlsm

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

Result:

dB below Max Gain	3 level analysis
12	57,2%
18	78,3%
24	92,6%
Leaking Index	**76,0 %**

--- Notes ---

Leaking Index tells how much the antenna pattern leaks to unwanted directions

User can set the azimuth range, default is 80 to 280 degrees

Zenith range is fixed 0 to 90 degrees

The antenna is better when

-smaller proportion of pattern leaks

-any leaking is attenuated more

Leaking Index in RX Ant Metrics

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

19	The percentage of leaking is calculated at three levels; Gmax -12 dB, -18 dB and -24 dB
20	Leaking index is the average percentage of leaking at these three levels
21	
22	The user can set the azimuth range un-evenly to support asymmetrical antenna patterns,
23	such as for example phased systems may show
24	Maximum Gain direction must be roughly into direction Az=0 to produce correct results
25	Default values are 80 and 280 degrees.
26	
27	As a comparison, the DMF calculation uses fixed azimuth 90 to 270 degrees
28	

Avg Gain RDF DMF | Noise Margin | **Leaking Index** | Summary of Metrics

Leaking Index Bottom Line

- RDF and DMF are general averaging calculations
- Leaking Index brings up only the amount of leaking
- Leaking index calculates more than back half and is configurable for narrower Main Lobes
- Leaking Index can be the final decision making criteria where RDF and DMF provide unclear differentiation between antennas

Leaking Index Limitations

- Leaking index is currently limited to 0-90 elevation
- Forward looking high elevation angles are not counted in
- Leaking Index drives to improve the pattern to -24 dB level, not further
- Leaking Index algorithm can be improved

Examples

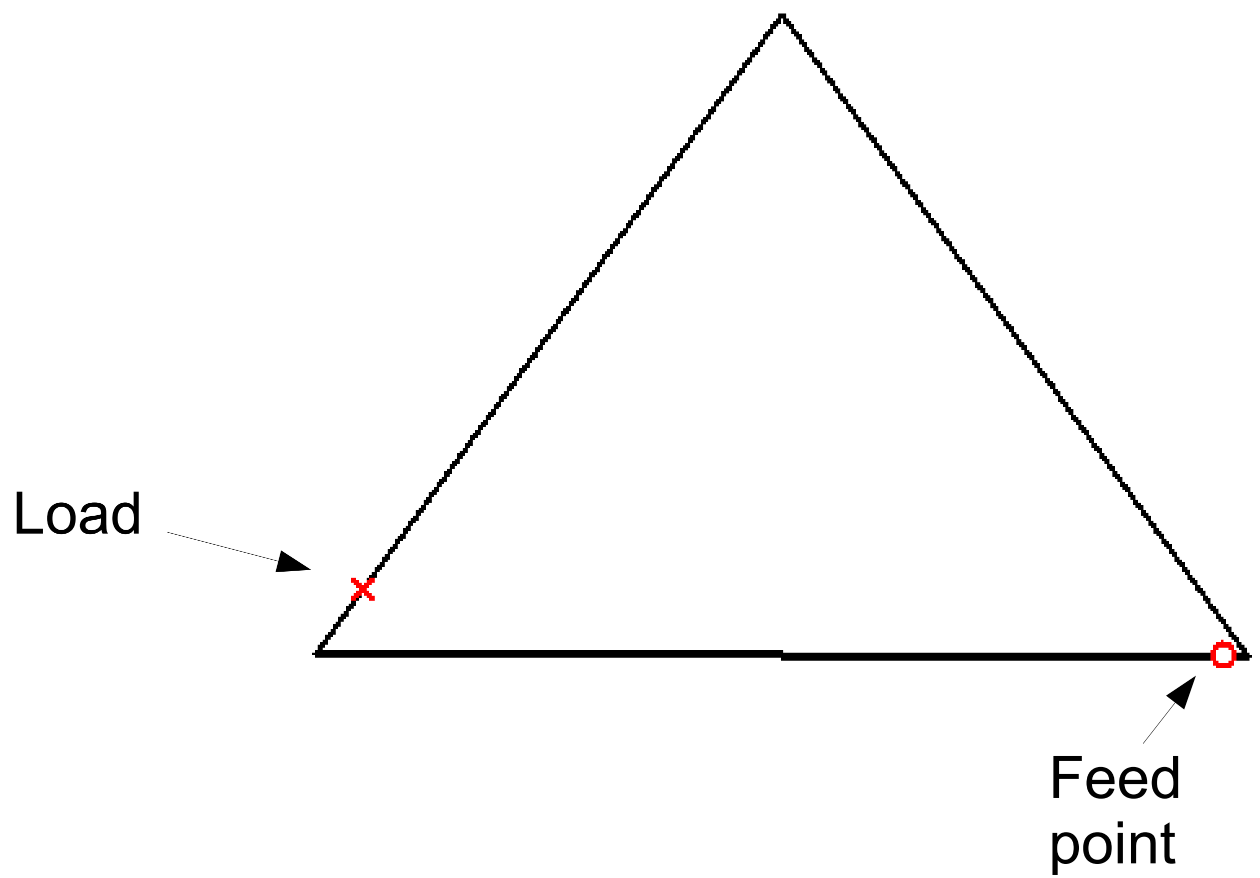
Examples

- Various antenna examples
- Also a new antenna concept

Examples

- FO0AAA triangle / delta
- Beverage
- Twin Triangle
- Linear Inline targetX Antenna - LIXA
- Staggered beverage
- Linear Inline Receiving Array - LIRA

Triangle Antenna

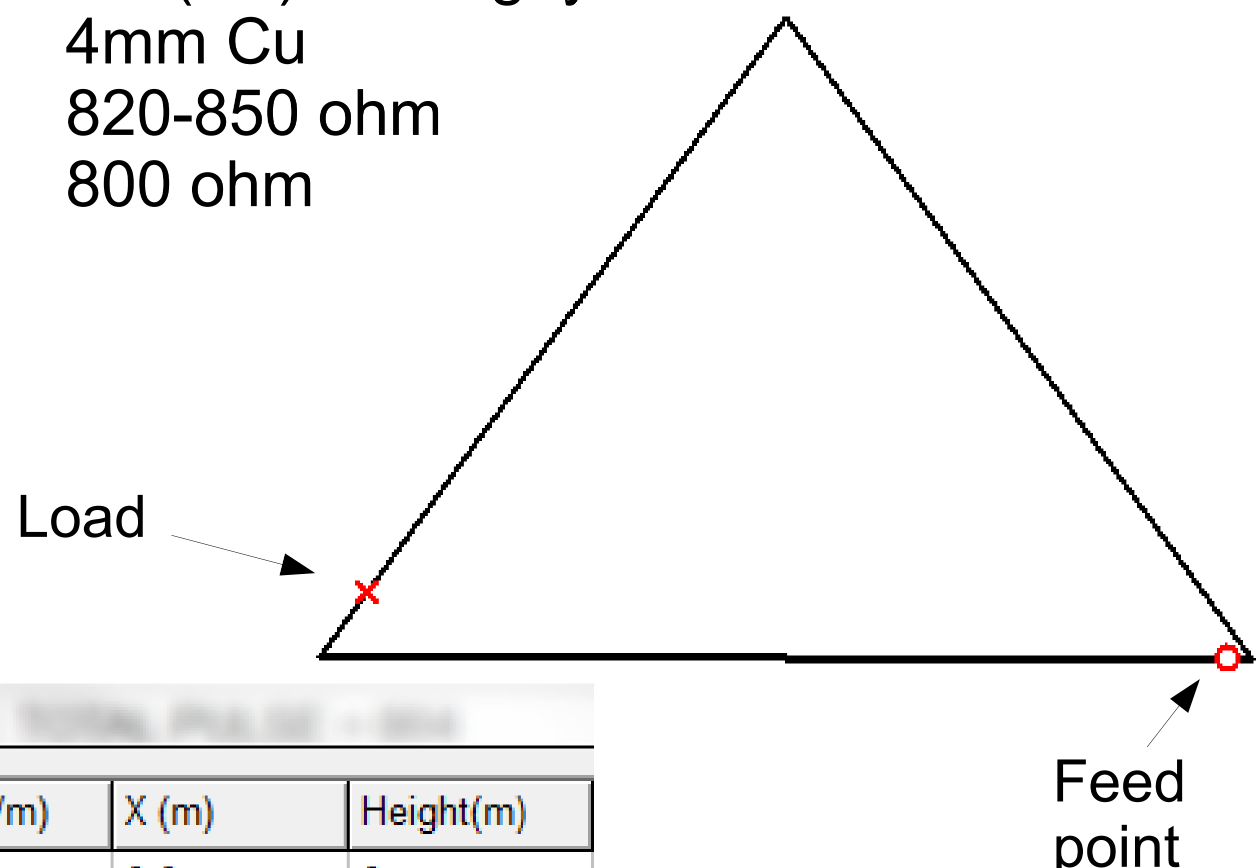


Idea from Earl K6SE

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Triangle Antenna

Triangle Height	5.5m (18'4“)
Bottom Wire Height	3m (10')
Bottom Wire Length	8m (26'6“)
Construction Width	3m (10') struts/guys
Wire	4mm Cu
Load	820-850 ohm
Feed	800 ohm



For all antennas

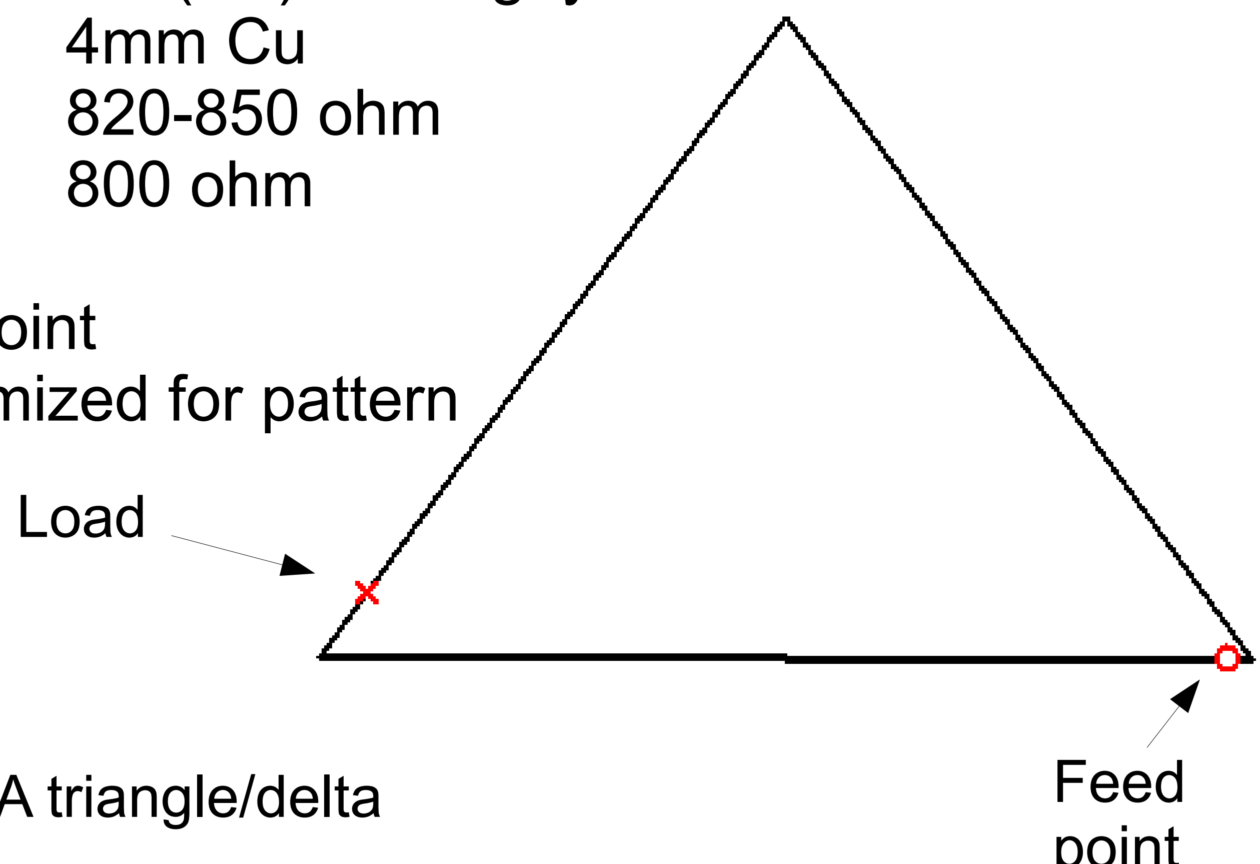
Real ground setup

No.	Dielec.	Conduct(mS/m)	X (m)	Height(m)
1	13.0	3.0	0.0	0

Triangle Antenna

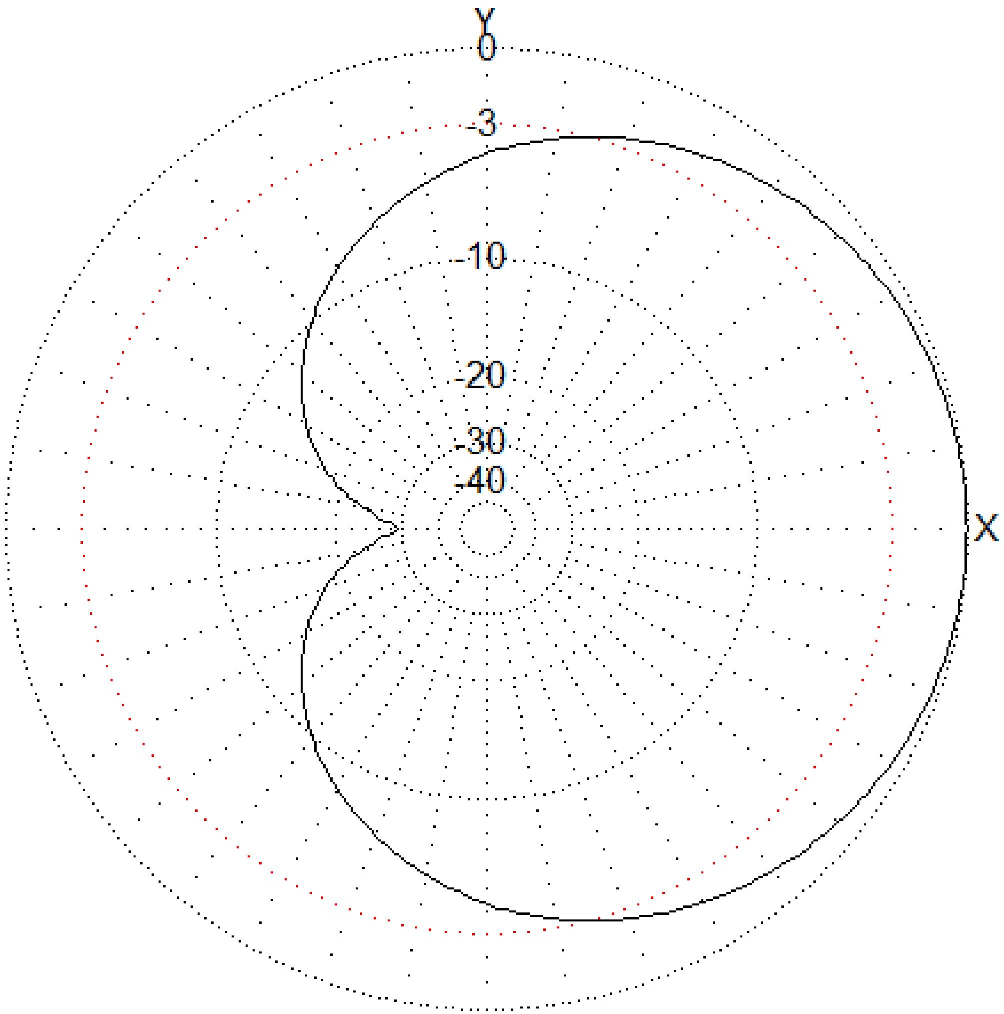
Triangle Height	5.5m (18'4“)
Bottom Wire Height	3m (10')
Bottom Wire Length	8m (26'6“)
Construction Width	3m (10') struts/guys
Wire	4mm Cu
Load	820-850 ohm
Feed	800 ohm

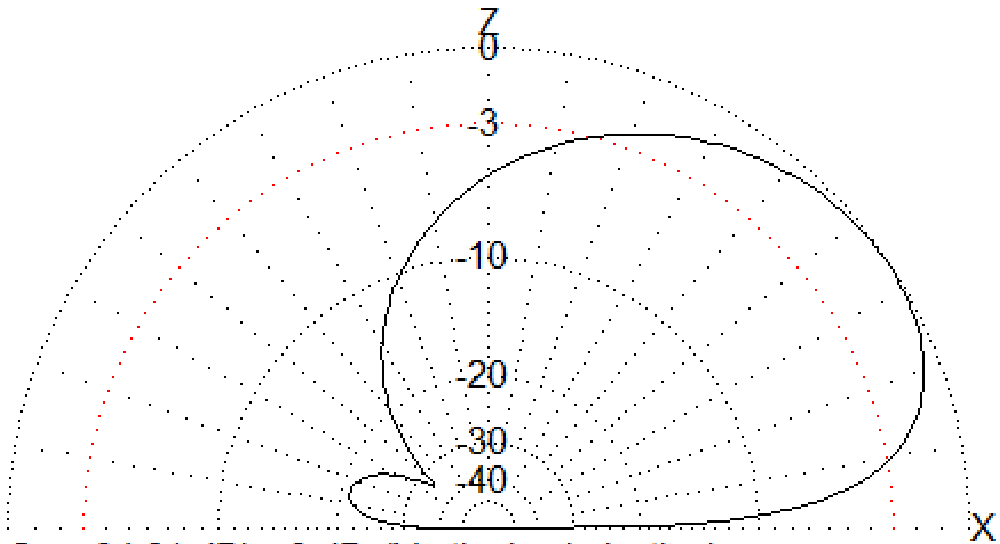
Easy to install feed point
Load placement optimized for pattern



Almost like FO0AAA triangle/delta
by Earl K6SE

Triangle Metrics

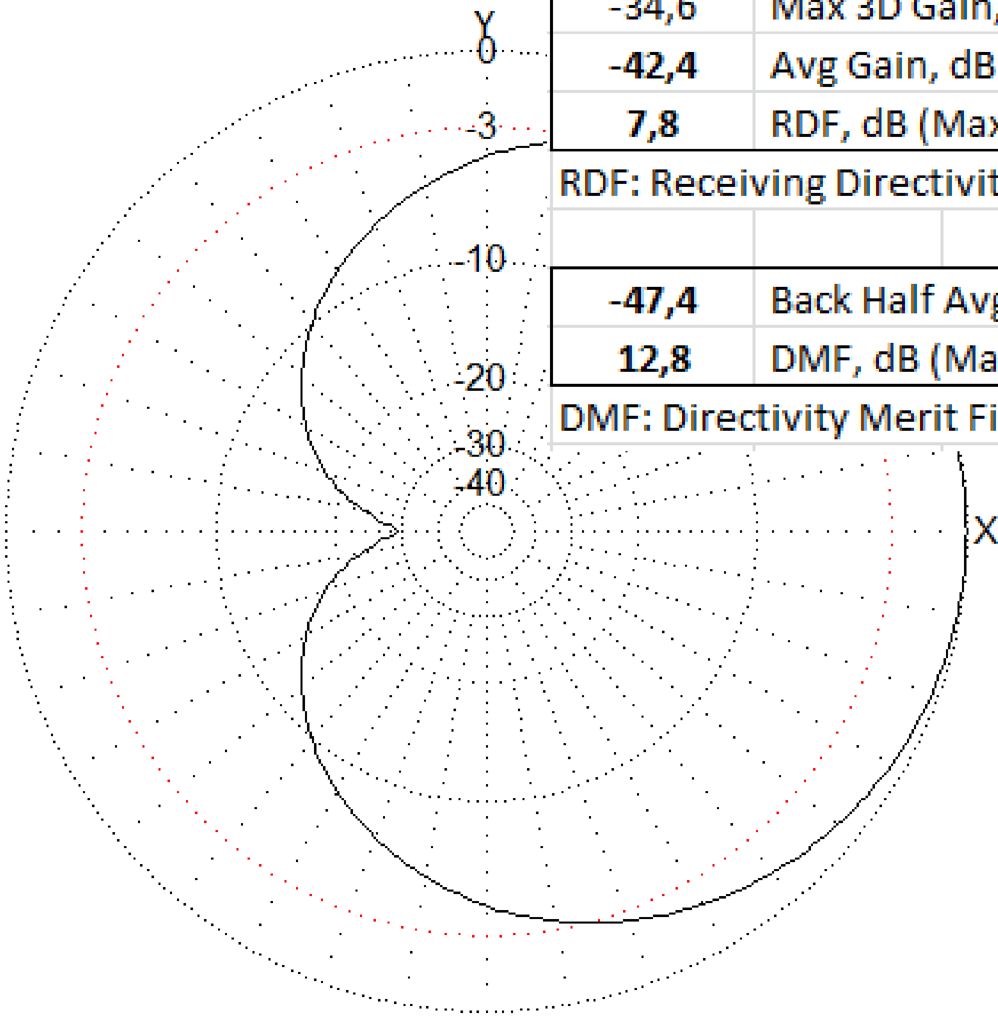


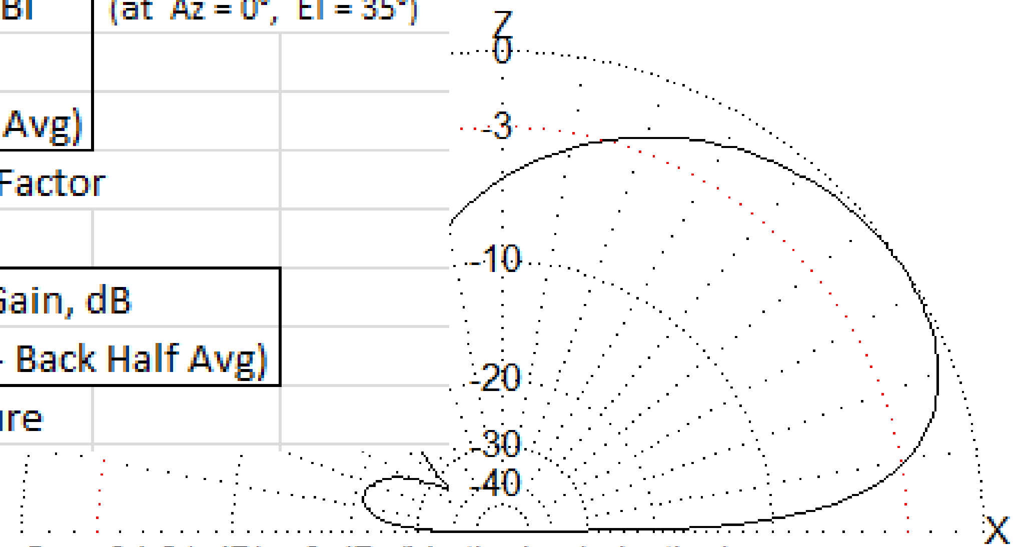


Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

Triangle RDF, DMF

01 Triangle v01.csv		
-34,6	Max 3D Gain, dBi	(at Az = 0°, El = 35°)
-42,4	Avg Gain, dB	
7,8	RDF, dB (Max - Avg)	
RDF: Receiving Directivity Factor		
-47,4	Back Half Avg Gain, dB	
12,8	DMF, dB (Max - Back Half Avg)	
DMF: Directivity Merit Figure		





Ga : -34.61 dBi = 0 dB (Vertical polarization)
F/B: 20.90 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 833.471 - j9.556 Ohm
SWR: 1.0 (800.0 Ohm),
Elev: 33.3 deg (Real GND :0.00 m height)

Triangle Noise Margin

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin	**-5,4 dB**	above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-13

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

38 dB on 80 at a quiet rural site, minimum noise level expected

56 dB on 80 at a residential site, median value

The distribution around the median value curves is described in Radio Noise document Table 2

The Noise Margin should be several dB to achieve good antenna system performance in all conditions

ZERO RADIO CLUB **RADIATORS** AH0K OH0K OH4A OH0V

Triangle Noise Margin

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Quiet Rural QTH

Result:

Noise Margin	**-5,4 dB**	above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-13

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

38 dB on 80 at a quiet rural site, minimum noise level expected

56 dB on 80 at a residential site, median value

The distribution around the median value curves is described in Radio Noise document Table 2

The Noise Margin should be several dB to achieve good antenna system performance in all conditions

Triangle Noise Margin

Residential QTH

	User input	
Noise Level P.372-13	64	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **12,6 dB** above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-13

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

38 dB on 80 at a quiet rural site, minimum noise level expected

56 dB on 80 at a residential site, median value

The distribution around the median value curves is described in Radio Noise document Table 2

The Noise Margin should be several dB to achieve good antenna system performance in all conditions

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Triangle Noise Margin

	User input	
Noise Level P.372-13	64	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Residential QTH

Result:

Noise Margin	**12,6 dB**	above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-13

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

-5.4 dB to 12.6 dB difference comes from change to Residential from Quiet Rural

Triangle Noise Margin

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

	User input	
Noise Level P.372-13	64	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Residential QTH

Result:

Noise Margin **12,6 dB** above electronics noise

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFigure

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.372-13

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.372-13 Figure 2

64 dB on 160 at a residential receiving site, median value

-5,4 dB to 12,6 dB difference comes from change
to Residential from Quiet Rural
That equals receiving site Noise Level change from 46 dB to 64 dB

Triangle Leaking Index

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

Result:

dB below Max Gain	3 level analysis
12	56,9%
18	79,1%
24	94,0%
Leaking Index	**76,7 %**

--- Notes ---

Leaking Index tells how much the antenna pattern leaks to unwanted directions

User can set the azimuth range, default is 80 to 280 degrees

Zenith range is fixed 0 to 90 degrees

The antenna is better when

-smaller proportion of pattern leaks

-any leaking is attenuated more

The percentage of leaking is calculated at three levels; Gmax -12 dB, -18 dB and -24 dB

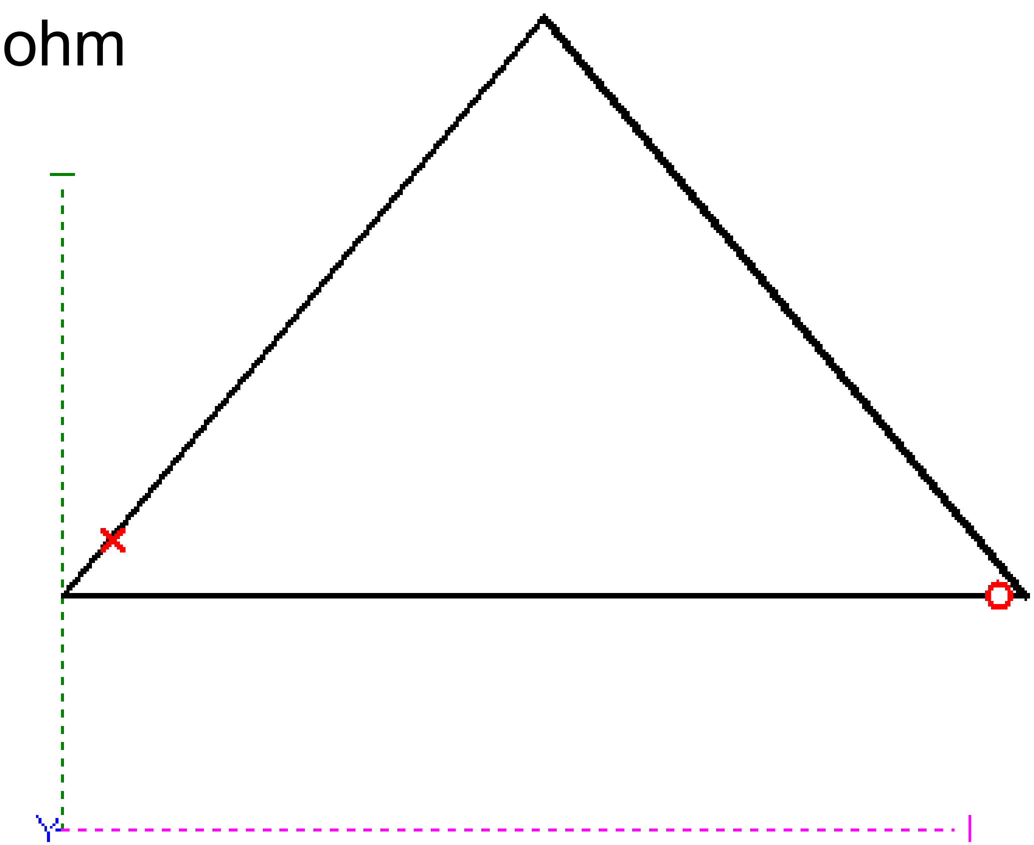
Leaking index is the average percentage of leaking at these three levels

Comparison

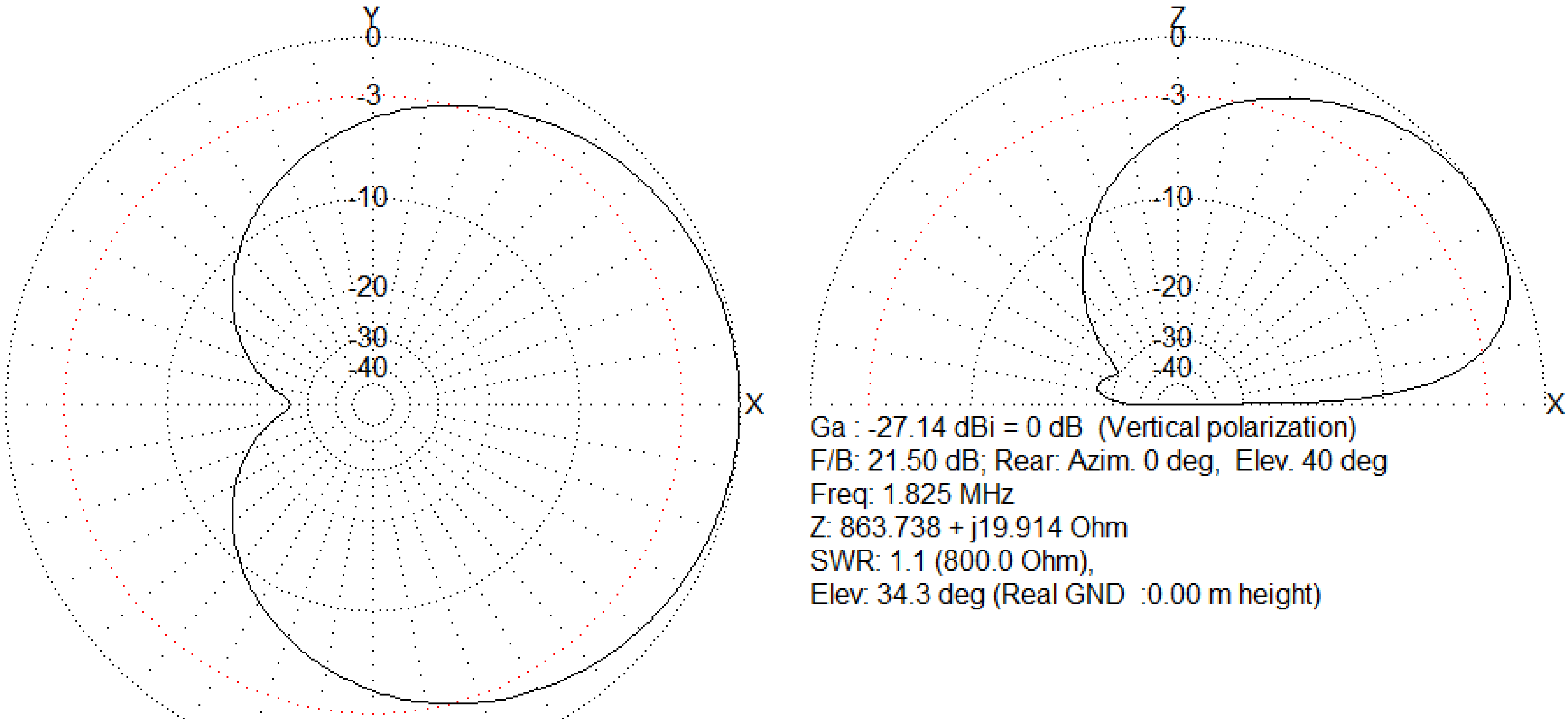
Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5

Bigger Triangle

Triangle Height	7.5m (25')
Bottom Wire Height	3m (10')
Bottom Wire Length	15m (50')
Construction Width	3m (10') struts/guys
Wire	4mm Al
Load	830-850 ohm
Feed	800 ohm



Bigger Triangle



Ga : -27.14 dBi = 0 dB (Vertical polarization)
F/B: 21.50 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 863.738 + j19.914 Ohm
SWR: 1.1 (800.0 Ohm),
Elev: 34.3 deg (Real GND :0.00 m height)

	User input			
Noise Level P.372-13	46	dB		
Feed System Losses	2	dB	Result:	
RX Noise Figure	4	dB	Noise Margin	**2,1 dB**

Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5

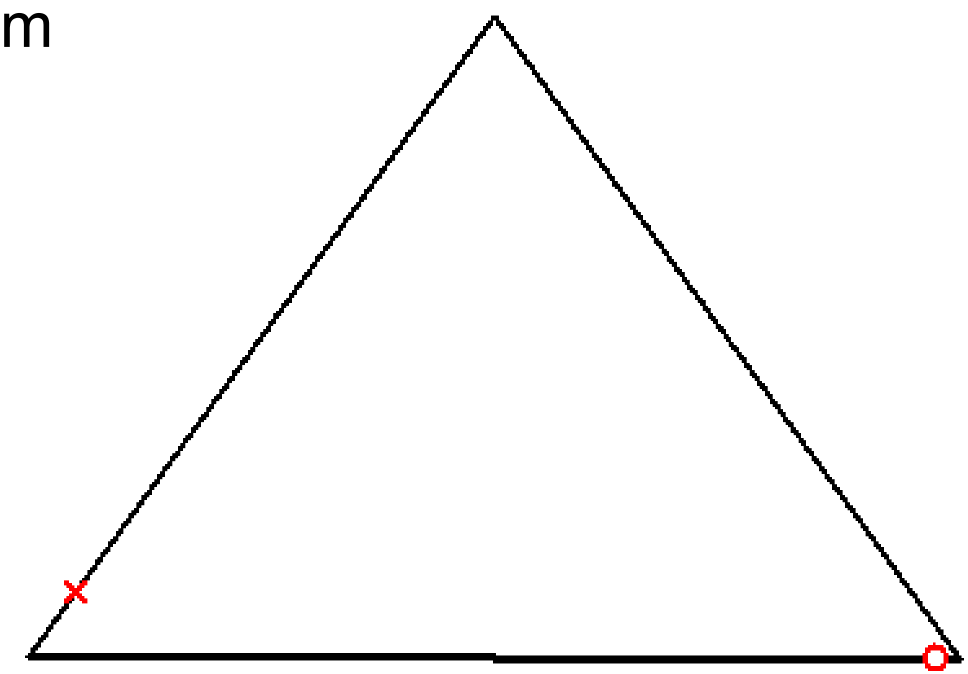
Noise Margin increased to 2.1 dB from -5,4 dB

2,1 dB is not a good enough Noise Margin for the absolute most quiet QTH

Smaller Triangle

RESIDENTIAL

Construction Height	6m (20')
Bottom Wire Height	3m (10')
Bottom Wire Length	5m (13'4“)
Construction Width	2m (8') struts/guys
Wire	4mm Al
Load	740-760 ohm
Feed	800 ohm



Smaller Triangle

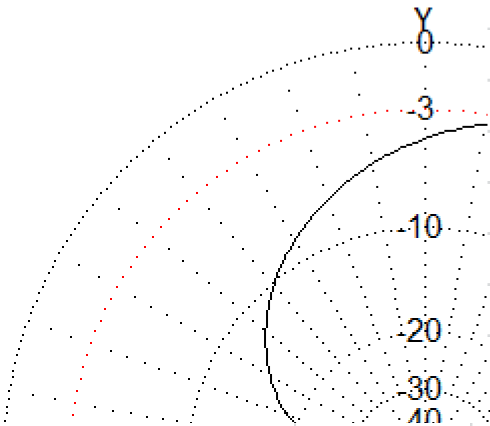
RESIDENTIAL

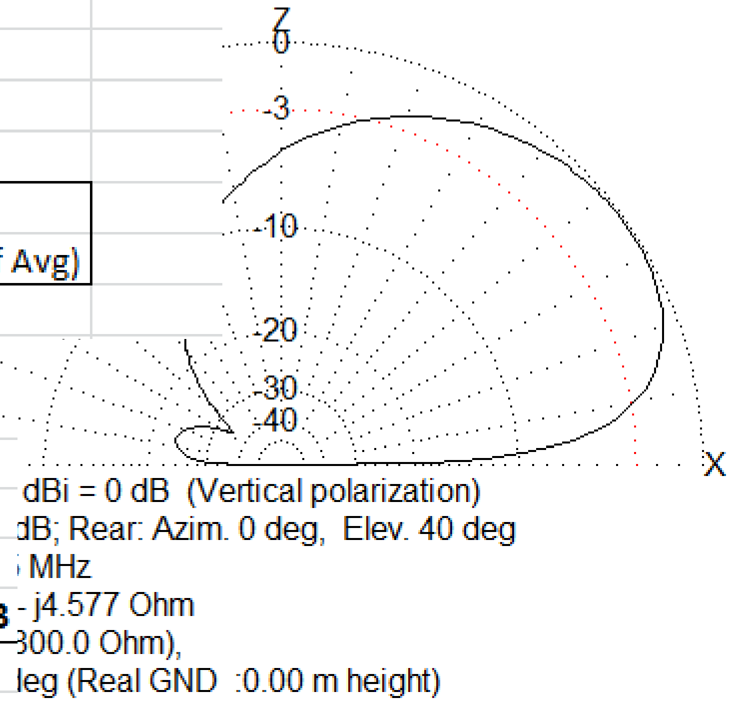
-43,7	Max 3D Gain, dBi	(at Az = 0°, El = 34°)
-51,6	Avg Gain, dB	
7,8	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-56,6	Back Half Avg Gain, dB
12,9	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





	User input	
Noise Level P.372-13	64	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **3,4 dB**

--- Notes ---

NoiseMargin = NoiseLevel + AverageGain -3 dB - FeedSystemLosses - NoiseFi

Receiving antenna gain is typically negative in dBi

AverageGain is "Avg Gain RDF DMF" sheet N20

Noise Level from Figure 10 of P.372-13 document: https://www.itu.int/dms

46 dB on 160 at a quiet rural receiving site, minimum noise level expected: P.

64 dB on 160 at a residential receiving site, median value

dB below Max Gain	3 level analysis
12	56,1%
18	77,4%
24	91,8%
Leaking Index	**75,1 %**

Comparison

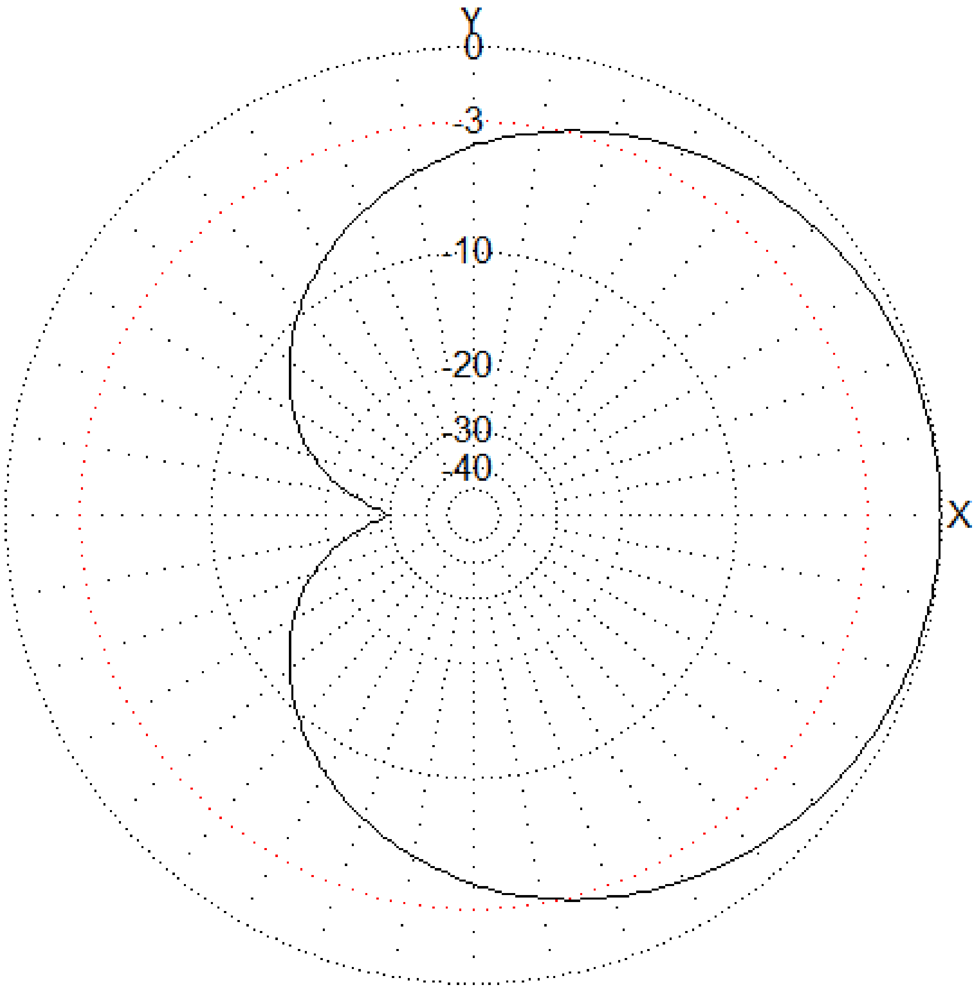
Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0

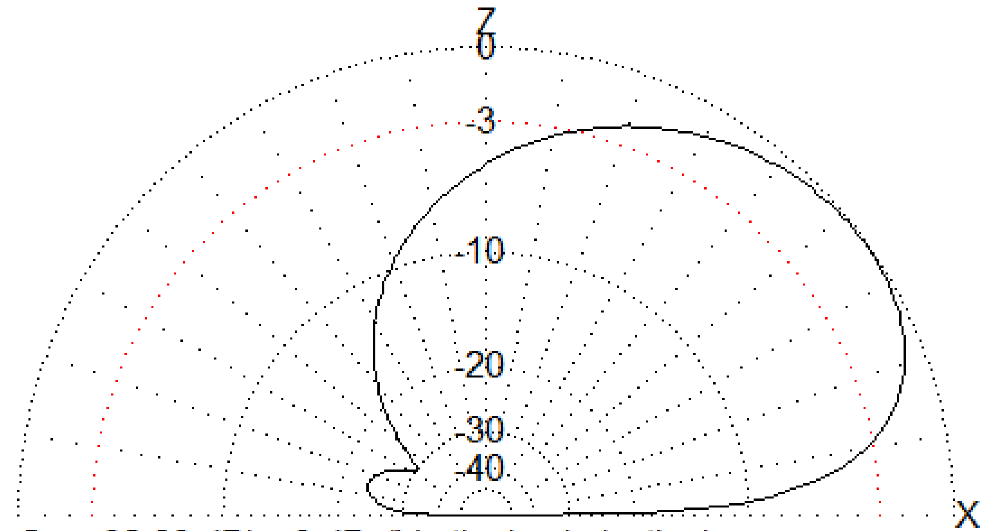
Noise Margin shows 3,4 dB at a Residential QTH

For a 5 meters long antenna, the result is surprising

Smaller Triangle 80m

RESIDENTIAL





Ga : -32.63 dBi = 0 dB (Vertical polarization)
F/B: 23.16 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 3.650 MHz
Z: 753.714 + j0.987 Ohm
SWR: 1.1 (800.0 Ohm),
Elev: 35.3 deg (Real GND :0.00 m height)

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Smaller Triangle 80m

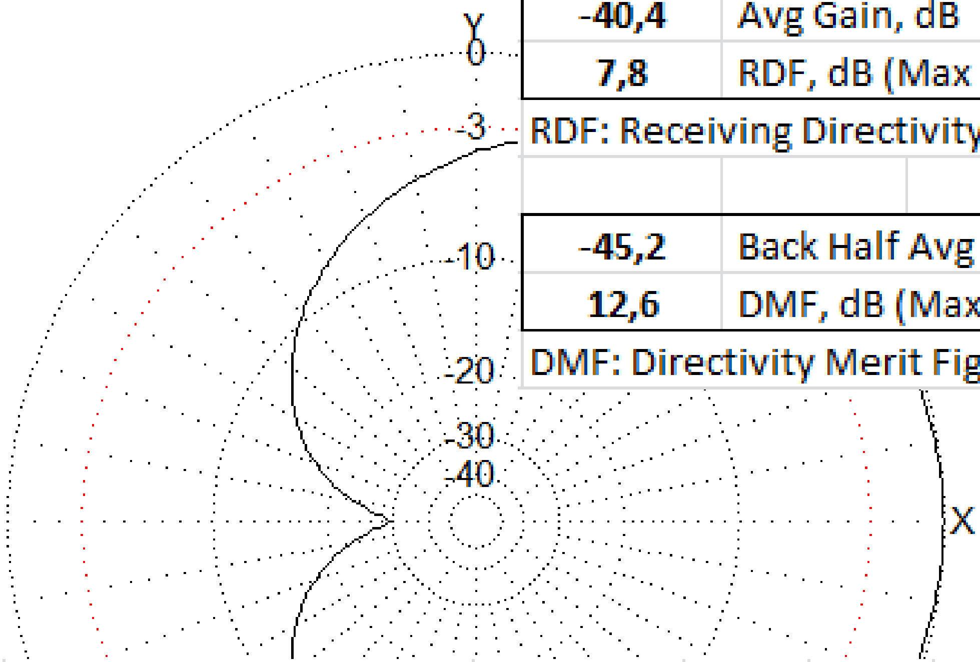
RESIDENTIAL

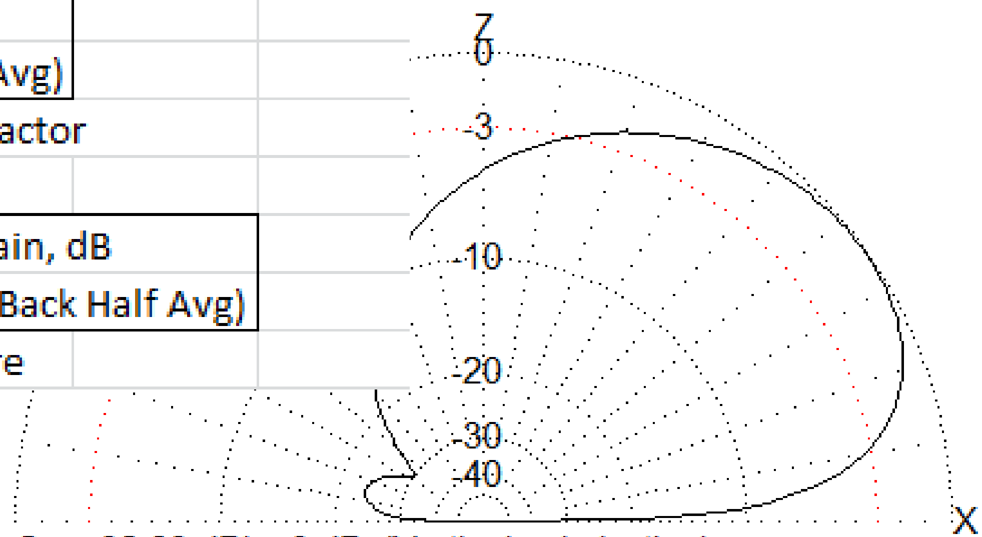
-32,6	Max 3D Gain, dBi	(at Az = 0°, El = 37°)
-40,4	Avg Gain, dB	
7,8	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-45,2	Back Half Avg Gain, dB
12,6	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -32.63 dBi = 0 dB (Vertical polarization)
F/B: 23.16 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 3.650 MHz

:0.00 m height)

	User input	
Noise Level P.372-13	56	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **6,6 dB**

dB below Max Gain	3 level analysis
12	57,4%
18	78,2%
24	92,3%
Leaking Index	**76,0 %**

38 dB on 80 at a quiet rural site, minimum noise level expected

56 dB on 80 at a residential site, median value

Comparison

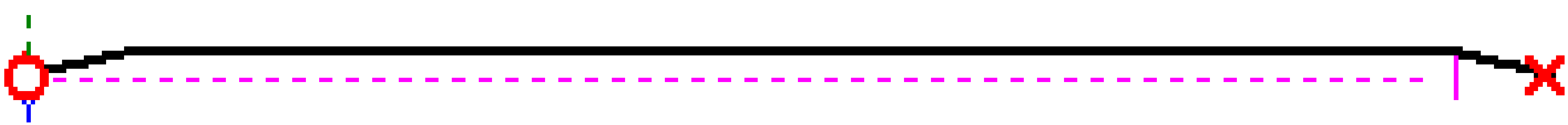
Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0

5 m long, 6m high Triangle antenna just about functions in a residential area QTH

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Beverage 170m

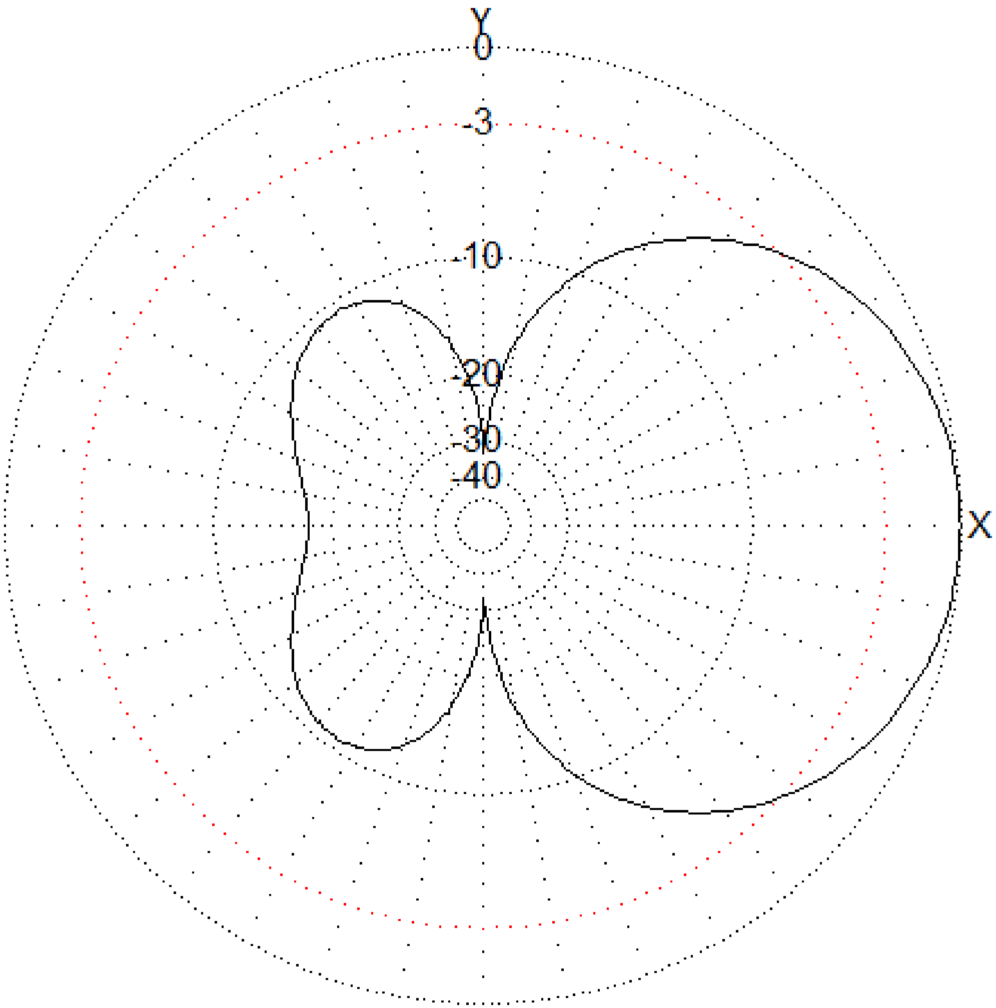
Total construction length 170m (558')
Wire height 3m (10')
Construction width 2m (6'7“) with struts
Loads 820-850 ohm
Feed 800 ohm (0 and 180 deg)

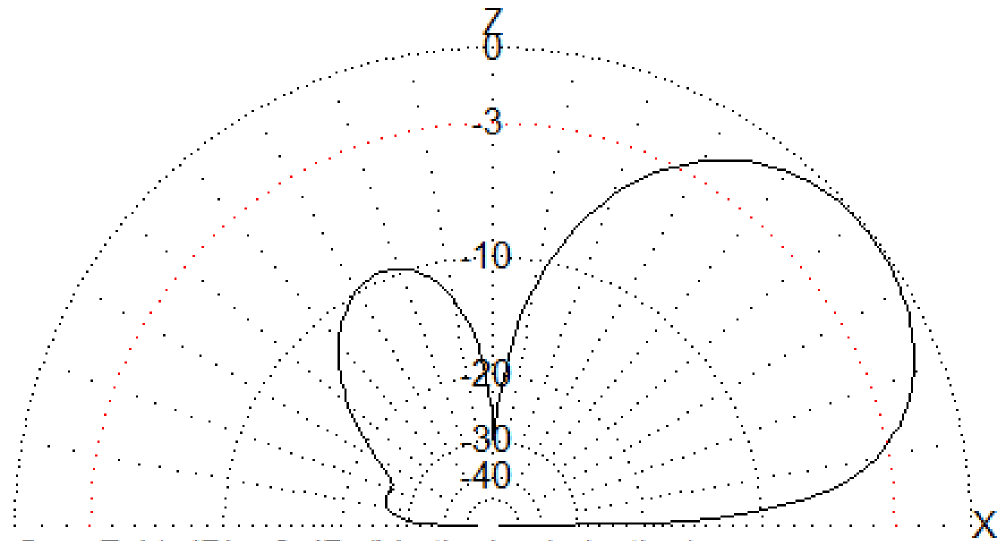


Feed 600 ohm

Load 450 ohm

Beverage 170m





Ga : -7.41 dBi = 0 dB (Vertical polarization)
F/B: 16.05 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 457.194 - j26.724 Ohm
SWR: 1.3 (600.0 Ohm),
Elev: 37.5 deg (Real GND :0.00 m height)

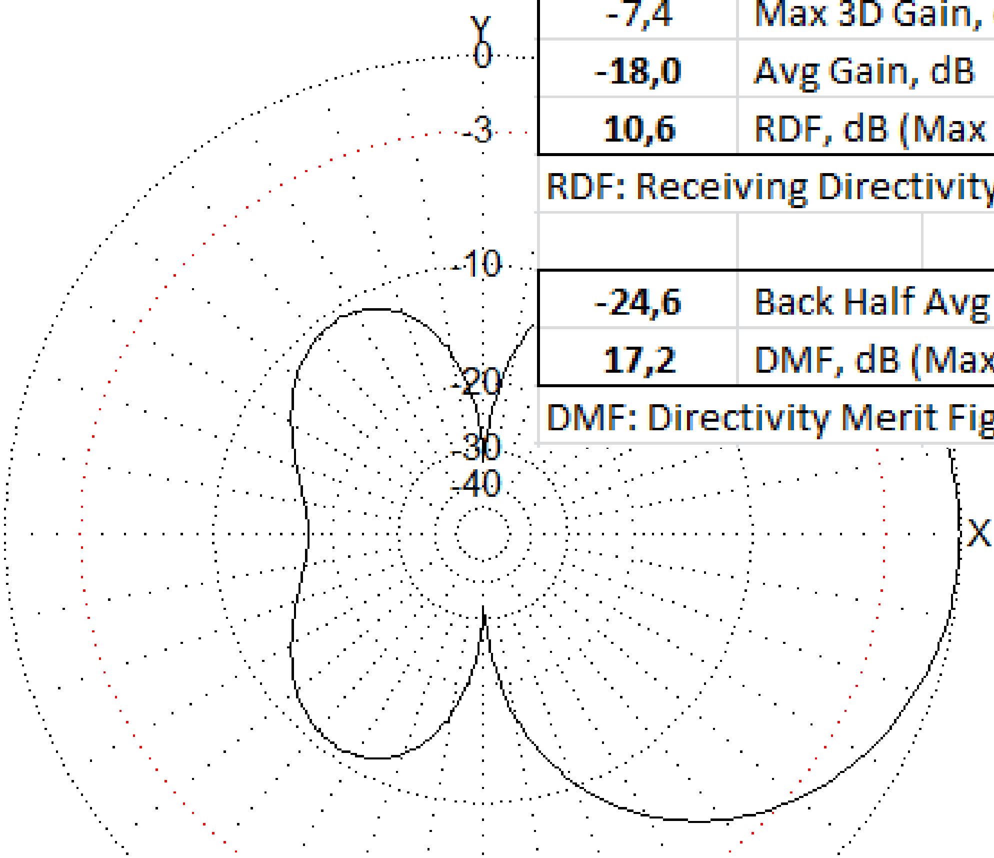
Beverage 170m

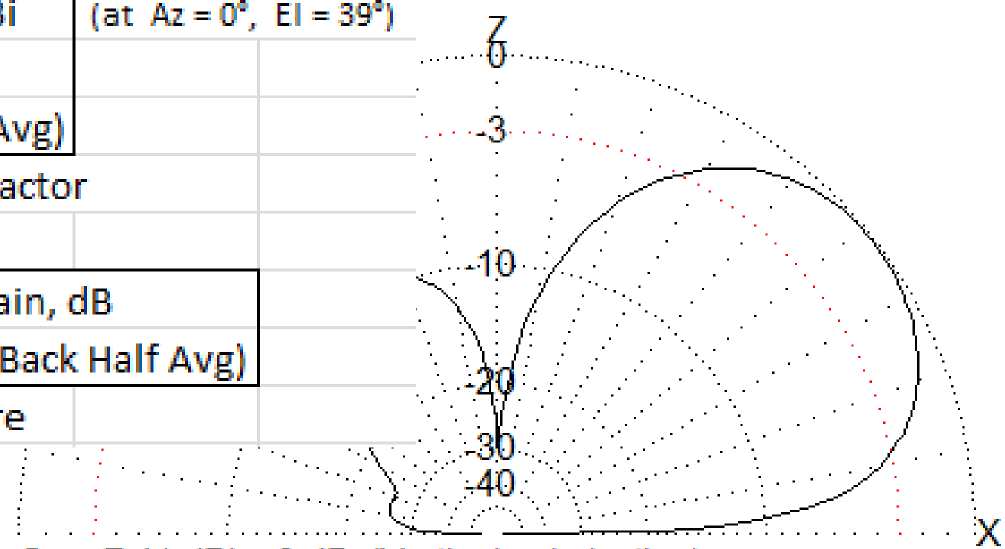
-7,4	Max 3D Gain, dBi	(at Az = 0°, El = 39°)
-18,0	Avg Gain, dB	
10,6	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-24,6	Back Half Avg Gain, dB
17,2	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





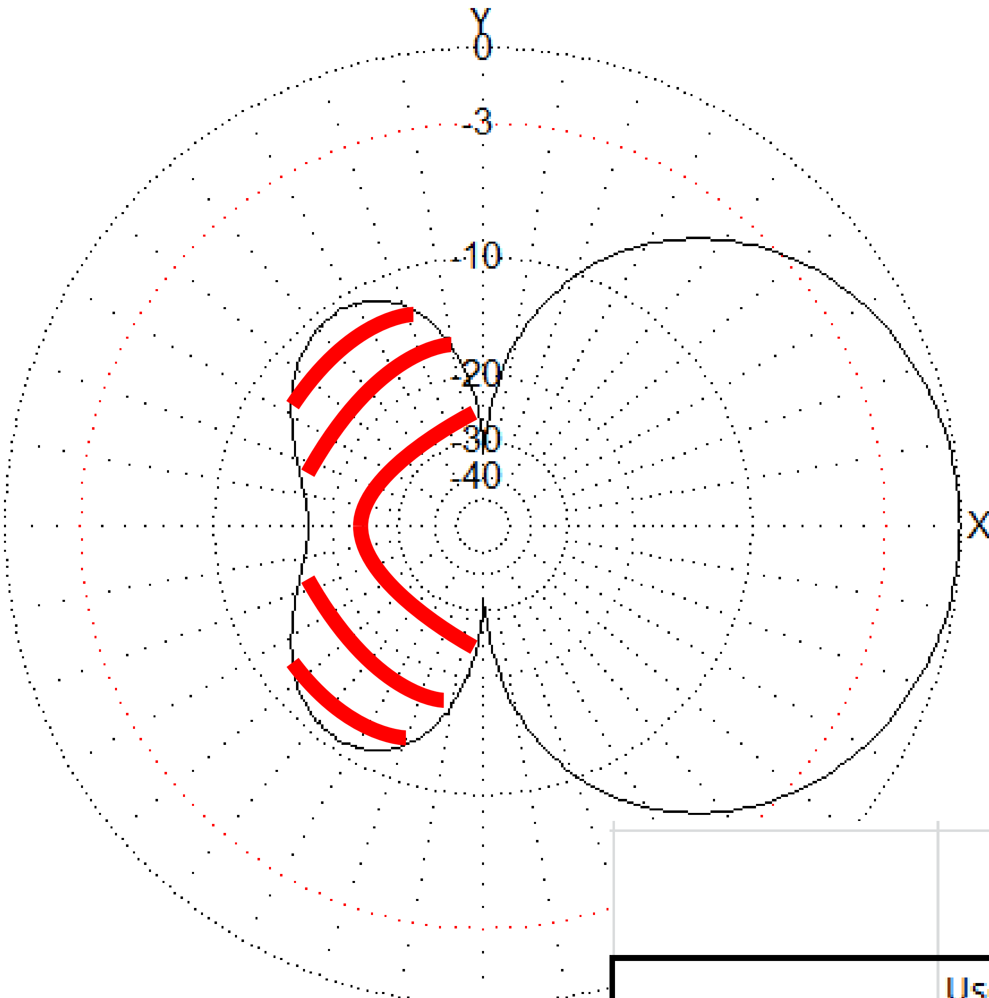
Ga : -7.41 dBi = 0 dB (Vertical polarization)
F/B: 16.05 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 457.194 - j26.724 Ohm
SWR: 1.3 (600.0 Ohm),
Elev: 37.5 deg (Real GND :0.00 m height)

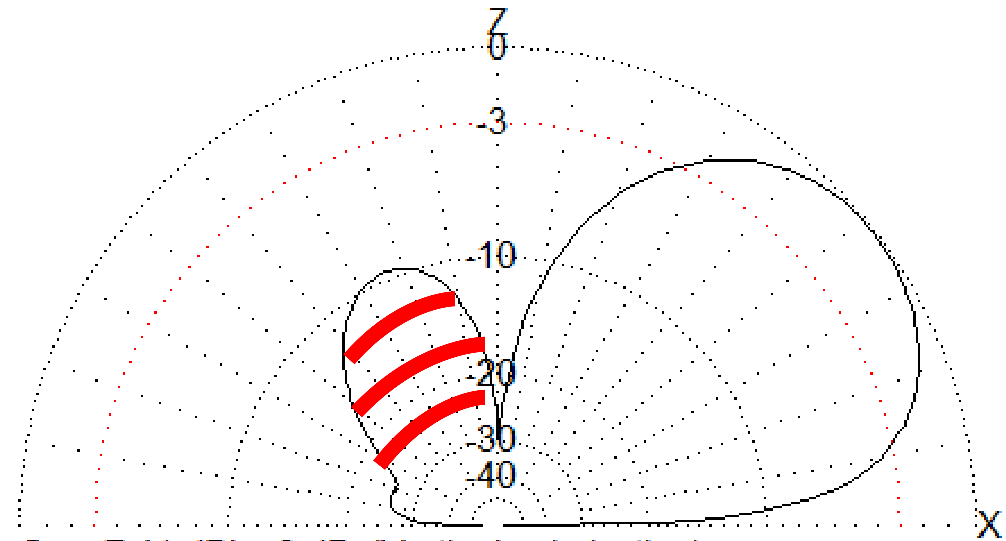
	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin	**19,0 dB**

Beverage 170m Leaking Index





Ga : -7.41 dBi = 0 dB (Vertical polarization)
F/B: 16.05 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 457.194 - j26.724 Ohm
SWR: 1.3 (600.0 Ohm),
Elev: 37.5 deg (Real GND :0.00 m height)

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

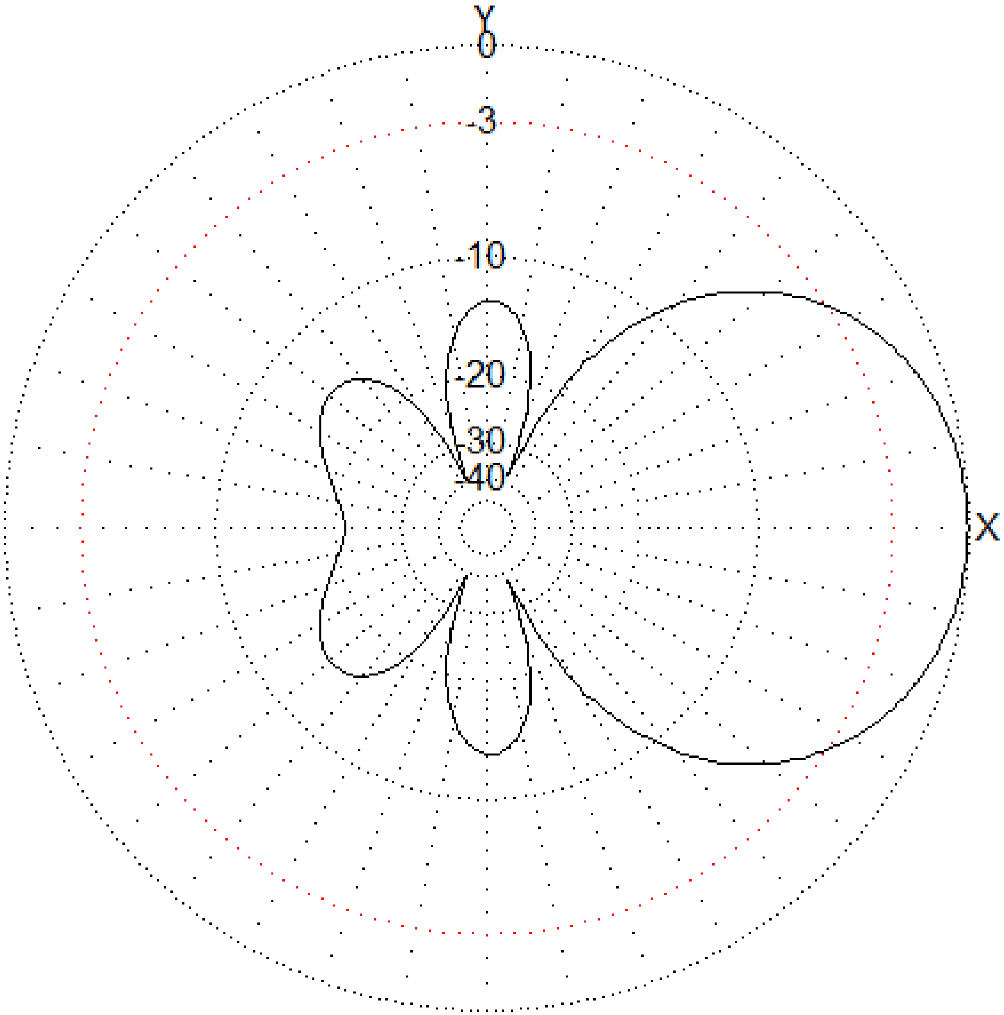
dB below Max Gain	3 level analysis
12	23,9%
18	55,6%
24	74,7%
Leaking Index	**51,4 %**

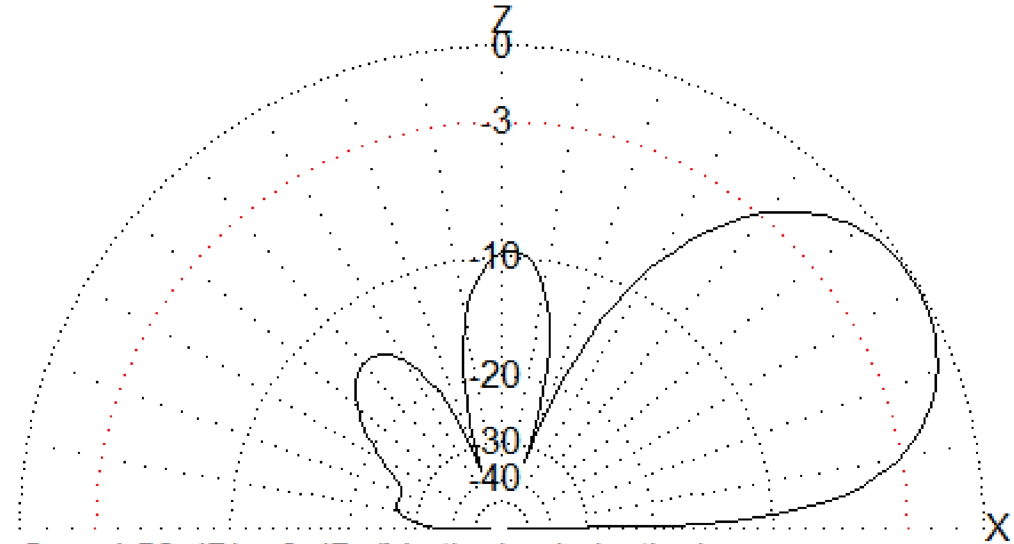
Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

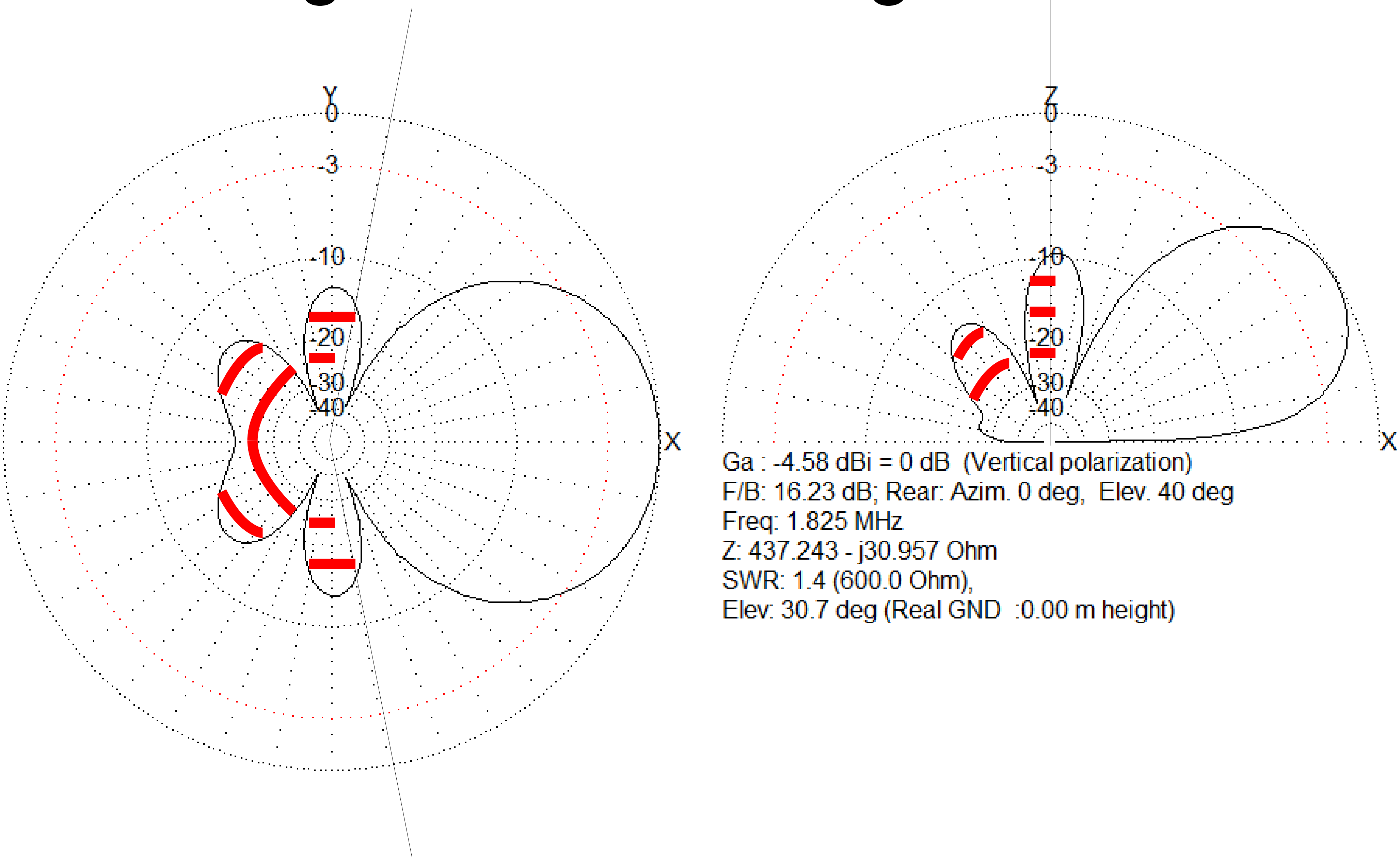
Beverage 250m





Ga : -4.58 dBi = 0 dB (Vertical polarization)
F/B: 16.23 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 437.243 - j30.957 Ohm
SWR: 1.4 (600.0 Ohm),
Elev: 30.7 deg (Real GND :0.00 m height)

Beverage 250m Leaking Index



Ga : -4.58 dBi = 0 dB (Vertical polarization)
F/B: 16.23 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 437.243 - j30.957 Ohm
SWR: 1.4 (600.0 Ohm),
Elev: 30.7 deg (Real GND :0.00 m height)

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

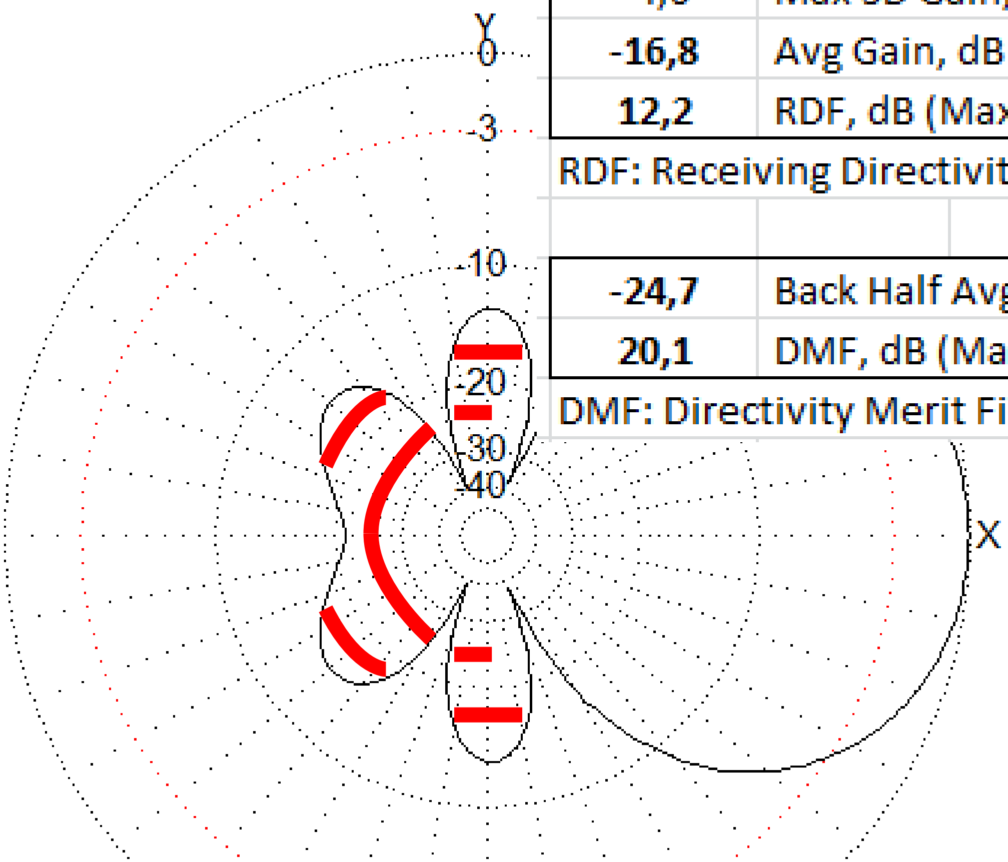
Beverage 250m

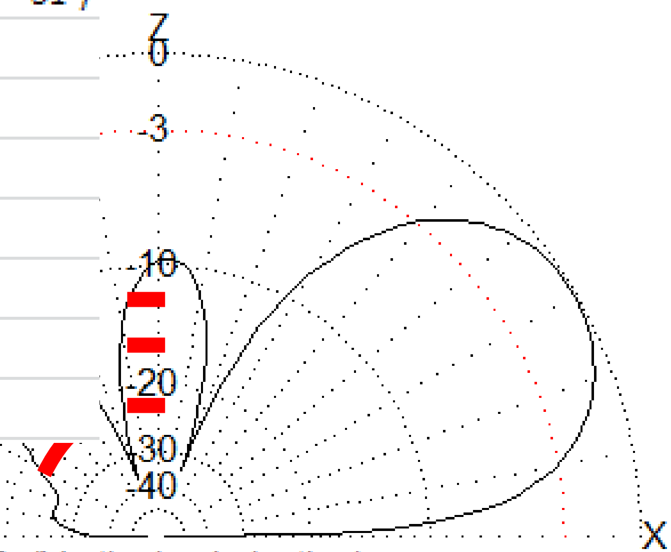
-4,6	Max 3D Gain, dBi	(at Az = 0°, El = 31°)
-16,8	Avg Gain, dB	
12,2	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-24,7	Back Half Avg Gain, dB
20,1	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -4.58 dBi = 0 dB (Vertical polarization)
F/B: 16.23 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 437.243 - j30.957 Ohm
SWR: 1.4 (600.0 Ohm),
Elev: 30.7 deg (Real GND :0.00 m height)

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:
Noise Margin **20,2 dB**

dB below Max Gain	3 level analysis
12	8,4%
18	48,3%
24	73,0%
Leaking Index	**43,2 %**

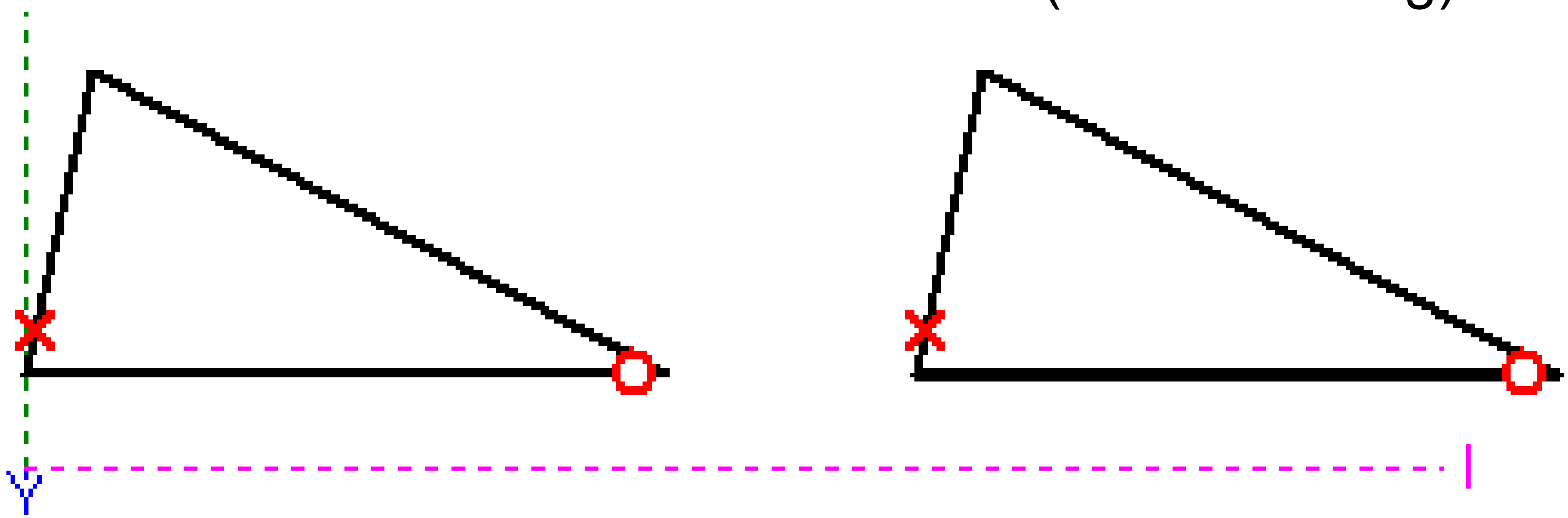
Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0

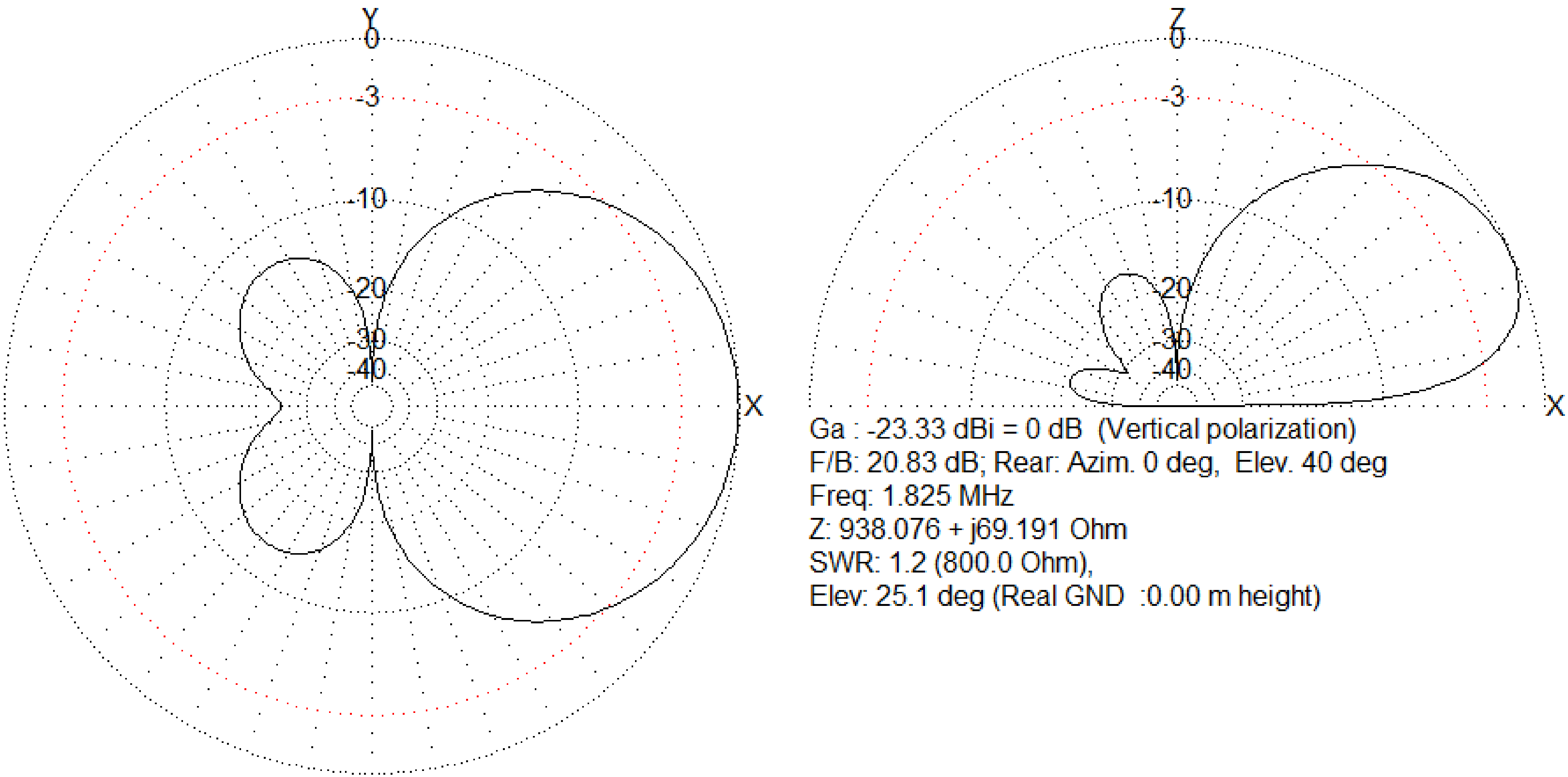
Beverages show their power compared to the smallest antennas

Twin Triangle

Total construction length 58m (190')
Bottom wires at 3m (10')
Bottom wire lengths 24m (78'9")
Triangle height 9,5m (31'2")
Construction Width 3m (10')
Wire 4mm Al
Loads 840-860 ohm
Feed 800 ohm (0 and 180 deg)

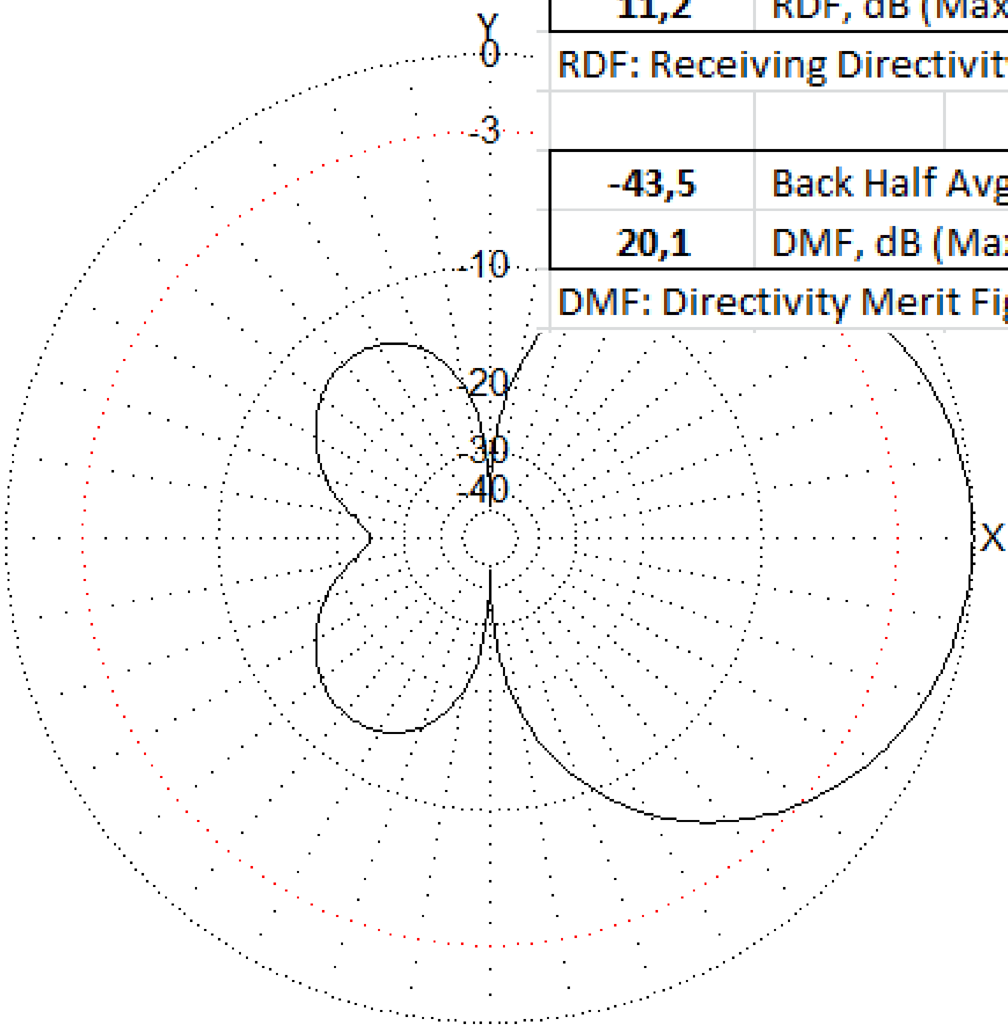


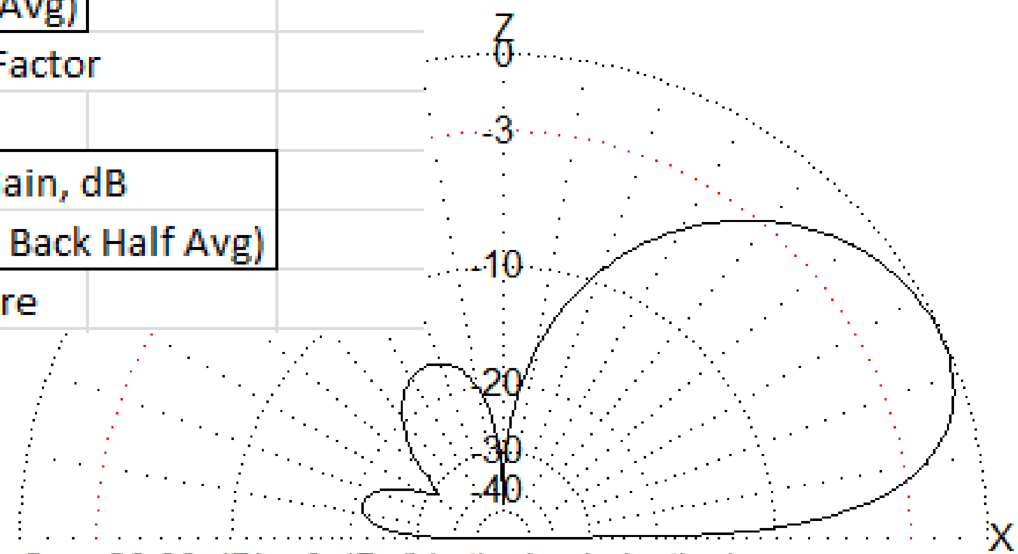
Twin Triangle



Twin Triangle RDF DMF

-23,3	Max 3D Gain, dBi	(at Az = 0°, El = 26°)
-34,5	Avg Gain, dB	
11,2	RDF, dB (Max - Avg)	
RDF: Receiving Directivity Factor		
-43,5	Back Half Avg Gain, dB	
20,1	DMF, dB (Max - Back Half Avg)	
DMF: Directivity Merit Figure		





Ga : -23.33 dBi = 0 dB (Vertical polarization)
F/B: 20.83 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 938.076 + j69.191 Ohm
SWR: 1.2 (800.0 Ohm),
Elev: 25.1 deg (Real GND :0.00 m height)

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

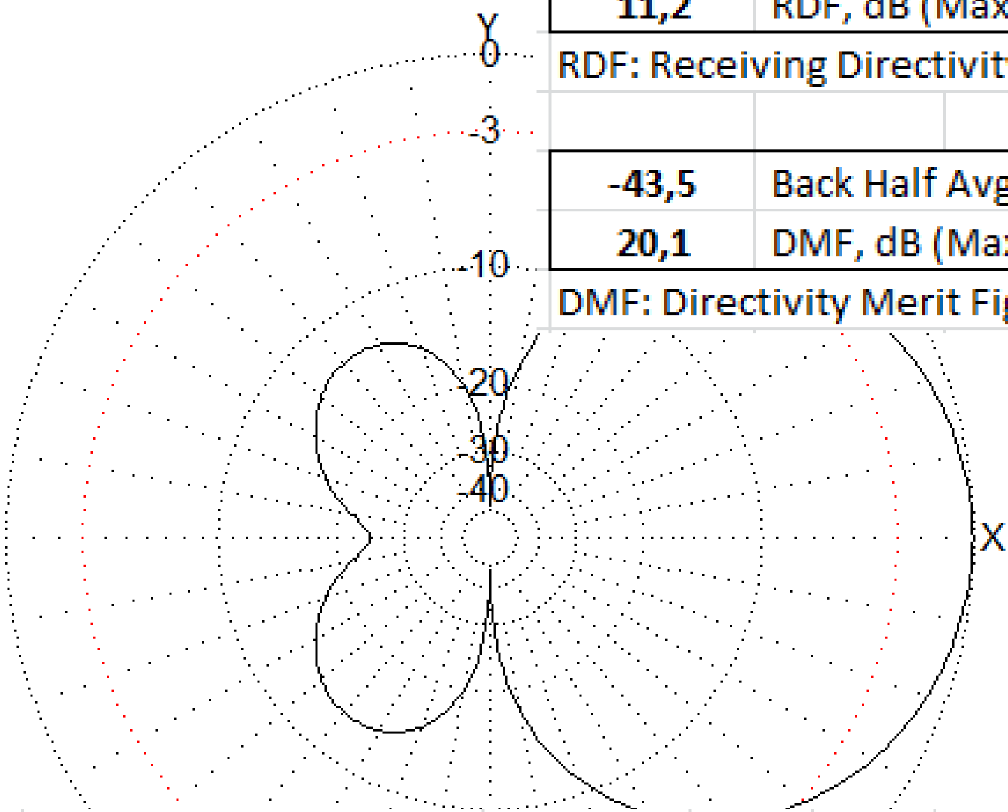
Twin Triangle Noise Margin

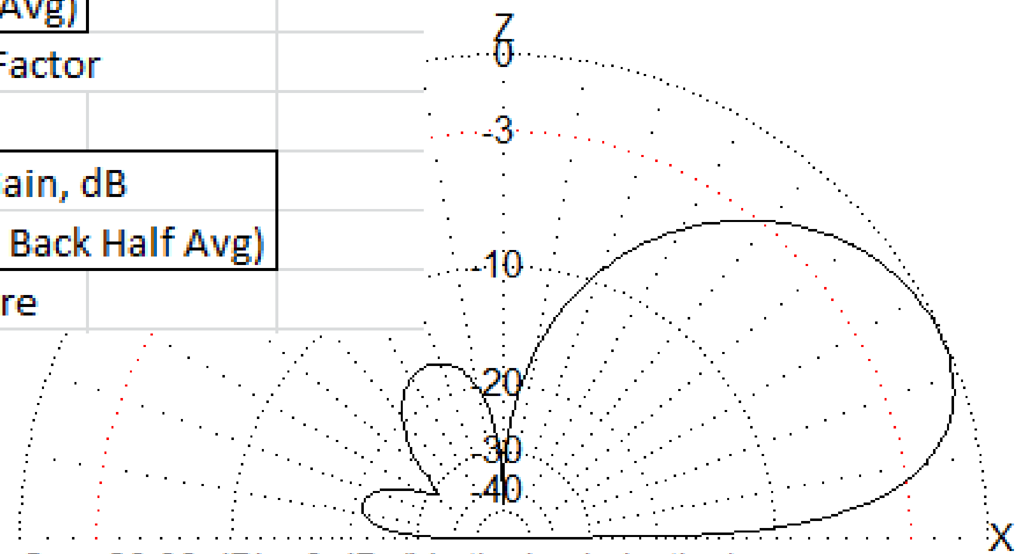
-23,3	Max 3D Gain, dBi	(at Az = 0°, El = 26°)
-34,5	Avg Gain, dB	
11,2	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-43,5	Back Half Avg Gain, dB
20,1	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -23.33 dBi = 0 dB (Vertical polarization)
F/B: 20.83 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 938.076 + j69.191 Ohm
SWR: 1.2 (800.0 Ohm),
Elev: 25.1 deg (Real GND :0.00 m height)

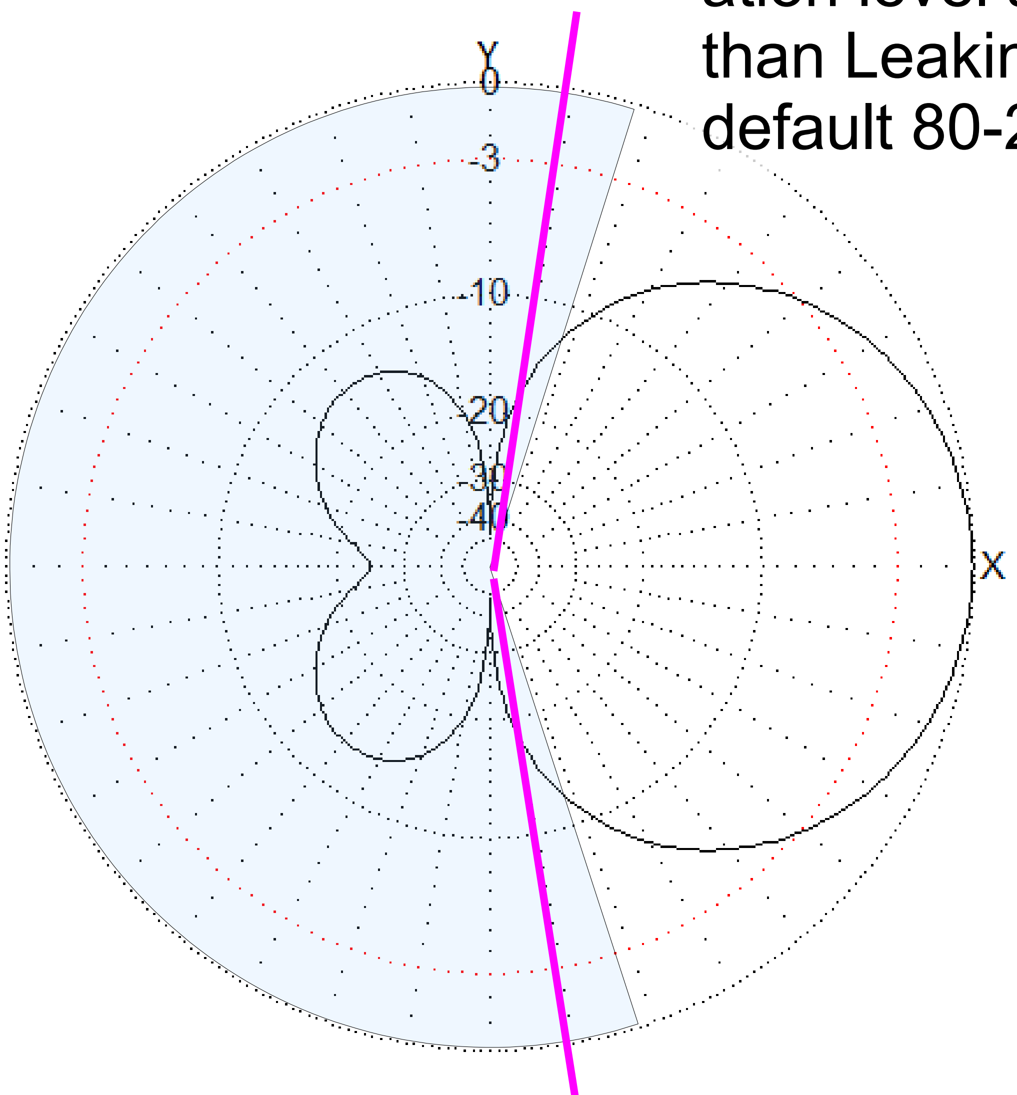
	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

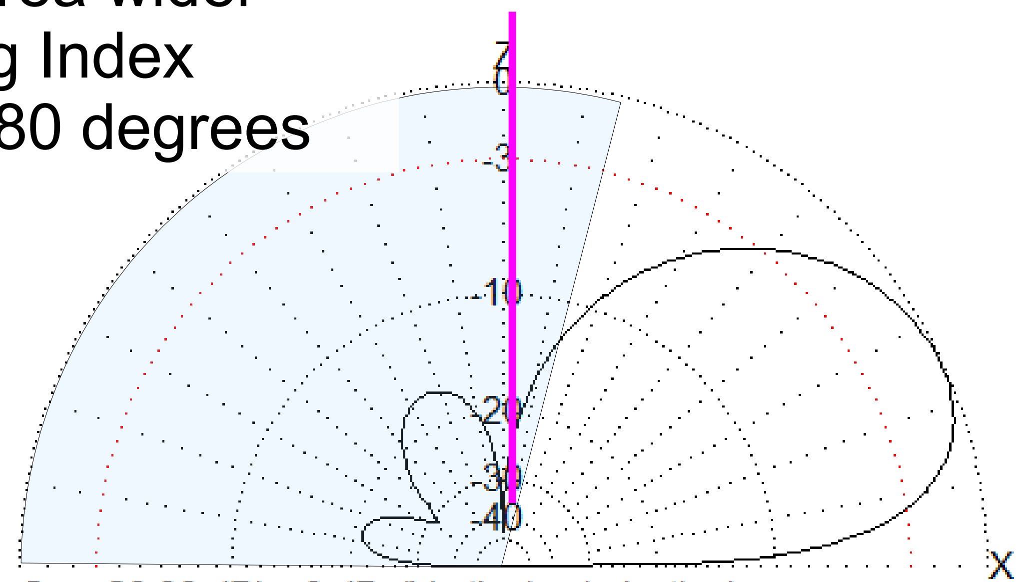
Result:

Noise Margin **2,5 dB**

Twin Triangle Leaking Index

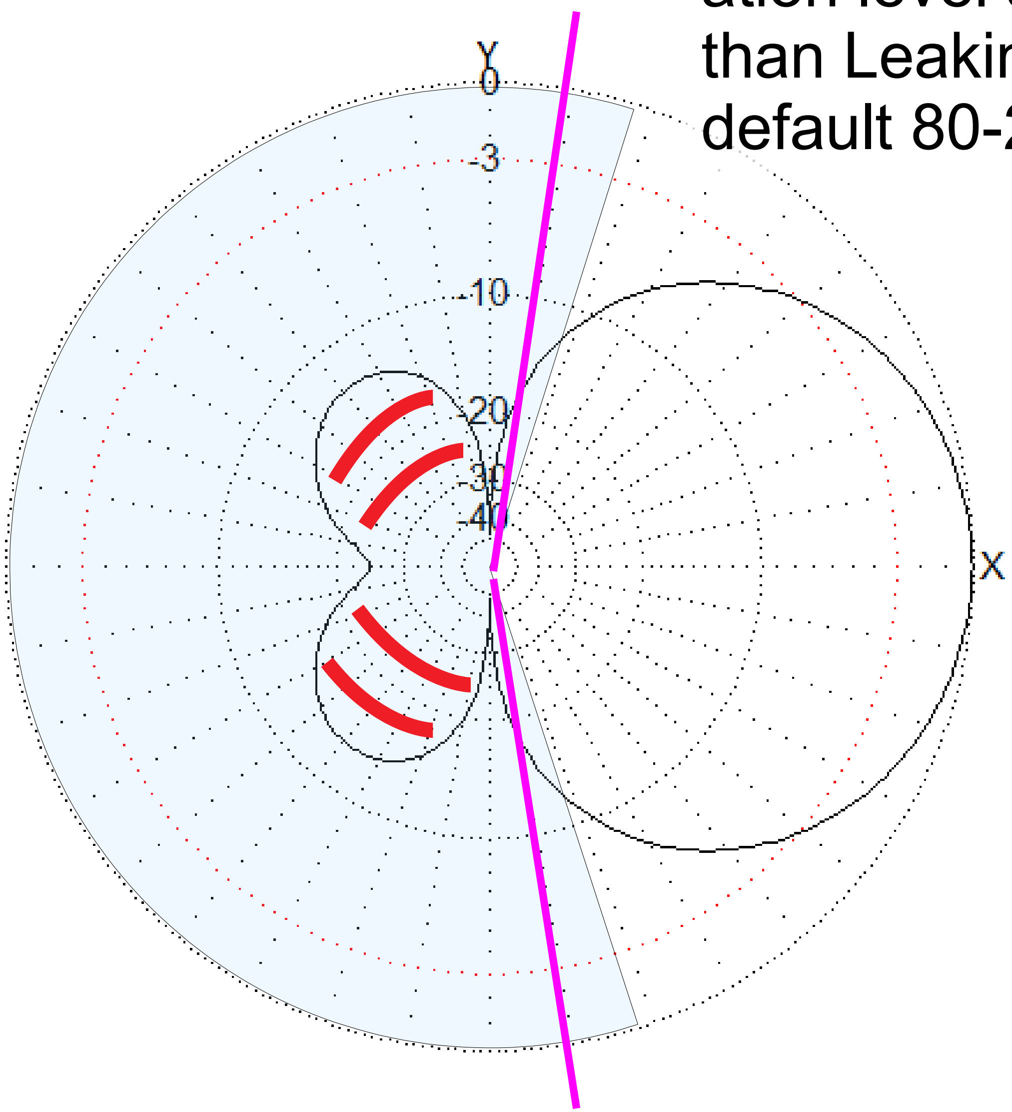
-12 dB or better attenuation level area wider than Leaking Index default 80-280 degrees

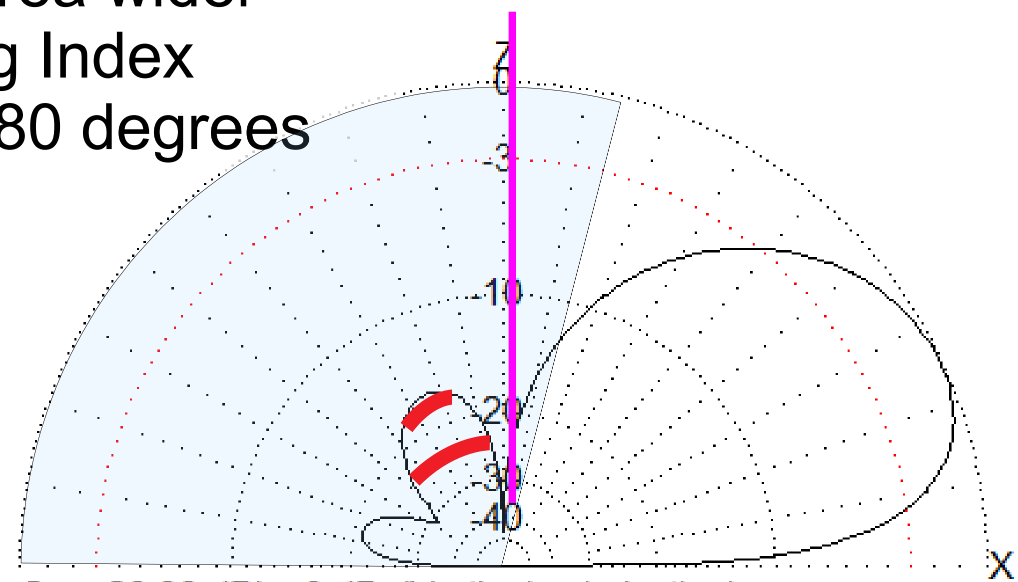




Twin Triangle Leaking Index

-12 dB or better attenuation level area wider than Leaking Index default 80-280 degrees

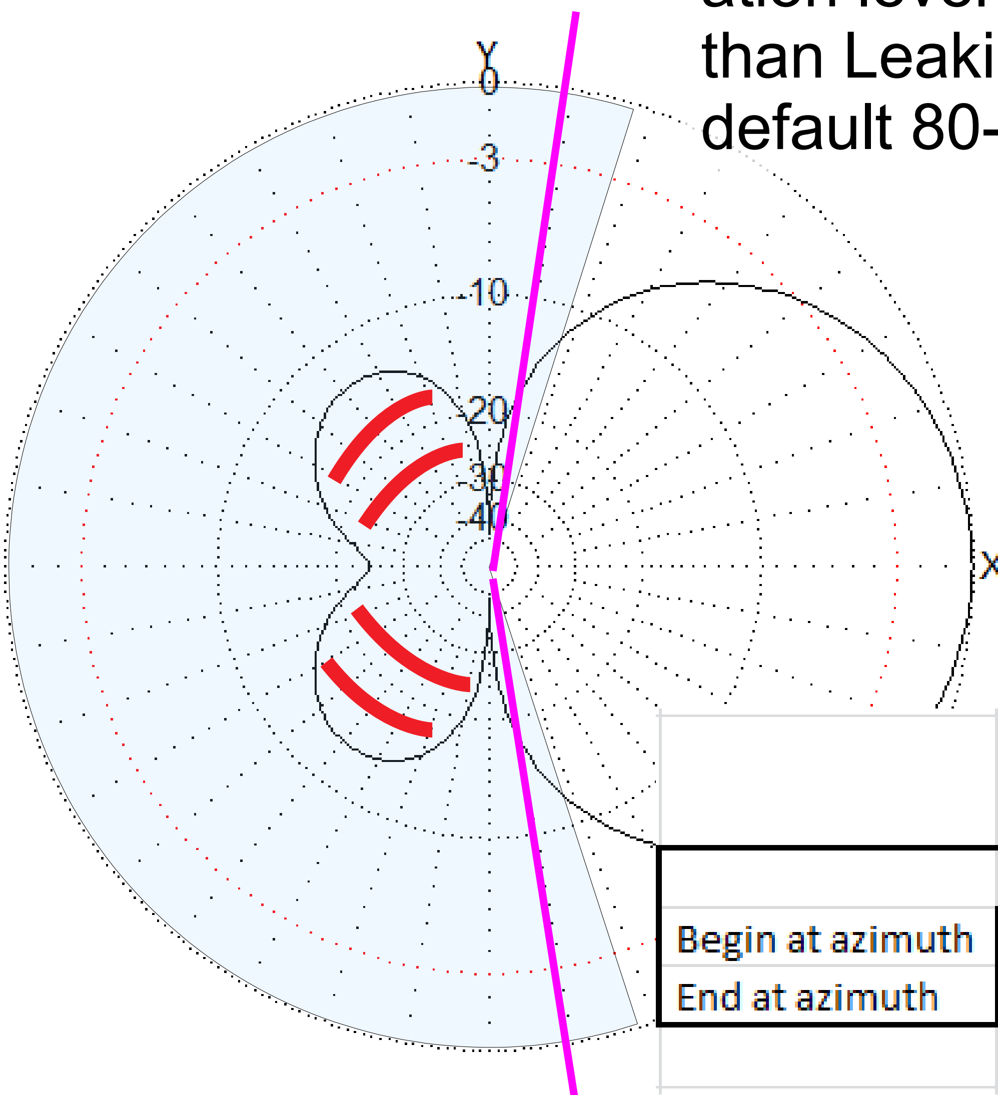


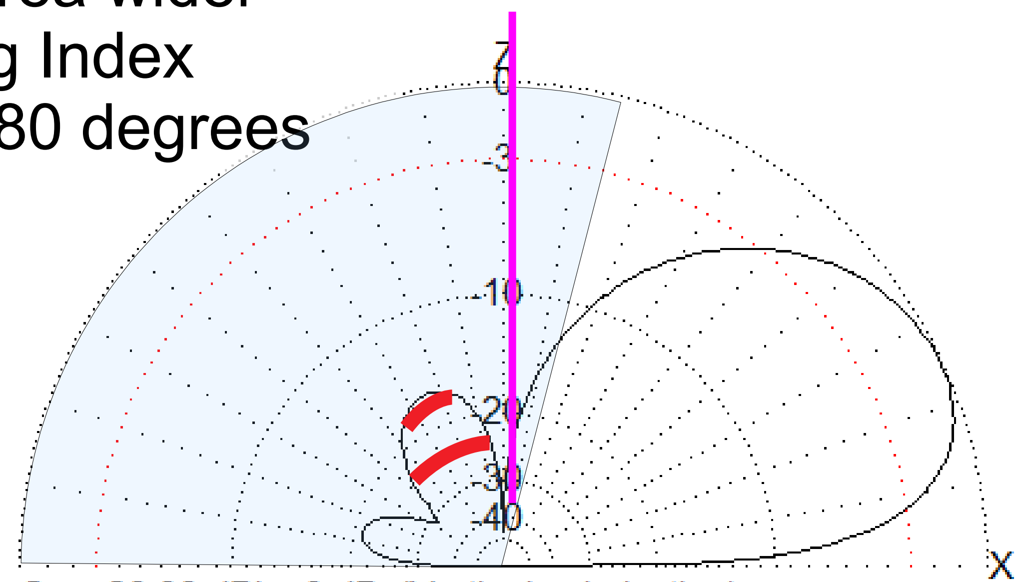


Ga : -23.33 dBi = 0 dB (Vertical polarization)
F/B: 20.83 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 938.076 + j69.191 Ohm
SWR: 1.2 (800.0 Ohm),
Elev: 25.1 deg (Real GND :0.00 m height)

Twin Triangle Leaking Index

-12 dB or better attenu-
ation level area wider
than Leaking Index
default 80-280 degrees





Ga : -23.33 dBi = 0 dB (Vertical polarization)
F/B: 20.83 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	47,9%
24	77,4%
Leaking Index	**41,8 %**

Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5

Notice !!

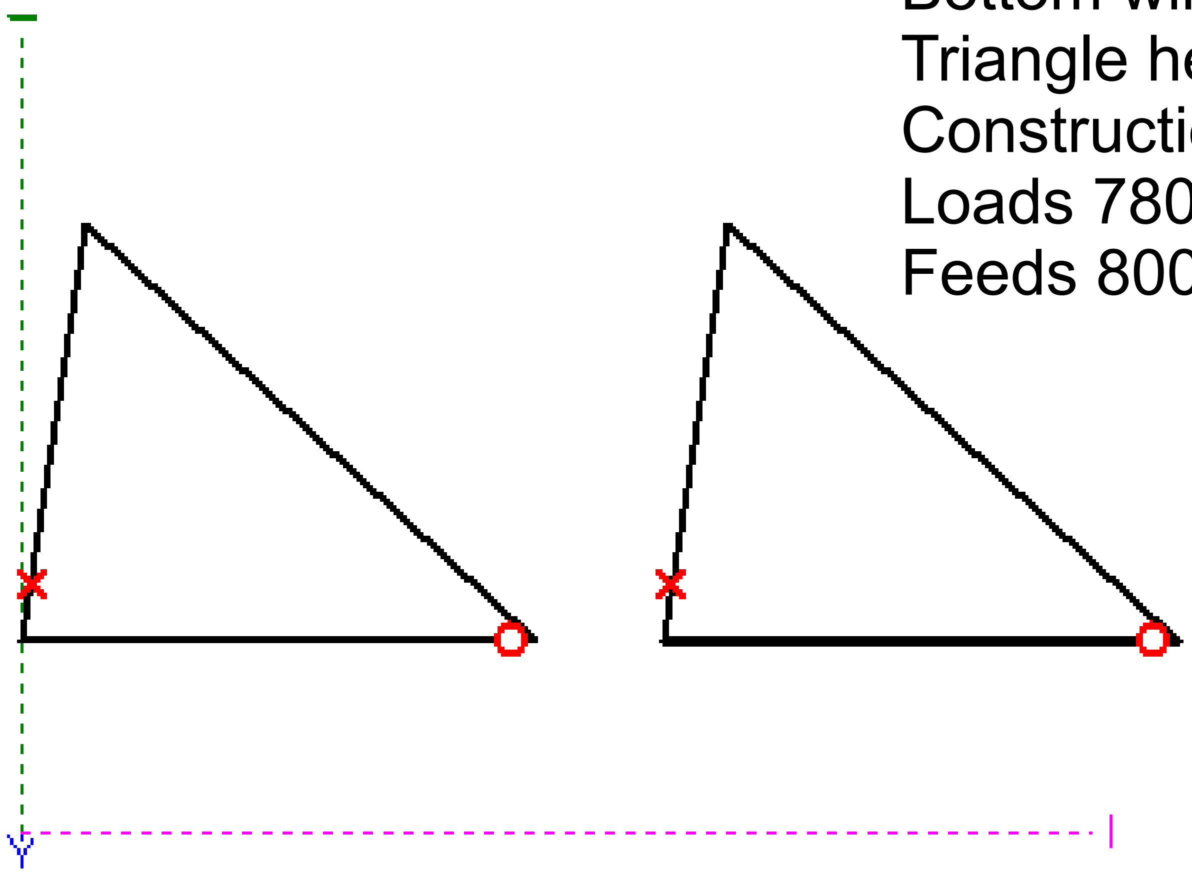
- RDF gets worse
- DMF stays exactly the same
- Leaking Index improves

- However, Noise Margin is too small for the most quiet QTH

Smaller Twin Triangle

RESIDENTIAL

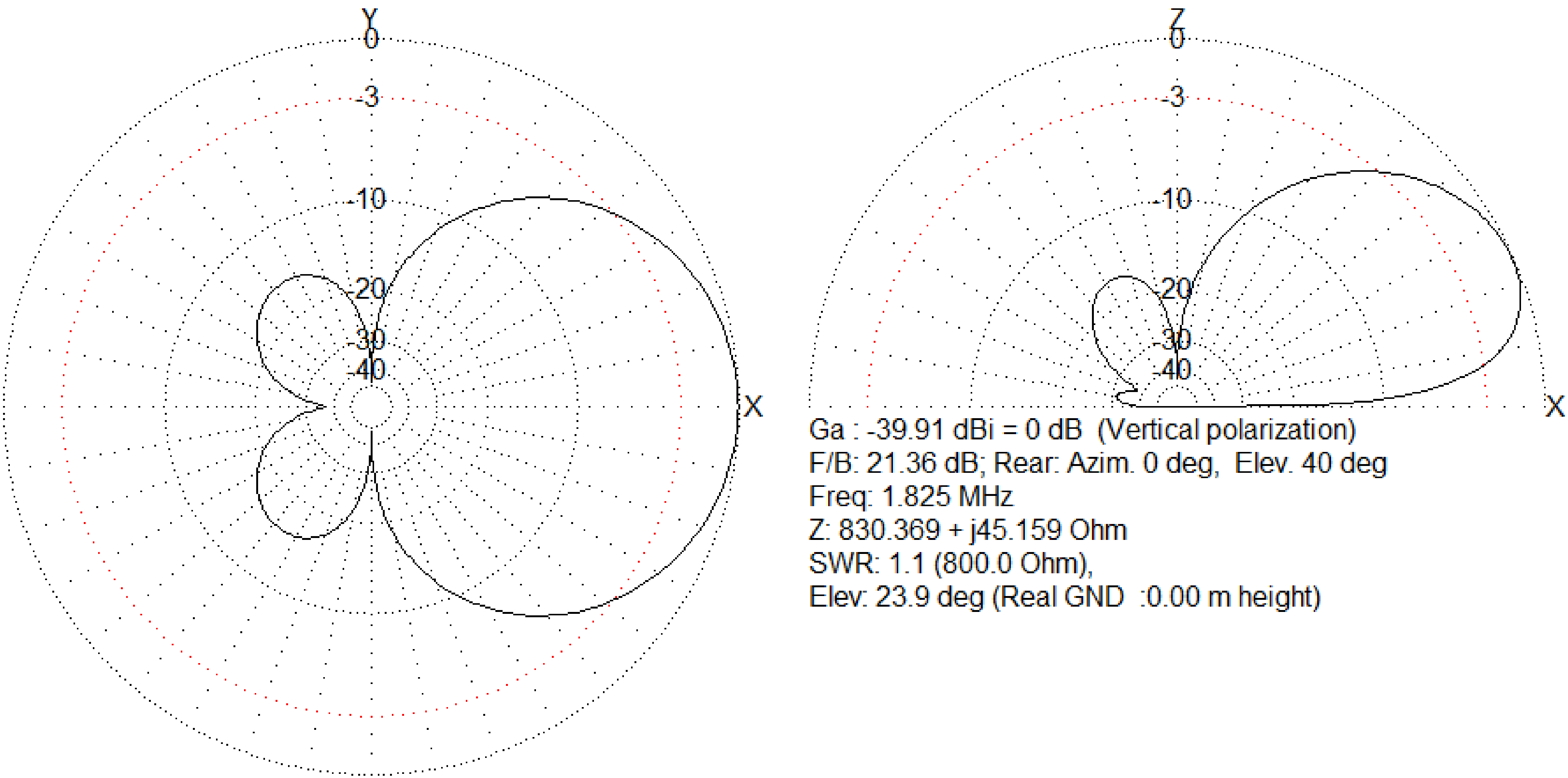
Total construction length 25m (82')
Bottom wires at 3m (10')
Bottom wire lengths 8m (26'3“)
Triangle height 6.5m (21'4“)
Construction width 3m (10')
Loads 780-800 ohm
Feeds 800 ohm (0 and 180 deg)



ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Smaller Twin Triangle

RESIDENTIAL



ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Smaller Twin Triangle

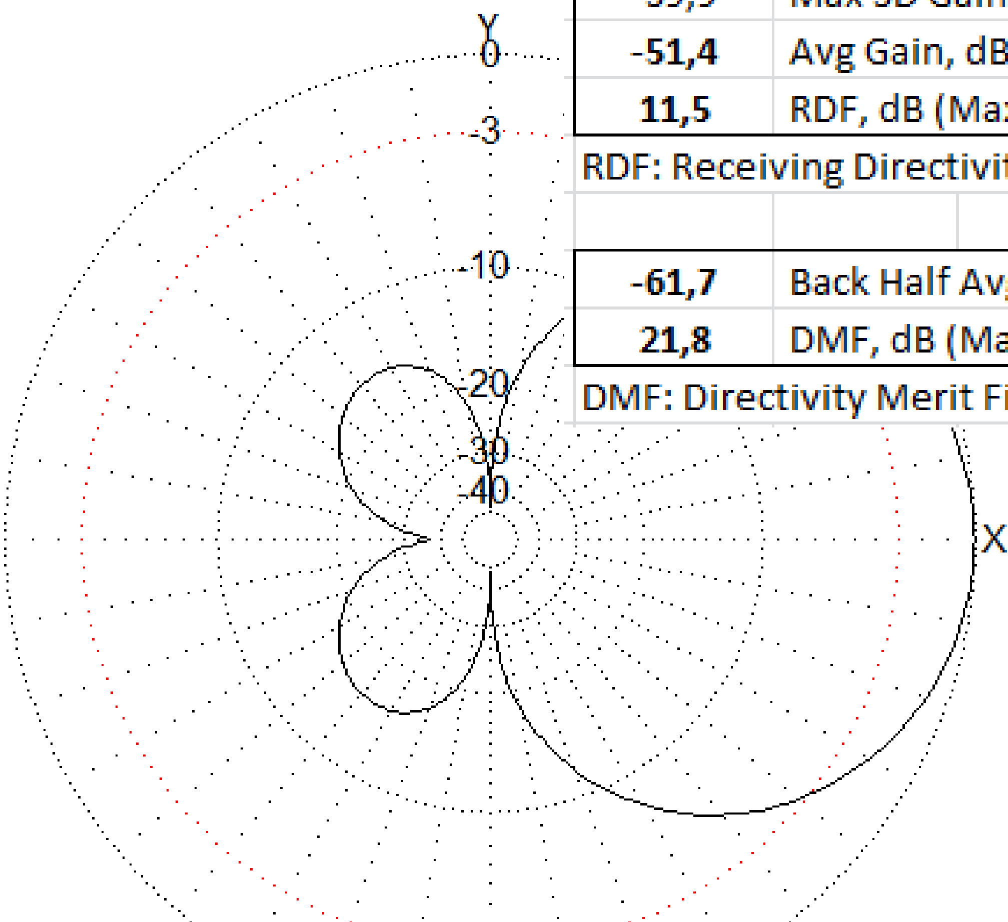
RESIDENTIAL

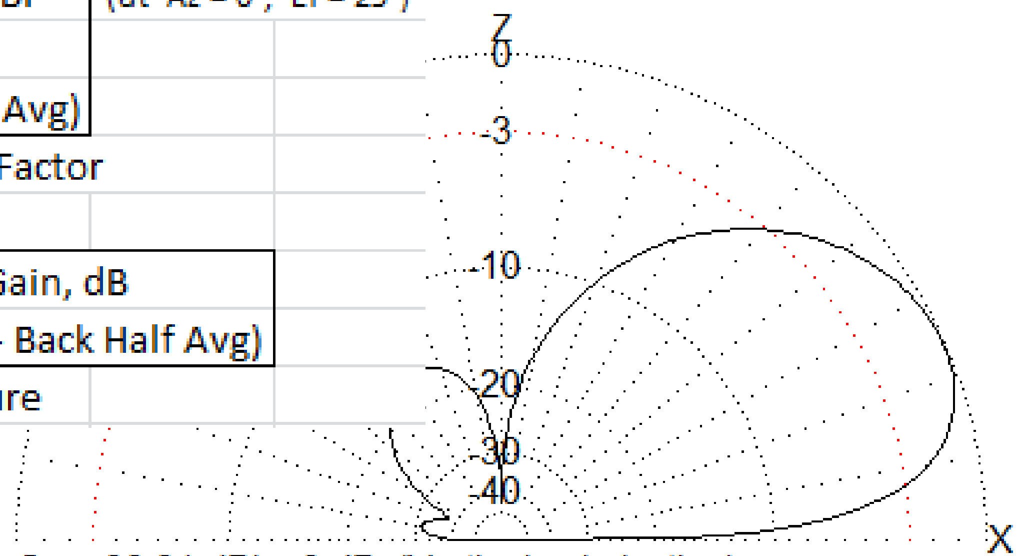
-39,9	Max 3D Gain, dBi	(at Az = 0°, El = 25°)
-51,4	Avg Gain, dB	
11,5	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-61,7	Back Half Avg Gain, dB
21,8	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -39.91 dBi = 0 dB (Vertical polarization)
F/B: 21.36 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 830.369 + j45.159 Ohm
SWR: 1.1 (800.0 Ohm),
Elev: 23.9 deg (Real GND :0.00 m height)

	User input	
Noise Level P.372-13	64	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **3,6 dB**

dB below Max Gain	3 level analysis
12	0,0%
18	36,9%
24	67,8%
Leaking Index	**34,9 %**

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5
08 Smaller Twin Triangle v03.csv	-39,9	0°	25°	-51,4	11,5	-61,7	21,8	64	3,6	34,9	25,0	3,0	9,5

Notice !!

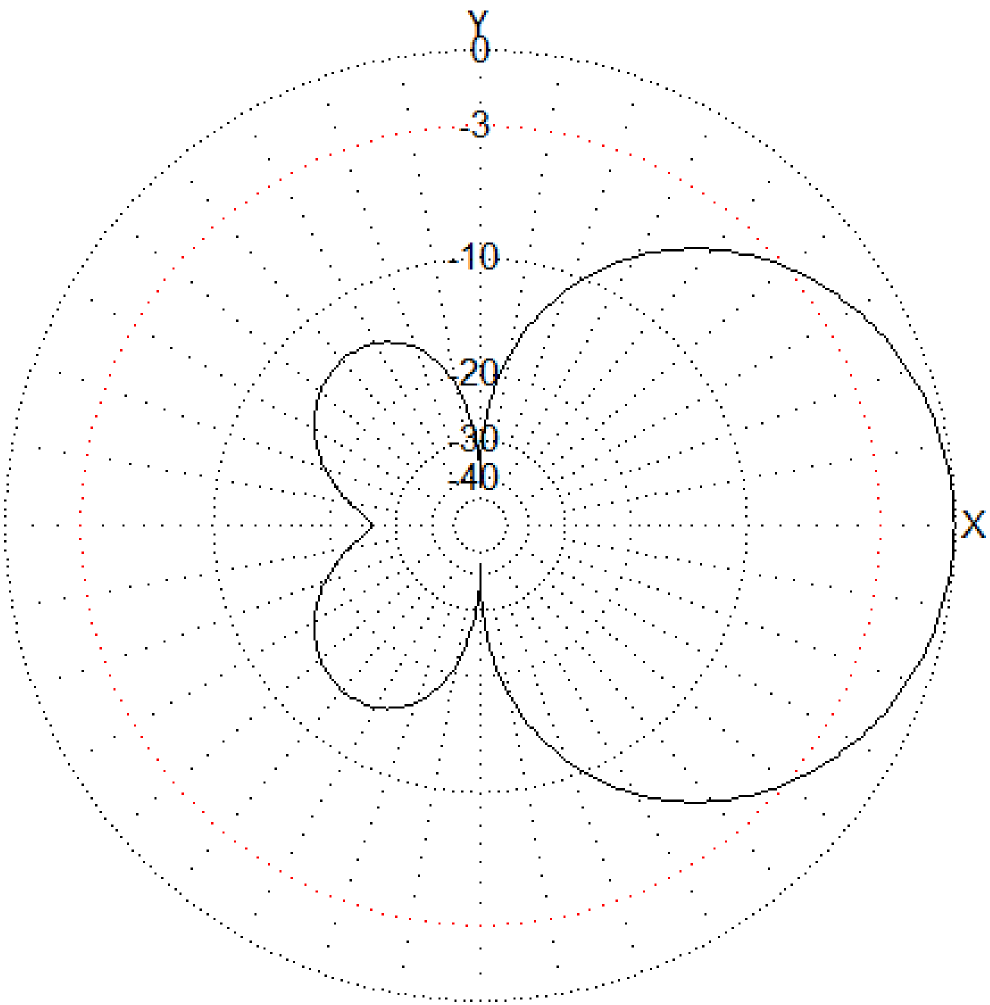
- RDF worse than 250m beverage
- DMF 1.7 dB better than 250m beverage
- Leaking Index improves clearly

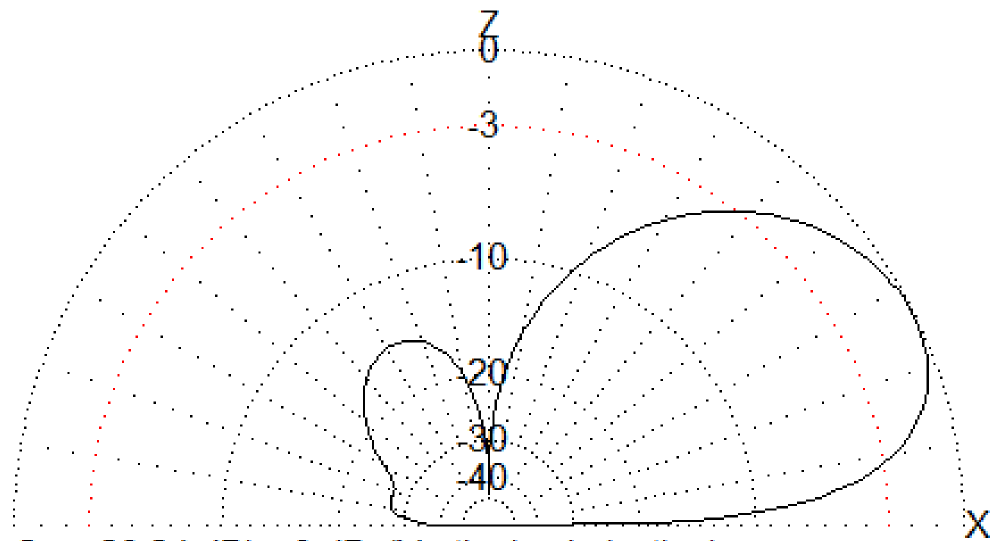
- Noise Margin too small to ensure hearing the weakest possible signals even at Residential QTH

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Smaller Twin Triangle 80m

RESIDENTIAL





Ga : -23.24 dBi = 0 dB (Vertical polarization)
F/B: 18.76 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 3.650 MHz
Z: 945.447 + j27.290 Ohm
SWR: 1.2 (800.0 Ohm),
Elev: 26.2 deg (Real GND :0.00 m height)

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Smaller Twin Triangle 80m

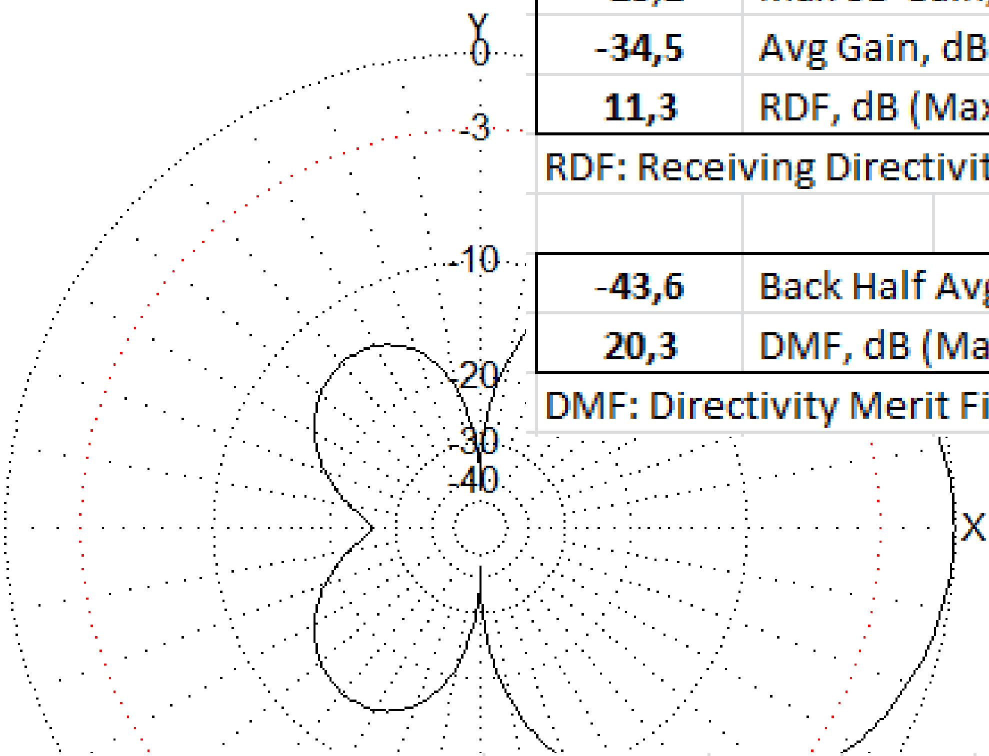
RESIDENTIAL

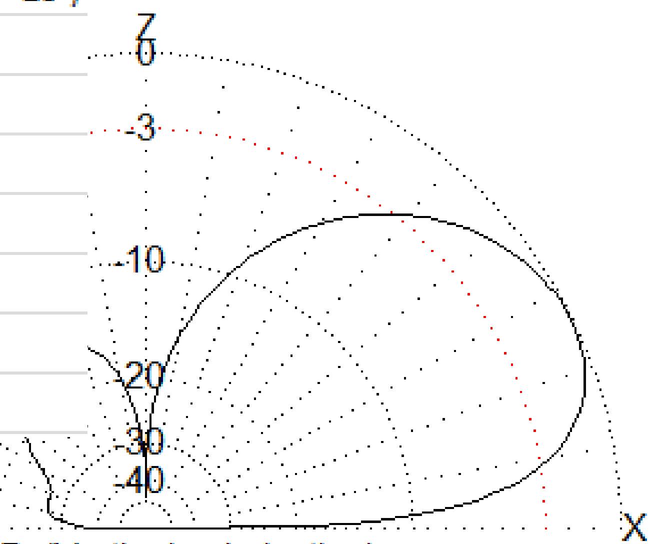
-23,2	Max 3D Gain, dBi	(at Az = 0°, El = 26°)
-34,5	Avg Gain, dB	
11,3	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-43,6	Back Half Avg Gain, dB
20,3	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -23.24 dBi = 0 dB (Vertical polarization)
F/B: 18.76 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 3.650 MHz
Z: 945.447 + j27.290 Ohm
SWR: 1.2 (800.0 Ohm),
.00 m height)

	User input	
Noise Level P.372-13	56	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

38 dB on 80 at a quiet rural site

56 dB on 80 at a residential site

Result:

Noise Margin **12,5 dB**

dB below Max Gain	3 level analysis
12	0,0%
18	45,9%
24	72,5%
Leaking Index	**39,5 %**

Smaller Twin Triangle 80m

	User input	
Noise Level P.372-13	56	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Residential QTH

Result:

Noise Margin	**12,5 dB**	above electronics noise

	User input	
Noise Level P.372-13	38	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Quiet rural QTH

Result:

Noise Margin	**-5,5 dB**	above electronics noise

Total construction length 25m (82ft)

Comparison

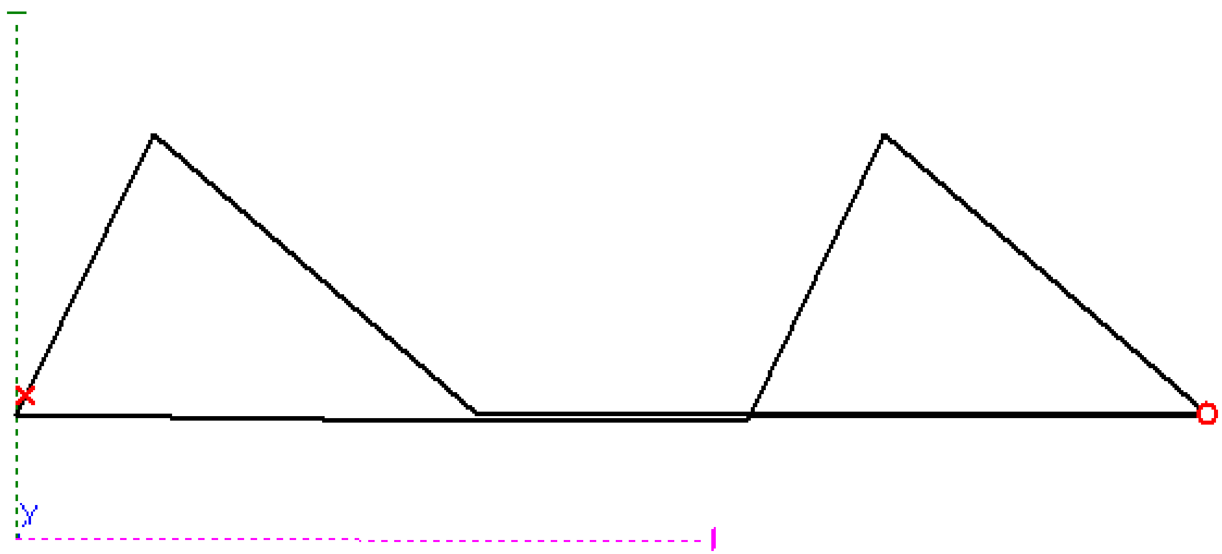
Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5
08 Smaller Twin Triangle v03.csv	-39,9	0°	25°	-51,4	11,5	-61,7	21,8	64	3,6	34,9	25,0	3,0	9,5
08 Smaller Twin Triangle v03 80m.(	-23,2	0°	26°	-34,5	11,3	-43,6	20,3	56	12,5	39,5	25,0	3,0	9,5

Smaller Twin Triangle gives solid performance on 80, marginal on 160 at a Residential area QTH

DMF and Leaking Index win over a 250m long beverage

LIXA proto

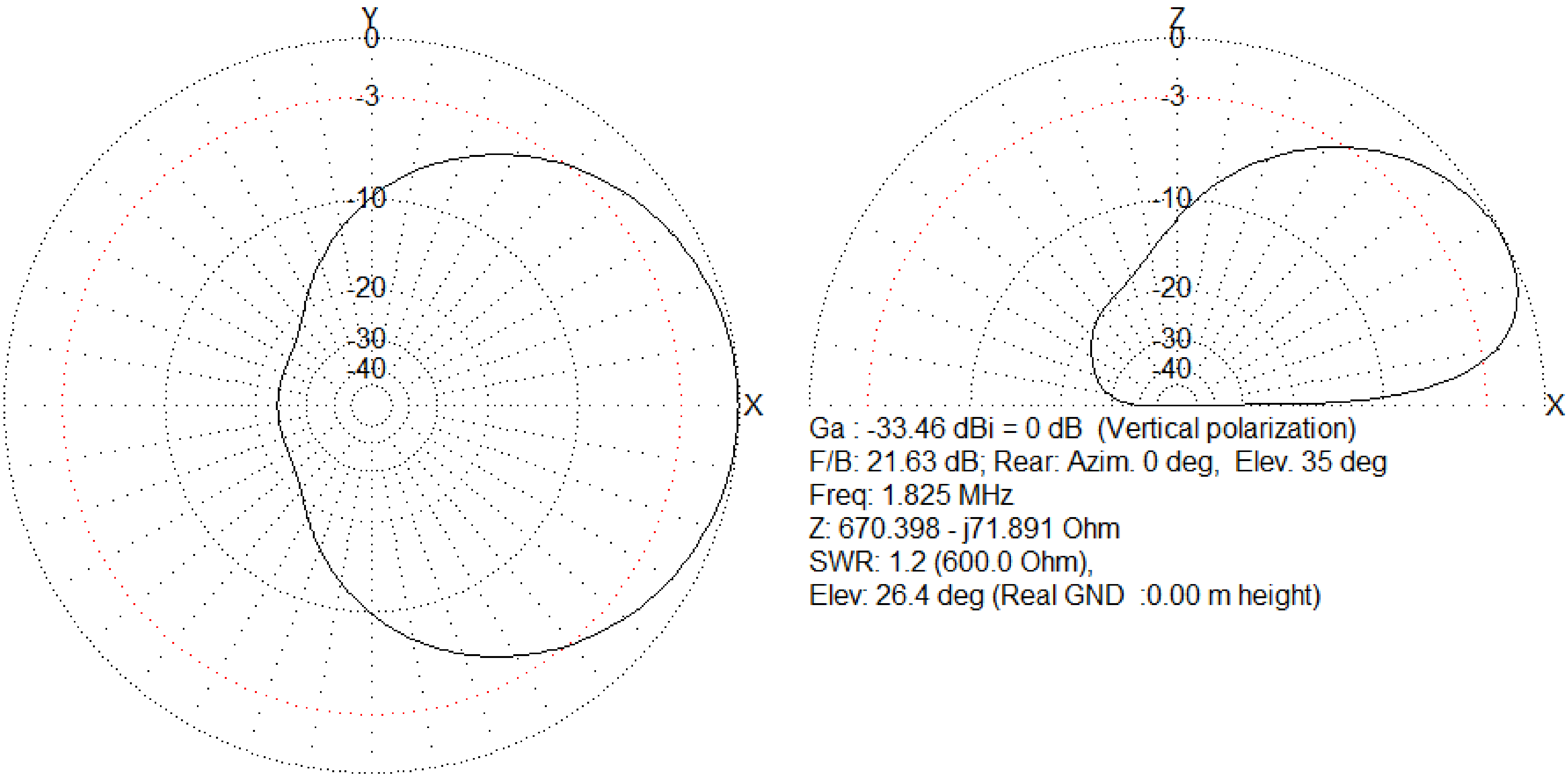
Linear Inline targetX Antenna



Total construction length 22.8m (74'9“)
Bottom wires at 2.4m (7' 10“)
Material 4mm Aluminum
Triangle height 5.4m (17'8“)
Construction width 3m (10')
Load 800 ohm
Feed 800 ohm

LIXA proto

Linear Inline targetX Antenna



Ga : -33.46 dBi = 0 dB (Vertical polarization)
F/B: 21.63 dB; Rear: Azim. 0 deg, Elev. 35 deg
Freq: 1.825 MHz
Z: 670.398 - j71.891 Ohm
SWR: 1.2 (600.0 Ohm),
Elev: 26.4 deg (Real GND :0.00 m height)

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

LIXA proto

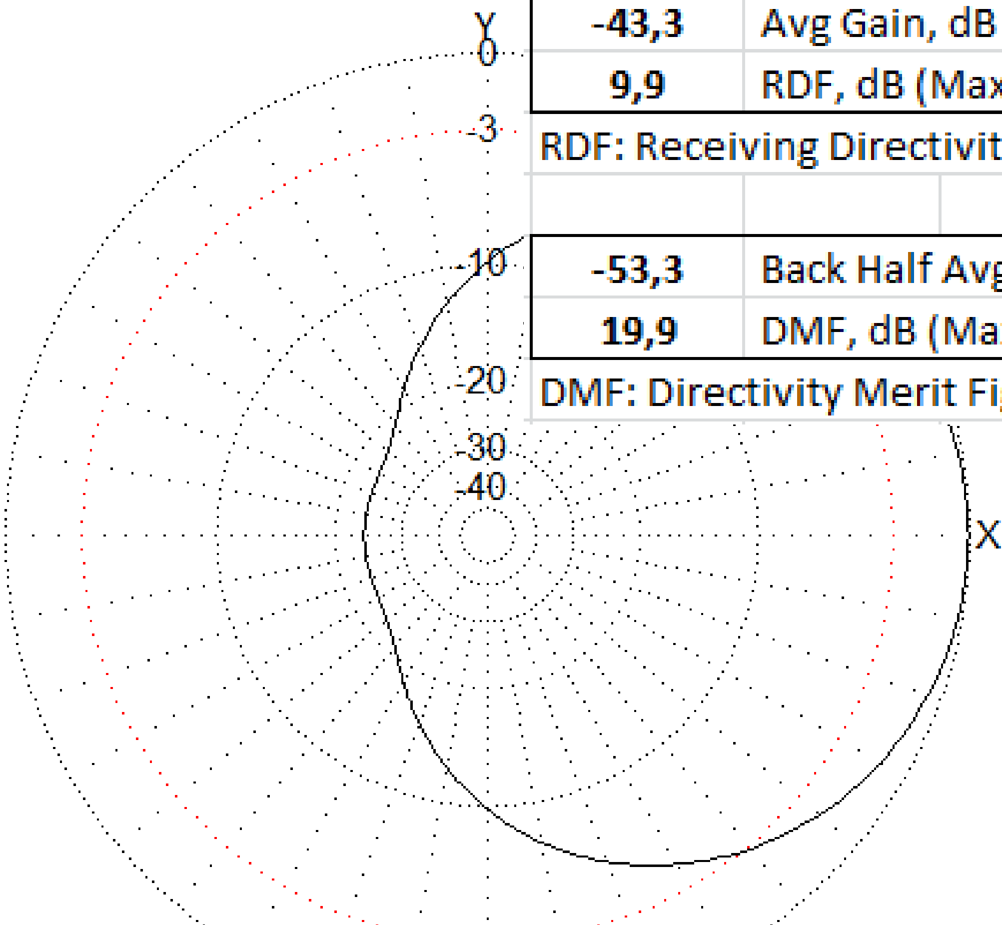
-33,5	Max 3D Gain, dBi
-43,3	Avg Gain, dB
9,9	RDF, dB (Max - Avg)

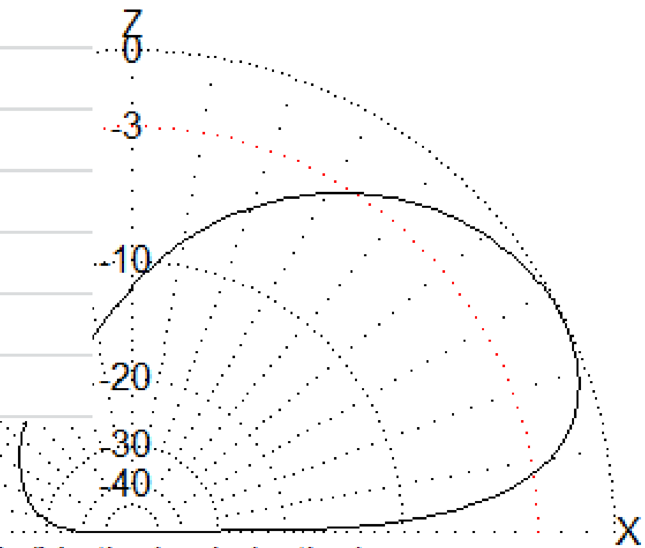
(at Az = 0°, El = 27°)

RDF: Receiving Directivity Factor

-53,3	Back Half Avg Gain, dB
19,9	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -33.46 dBi = 0 dB (Vertical polarization)
F/B: 21.63 dB; Rear: Azim. 0 deg, Elev. 35 deg
Freq: 1.825 MHz
Z: 670.398 - j71.891 Ohm
SWR: 1.2 (600.0 Ohm),
Elev: 26.4 deg (Real GND :0.00 m height)

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **-6,3 dB**

dB below Max Gain	3 level analysis
12	15,5%
18	46,2%
24	76,9%
Leaking Index	**46,2 %**

ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5
08 Smaller Twin Triangle v03.csv	-39,9	0°	25°	-51,4	11,5	-61,7	21,8	64	3,6	34,9	25,0	3,0	9,5
08 Smaller Twin Triangle v03 80m.c	-23,2	0°	26°	-34,5	11,3	-43,6	20,3	56	12,5	39,5	25,0	3,0	9,5
10 LIXA proto 201611.csv	-33,5	0°	27°	-43,3	9,9	-53,3	19,9	46	-6,3	46,2	22,8	3,0	7,8
10 LIXA proto 201611 80m.csv	-17,0	0°	31°	-26,3	9,4	-35,8	18,9	38	2,7	43,6	22,8	3,0	7,8

LIXA has a little better pattern than DHDL or Double Delta
This prototype is dual band 160/80, under testing at OH4A
Noise performance is marginal on 80, should be better on 160
OH4A QTH is not the most quiet

Also a dual rectangle version, feed and loads at low corners, is under testing

2x LIRA

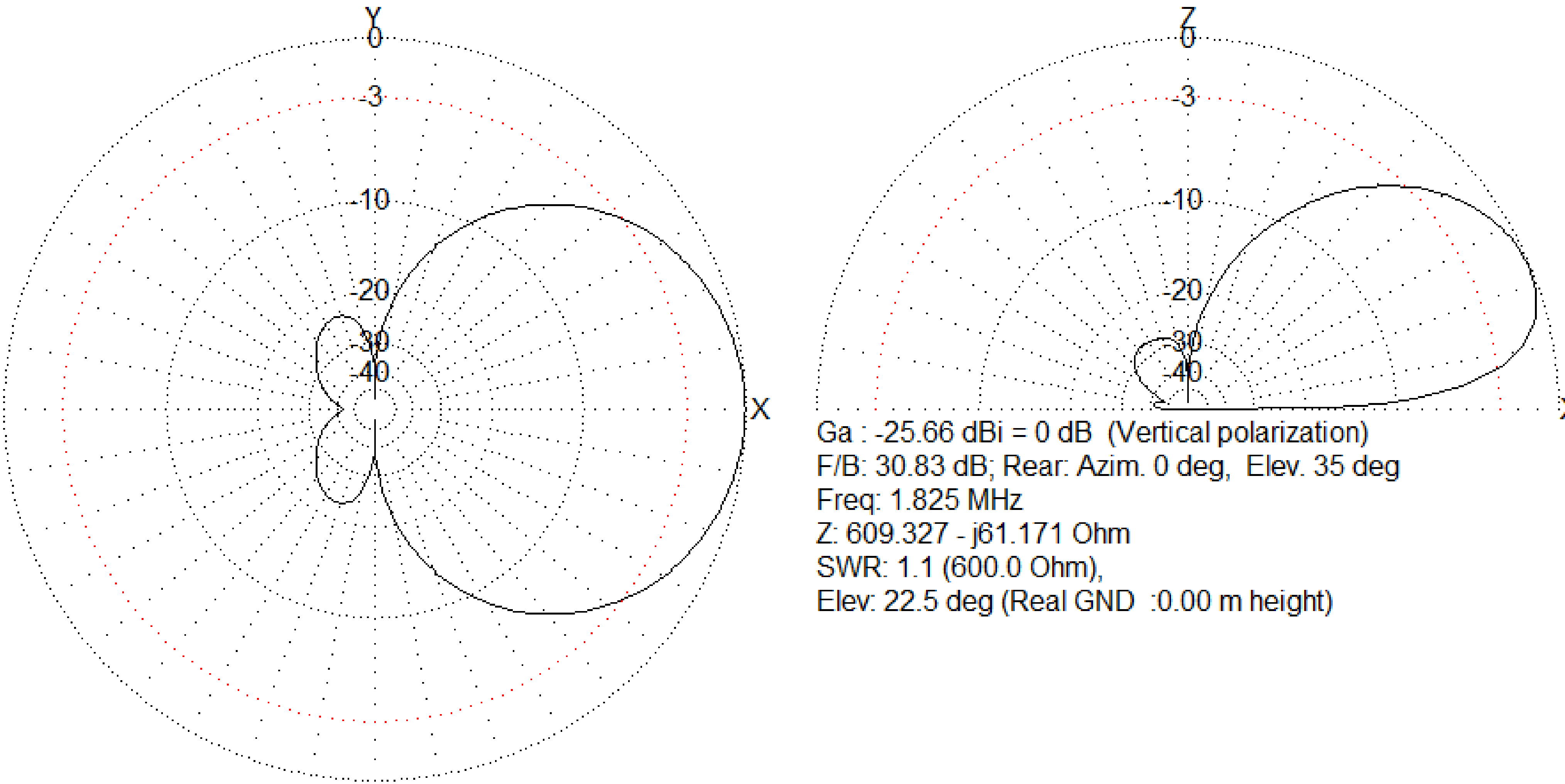
Linear Inline Receiving Antenna

Named after idea generator OH2RA

Total construction length 83m (272'4“)
Bottom wires at 2.4m (7' 10“)
Material 4mm Aluminum
Triangle height 8.1m (26'7“)
Construction width 3m (10')
Loads 920 ohm
Feeds 600 ohm (180 deg phase)

2x LIRA

Linear Inline Receiving Antenna



ZERO RADIO CLUB
RADIATORS
AH0K OH0K OH4A OH0V

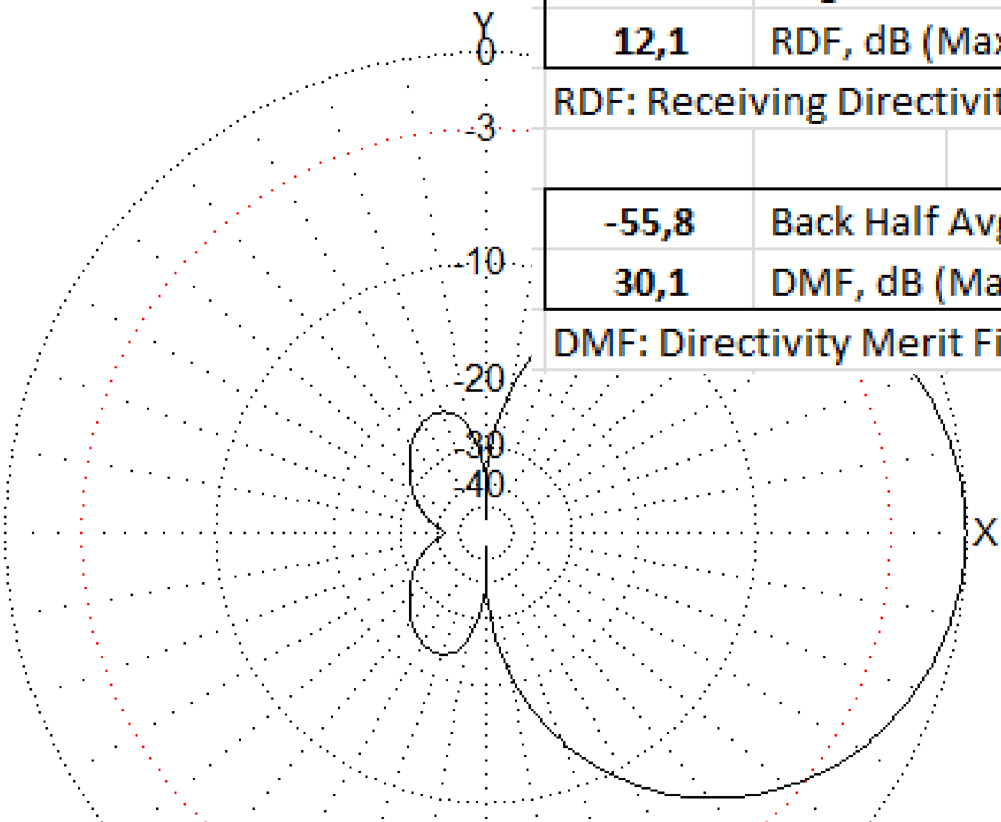
2x LIRA

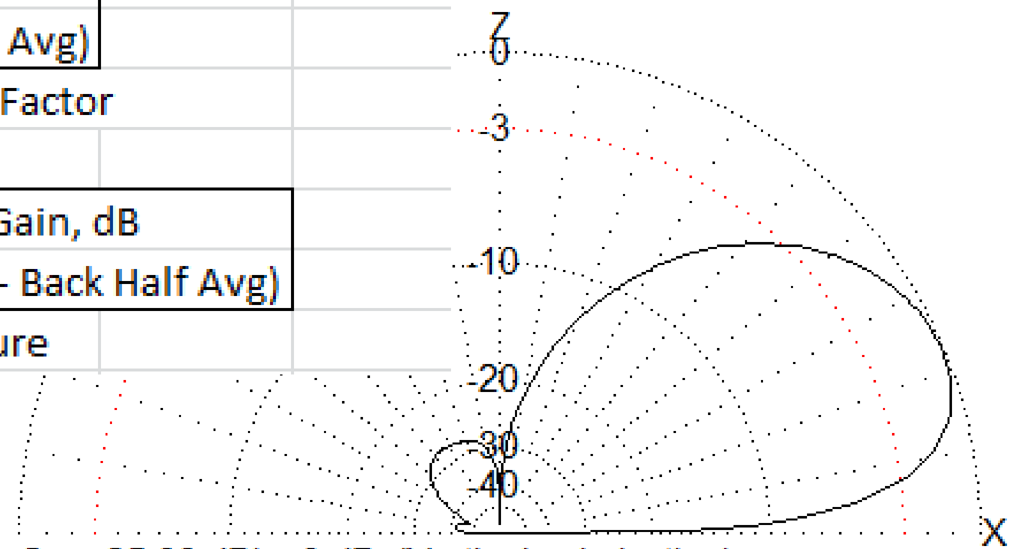
-25,7	Max 3D Gain, dBi	(at Az = 0°, El = 23°)
-37,8	Avg Gain, dB	
12,1	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-55,8	Back Half Avg Gain, dB
30,1	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -25.66 dBi = 0 dB (Vertical polarization)
F/B: 30.83 dB; Rear: Azim. 0 deg, Elev. 35 deg
Freq: 1.825 MHz
Z: 609.327 - j61.171 Ohm
SWR: 1.1 (600.0 Ohm),
Elev: 22.5 deg (Real GND :0.00

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin	**-0,8 dB**

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	13,8%
Leaking Index	**4,6 %**

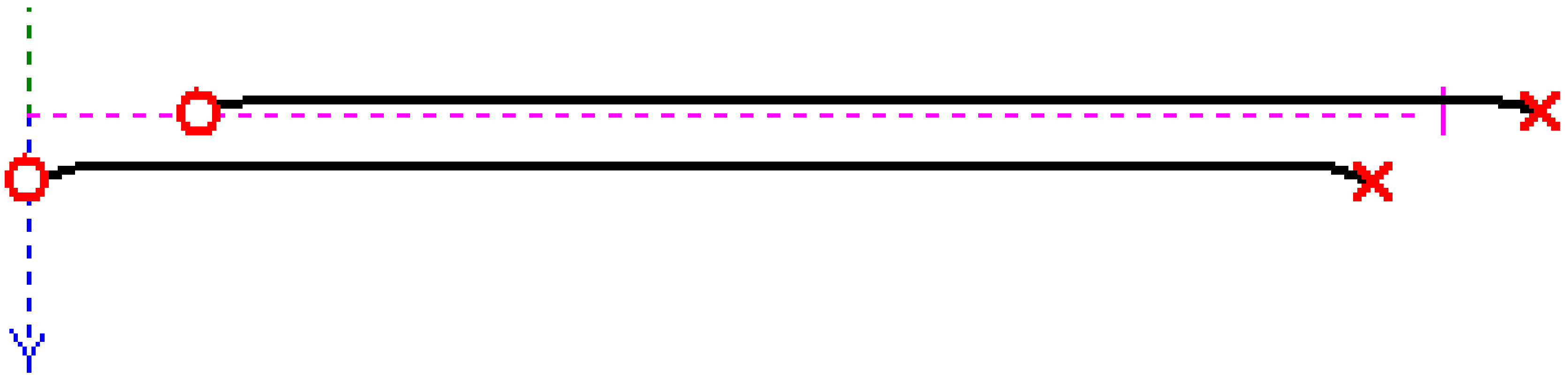
Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	46	-5,4	76,7	8,0	3,0	8,5
01 Triangle v01.csv	-34,6	0°	35°	-42,4	7,8	-47,4	12,8	64	12,6	76,7	8,0	3,0	8,5
02 Bigger Triangle v02.csv	-27,1	0°	35°	-34,9	7,7	-39,8	12,6	46	2,1	75,1	15,0	3,0	10,5
03 Smaller Triangle v03.csv	-43,7	0°	34°	-51,6	7,8	-56,6	12,9	64	3,4	75,1	5,0	2,0	6,0
04 Smaller Triangle v03 80m.csv	-32,6	0°	37°	-40,4	7,8	-45,2	12,6	56	6,6	76,0	5,0	2,0	6,0
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5
08 Smaller Twin Triangle v03.csv	-39,9	0°	25°	-51,4	11,5	-61,7	21,8	64	3,6	34,9	25,0	3,0	9,5
08 Smaller Twin Triangle v03 80m.c	-23,2	0°	26°	-34,5	11,3	-43,6	20,3	56	12,5	39,5	25,0	3,0	9,5
10 LIXA proto 201611.csv	-33,5	0°	27°	-43,3	9,9	-53,3	19,9	46	-6,3	46,2	22,8	3,0	7,8
10 LIXA proto 201611 80m.csv	-17,0	0°	31°	-26,3	9,4	-35,8	18,9	38	2,7	43,6	22,8	3,0	7,8
11 2x LIRA v4.csv	-25,7	0°	23°	-37,8	12,1	-55,8	30,1	46	-0,8	4,6	83,0	3,0	10,5

New performance level
RDF still worse than 250m beverage
DMF and Leaking Index show exceptional performance
Antenna total land area 83 x 3 m

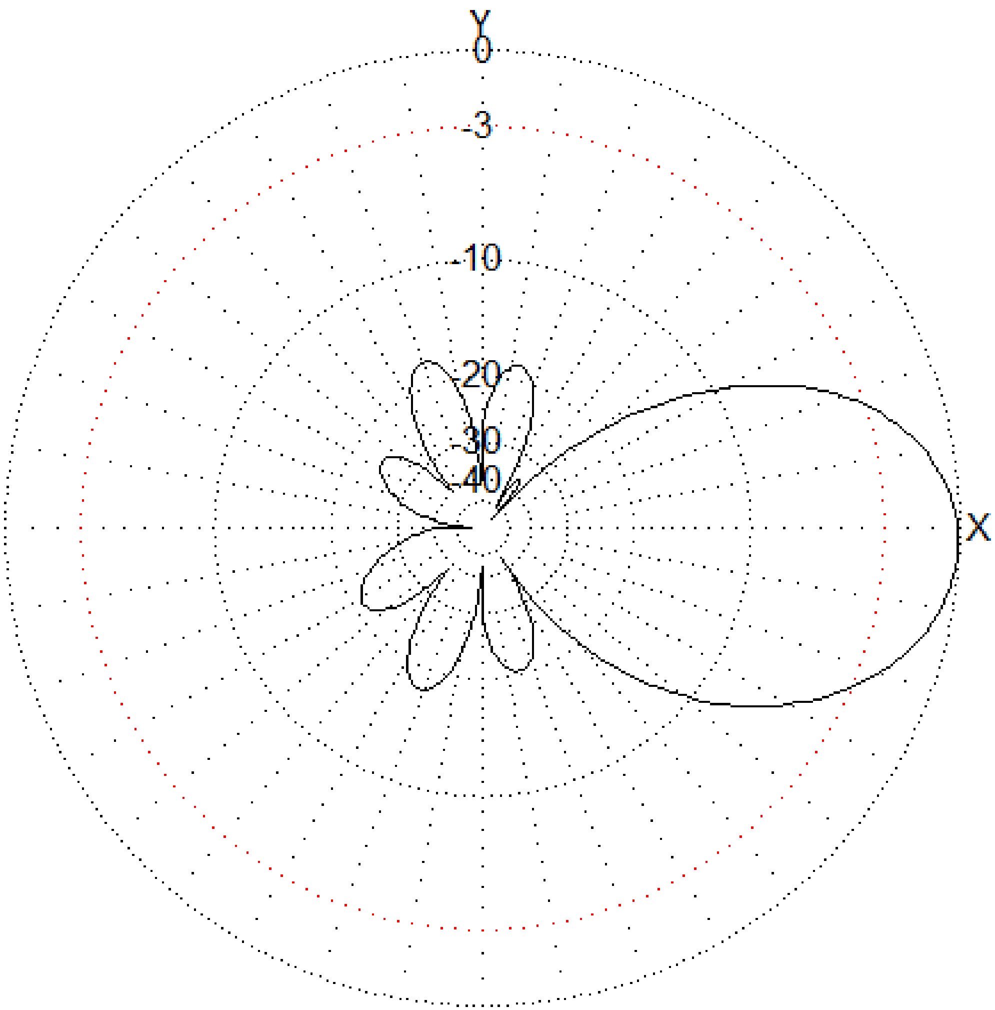
Noise Margin too small for the most Quiet Rural QTH

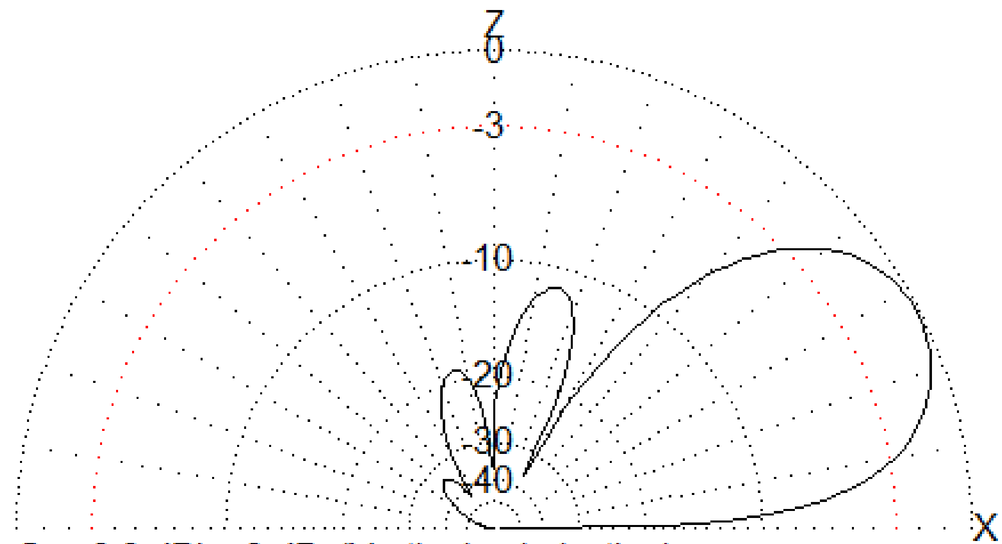
Staggered 320m Beverages



Construction length 360m (1181 ft)
Height 3m (10')
Width 100m (328')
Feed 500 ohm, 90 deg phasing
Loads 450 ohm

Staggered 320m Beverages





Ga : 0.3 dBi = 0 dB (Vertical polarization)
F/B: 33.78 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 440.527 - j95.983 Ohm
SWR: 1.3 (500.0 Ohm),
Elev: 26.9 deg (Real GND :0.00 m height)

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

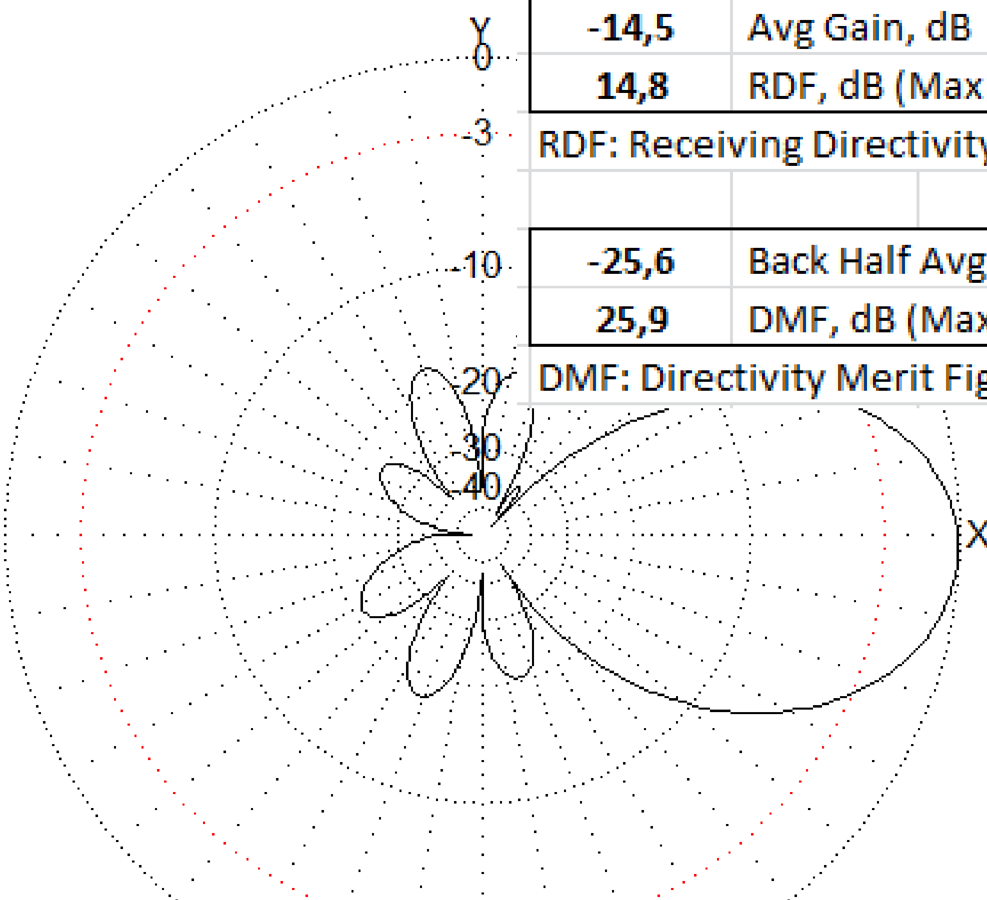
Staggered 320m Beverages

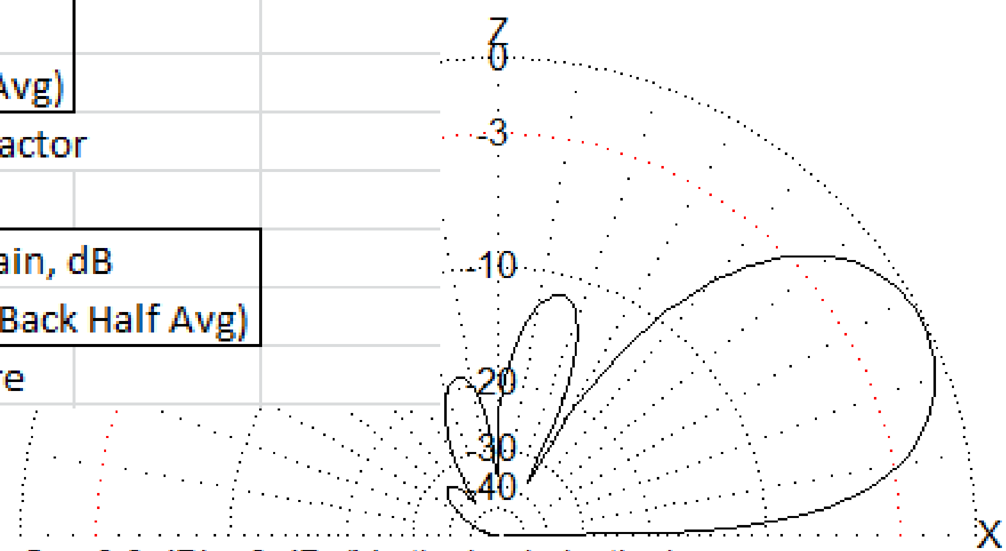
0,3	Max 3D Gain, dBi	(at Az = 358°, El = 27°)
-14,5	Avg Gain, dB	
14,8	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-25,6	Back Half Avg Gain, dB
25,9	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : 0.3 dBi = 0 dB (Vertical polarization)
F/B: 33.78 dB; Rear: Azim. 0 deg, Elev. 40 deg
Freq: 1.825 MHz
Z: 440.527 - j95.983 Ohm
SWR: 1.3 (500.0 Ohm),
Elev: 26.9 deg (Real GND :0.00 m height)

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin **22,5 dB**

dB below Max Gain	3 level analysis
12	0,0%
18	9,5%
24	35,5%
Leaking Index	**15,0 %**

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5
08 Smaller Twin Triangle v03.csv	-39,9	0°	25°	-51,4	11,5	-61,7	21,8	64	3,6	34,9	25,0	3,0	9,5
08 Smaller Twin Triangle v03 80m.(	-23,2	0°	26°	-34,5	11,3	-43,6	20,3	56	12,5	39,5	25,0	3,0	9,5
10 LIXA proto 201611.csv	-33,5	0°	27°	-43,3	9,9	-53,3	19,9	46	-6,3	46,2	22,8	3,0	7,8
10 LIXA proto 201611 80m.csv	-17,0	0°	31°	-26,3	9,4	-35,8	18,9	38	2,7	43,6	22,8	3,0	7,8
11 2x LIRA v4.csv	-25,7	0°	23°	-37,8	12,1	-55,8	30,1	46	-0,8	4,6	83,0	3,0	10,5
12 Beverage staggered 320m v4.cs	0,3	358°	27°	-14,5	14,8	-25,6	25,9	46,0	22,5	15,0	350,0	100,0	3,0

RDF is benchmark 14.8 dB
DMF dropped to 25.9 dB from 30.1 dB of 2x LIRA
Leaking Index increased to 15% from 4,6%

2x LIRA gives a good challenge to staggered beverages of 360x100m as a 83x3m land area antenna

2x LIRA in Picture

2x LIRA
First prototype

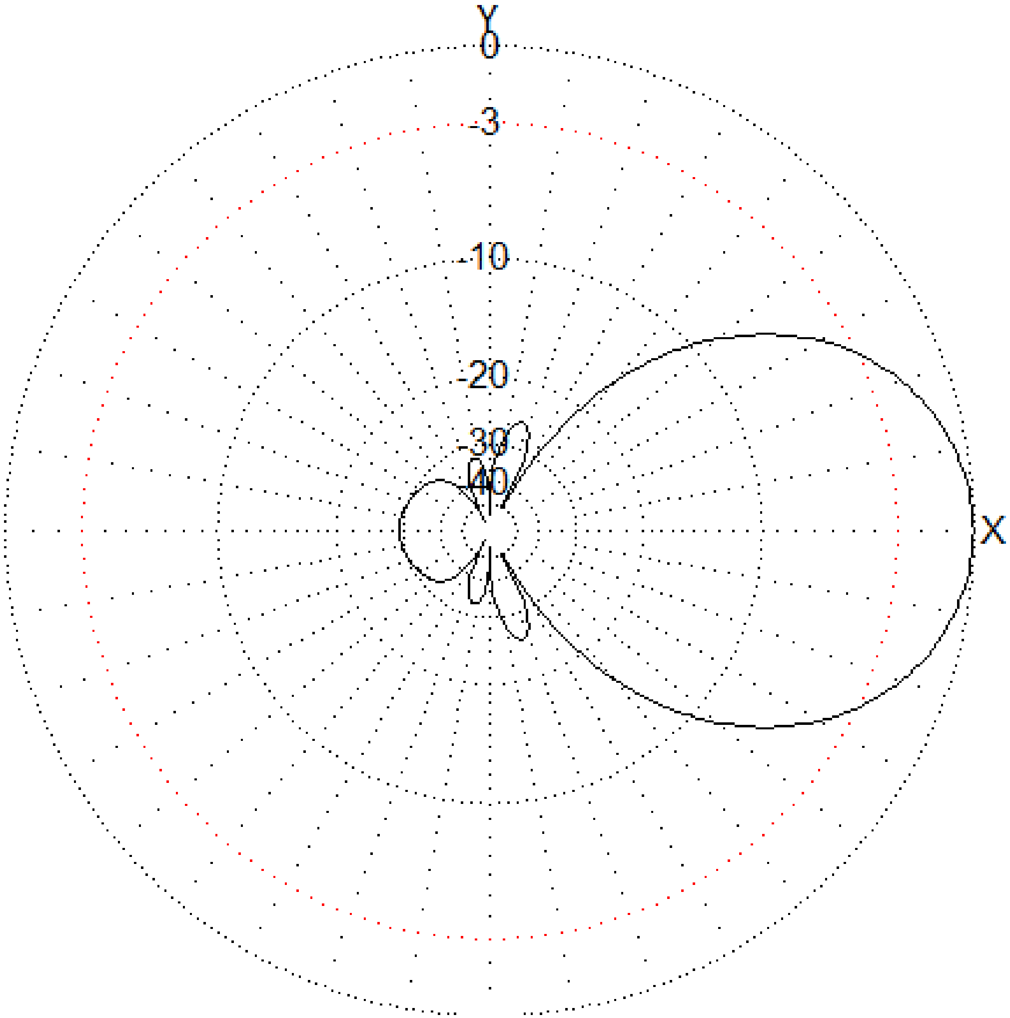
Under testing
since Dec 2016

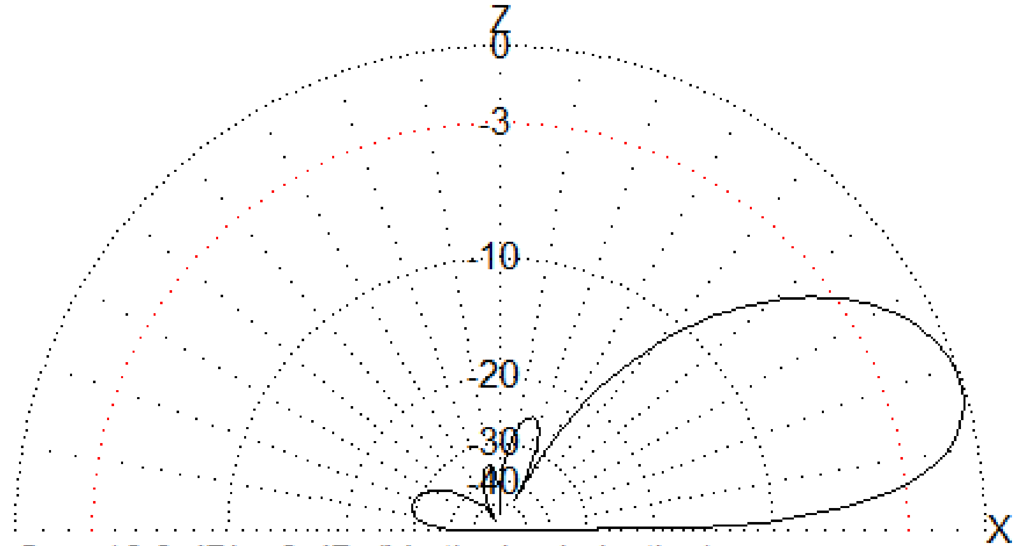
Southeastern
Finland

4x LIRA

Maximum Performance Receiving Antenna

4x LIRA





Ga : -18.3 dBi = 0 dB (Vertical polarization)
F/B: 28.81 dB; Rear: Azim. 0 deg, Elev. 35 deg
Freq: 1.825 MHz
Z: 639.841 + j68.441 Ohm
SWR: 1.1 (600.0 Ohm),
Elev: 18.2 deg (Real GND :0.00 m height)

Maximum Performance Receiving Antenna

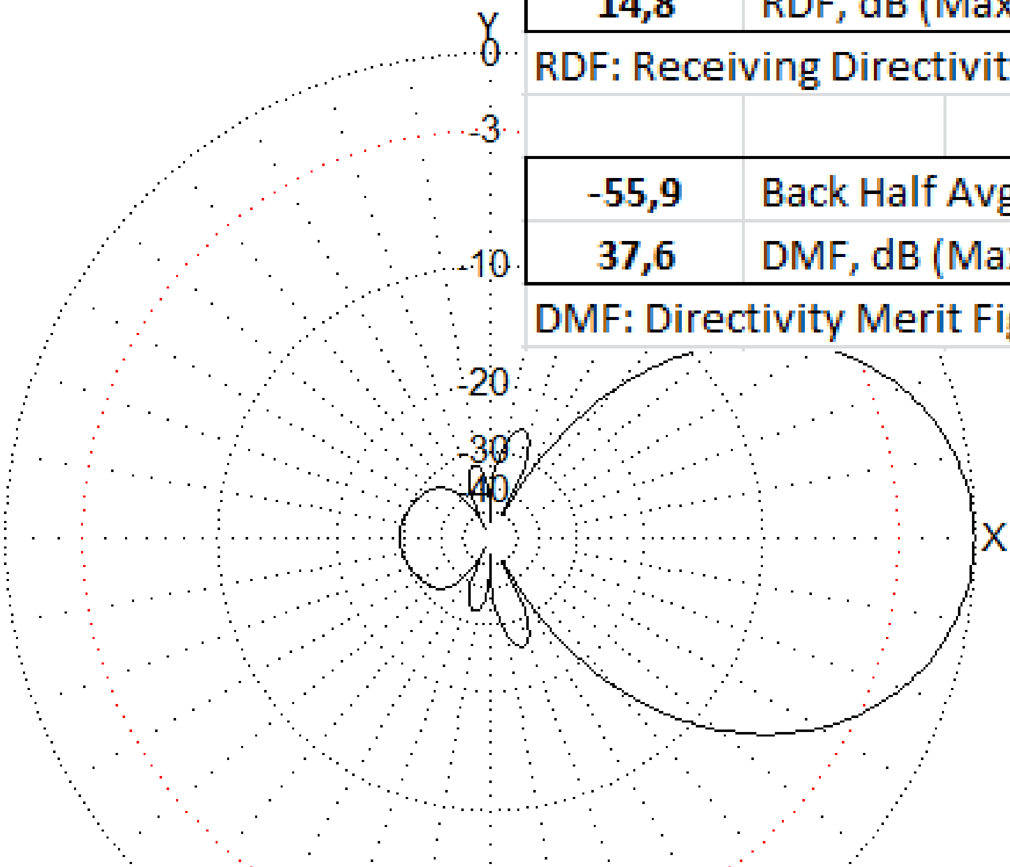
4x LIRA

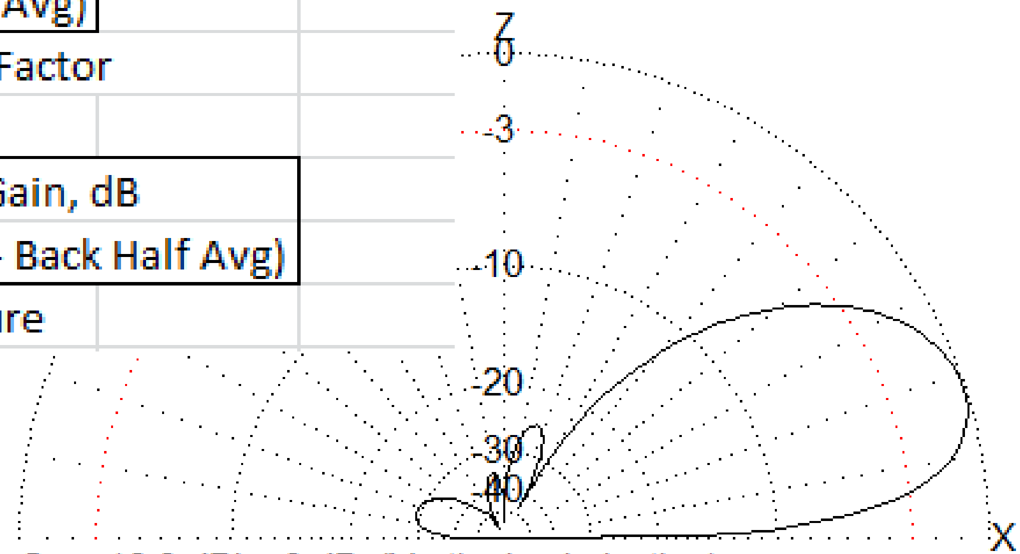
-18,3	Max 3D Gain, dBi	(at Az = 0°, El = 19°)
-33,1	Avg Gain, dB	
14,8	RDF, dB (Max - Avg)	

RDF: Receiving Directivity Factor

-55,9	Back Half Avg Gain, dB
37,6	DMF, dB (Max - Back Half Avg)

DMF: Directivity Merit Figure





Ga : -18.3 dBi = 0 dB (Vertical polarization)
F/B: 28.81 dB; Rear: Azim. 0 deg, Elev. 35 deg
Freq: 1.825 MHz
Z: 639.841 + j68.441 Ohm
SWR: 1.1 (600.0 Ohm),
Elev: 18.2 deg (Real GND :0.(

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	0,0%
Leaking Index	0,0 %

	User input	
Noise Level P.372-13	46	dB
Feed System Losses	2	dB
RX Noise Figure	4	dB

Result:

Noise Margin	3,9 dB

Maximum Performance Receiving Antenna

4x LIRA

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	0,0%
Leaking Index	**0,0 %**

Maximum Performance Receiving Antenna

4x LIRA

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	0,0%
Leaking Index	**0,0 %**

	User input	
Begin at azimuth	70	degrees
End at azimuth	290	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	0,0%
Leaking Index	**0,0 %**

Maximum Performance Receiving Antenna

4x LIRA

	User input	
Begin at azimuth	80	degrees
End at azimuth	280	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	0,0%
Leaking Index	**0,0 %**

	User input	
Begin at azimuth	70	degrees
End at azimuth	290	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	0,0%
24	0,0%
Leaking Index	**0,0 %**

	User input	
Begin at azimuth	50	degrees
End at azimuth	310	degrees

dB below Max Gain	3 level analysis
12	0,0%
18	0,4%
24	2,5%
Leaking Index	**1,0 %**

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Comparison

Antenna pattern file name	Gmax dBi	At Azim	At Elev	Gaver dB	RDF dB	Back Gaver dB	DMF dB	QTH Noise Lvl dB	Noise Margin dB	Leaking Index %	Length m	Width m	Height m
05 Beverage 170m.csv	-7,4	0°	39°	-18,0	10,6	-24,6	17,2	46	19,0	51,4	170,0	2,0	3,0
06 Beverage 250m.csv	-4,6	0°	31°	-16,8	12,2	-24,7	20,1	46	20,2	43,2	250,0	2,0	3,0
07 Twin Triangle v02.csv	-23,3	0°	26°	-34,5	11,2	-43,5	20,1	46	2,5	41,8	58,0	3,0	12,5
08 Smaller Twin Triangle v03.csv	-39,9	0°	25°	-51,4	11,5	-61,7	21,8	64	3,6	34,9	25,0	3,0	9,5
08 Smaller Twin Triangle v03 80m.	-23,2	0°	26°	-34,5	11,3	-43,6	20,3	56	12,5	39,5	25,0	3,0	9,5
10 LIXA proto 201611.csv	-33,5	0°	27°	-43,3	9,9	-53,3	19,9	46	-6,3	46,2	22,8	3,0	7,8
10 LIXA proto 201611 80m.csv	-17,0	0°	31°	-26,3	9,4	-35,8	18,9	38	2,7	43,6	22,8	3,0	7,8
11 2x LIRA v4.csv	-25,7	0°	23°	-37,8	12,1	-55,8	30,1	46	-0,8	4,6	83,0	3,0	10,5
12 Beverage staggered 320m v4.cs	0,3	358°	27°	-14,5	14,8	-25,6	25,9	46,0	22,5	15,0	350,0	100,0	3,0
13 4x LIRA L216 v2.csv	-18,3	0°	19°	-33,1	14,8	-55,9	37,6	46,0	3,9	0,0	216,0	3,0	13,0

RDF is same as staggered long beverages 14.8 dB
DMF increased to 37,6 dB – much better than any other antenna
Leaking Index 0 %

4x LIRA searches for a test location
Excellent usage for 216x3m land area

Maximizing own QTH?

- New tools open up new possibilities in finding the best alternative also to residential QTH operators
- You do not need a big land area to improve
- If you have a big land area, there is room and now also an opportunity for improvement

- Set criteria, compare, choose, design, build and Operate

ZERO RADIO CLUB RADIATORS AH0K OH0K OH4A OH0V

Conclusion

- One or two numbers alone is too simplified way to look at receiving antenna performance
- Noise Margin is a new amplification metric

- For pattern quality the RDF, DMF, Leaking Index and any combination are now available

- Receiving antenna metrics develop with computing capabilities
- Future: optimizing based on new metrics

Thank You for Listening

- Questions ?

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