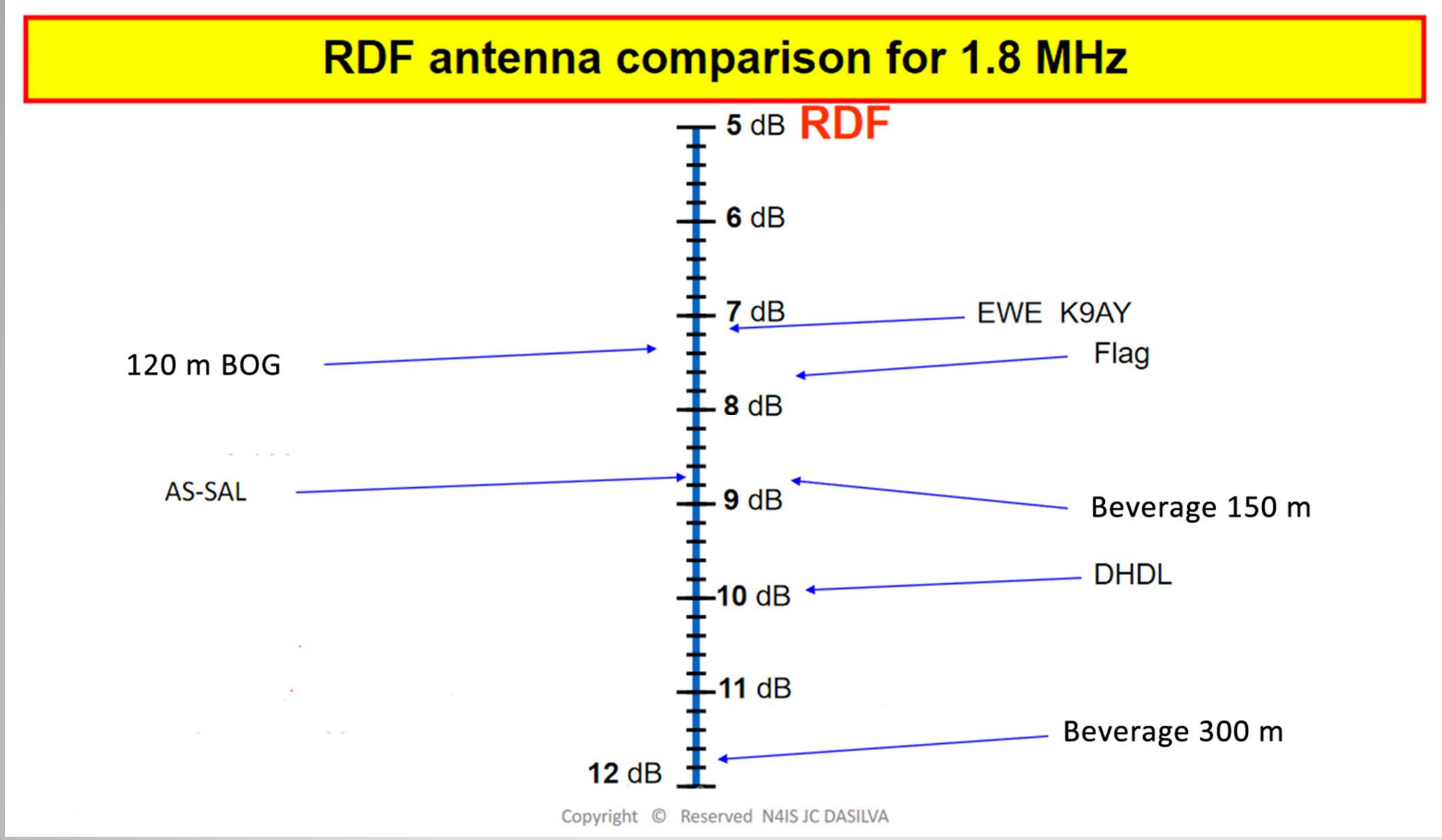
# How much Negative Gain can we tolerate with RX antennas?

- Modern receivers are very sensitive.
- If you can easily hear an increase in background noise when switching from a dummy load to an RX antenna under quietest conditions, then gain is sufficient.
- -10 to -20 dBi Gain is generally fine for most occasions.

**RX Antennas – Do any good?**

- It's all about the Signal-to-Noise ratio
  - –Not antenna gain
  - –Not about your S-meter reading
- Pattern is the most important attribute

# Comparison Chart of Different Rx antennas




| Antenna | Gain dBi | RDF | Front/ Back dB | Beam-width |
|---|---|---|---|---|
| Beverage pair 300 m, 120 m space | -2.9 | 14.6 | 40 | 35° |
| Beverage 300 m | -6.4 | 12.3 | 31 | 63° |
| Beverage 150 m | -10.6 | 9.0 | 23.9 | 80° |
| Beverage 90 m | -14.5 | 6.5 | 9.9 | 89° |
| 4 square of K9AY loops | -22.2 | 9.1 | 18.9 | 58° |
| K9AY loop | -25.6 | 7.2 | 11.5 | 163° |
| Flag | -29.7 | 7.4 | 22.8 | 146° |
| Flag array 20x5 m staggered 30 m | -29,6 | 10 | 30,7 | 98° |

**RDF**: Receiving Directivity Factor (RDF) compares forward gain at a desired direction and elevation angle versus average gain over the entire sphere.

Gain, front to back, and RDF computed at 20 degrees elevation over average ground and at 1.850 Mhz.

## Comparing Beverages and Beverage Arrays

| Antenna description | DMF dB | RDF dB | 3-dB-Angle Degrees | Gain dBi |
|---|---|---|---|---|
| 80-m Long Beverage | 11.1 | 7.3 | 90 | −16 |
| 160-m Long Beverage | 19.0 | 10.2 | 78 | −10 |
| 300-m Long Beverage | 21.3 | 12.9 | 62 | −5 |
| Broadside 80-m Beverages, 90-m Spacing | 14.4 | 9.6 | 48 | −13.3 |
| Broadside 160-m Beverages, 90-m Spacing | 21.3 | 11.9 | 48 | −7 |
| Broadside 300-m Beverages, 90m Spacing | 23.1 | 14.2 | 44 | −2 |
| 80-m Long End-Fire Beverages, Stagger = 30 m, φ = 140° | 20.0 | 9.7 | 77 | −15.5 |
| 160-m Long End-Fire Beverages, Stagger = 30m, φ = 140° | 30.1 | 11.6 | 69 | −9 |
| 300-m Long End-Fire Beverages, Stagger = 30 m, φ = 140° | 33.8 | 13.9 | 57 | -4 |
| 160m Beverages in End-Fire/Broadside Array (*1) | 34.0 | 13.0 | 46 | -6.4 |
| 160-m Beverages in End-Fire/Broadside Array (*2) | 34.7 | 14.1 | 34 | -6.4 |

(*1): End-Fire Cell: φ = 140°, Stagger = 30 m, Broadside Spacing: 90 m
(*2): End-Fire Cell: φ = 140°, Stagger = 30 m, Broadside Spacing: 135 m

## Loops and Arrays of Loops

| Antenna description | DMF dB | RDF dB | 3-dB-Angle Degrees | Gain dBi |
|---|---|---|---|---|
| Elongated Terminated Loop (EWE, Flag, K9AY etc) | ~ 11 | 7.5 | ~145 | −29 |
| 2 End-Fire Loops | 21.5 | 9.9 | 98 | −30 |

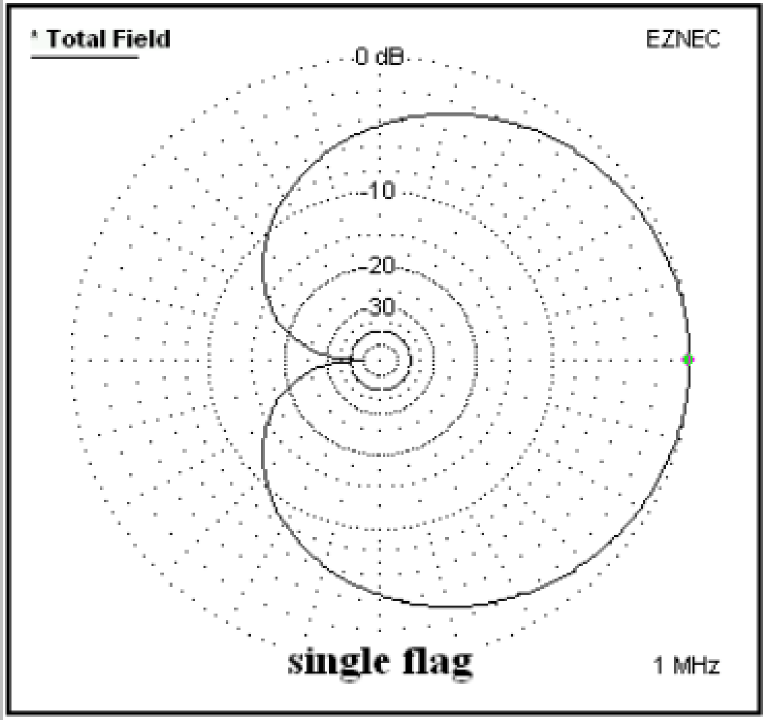
**DMF**: The directivity merit figure (DMF) is the peak front lobe (at a specified elevation angle) gain versus average gain in the entire back azimuth half of the antenna, from 90° to 270° .

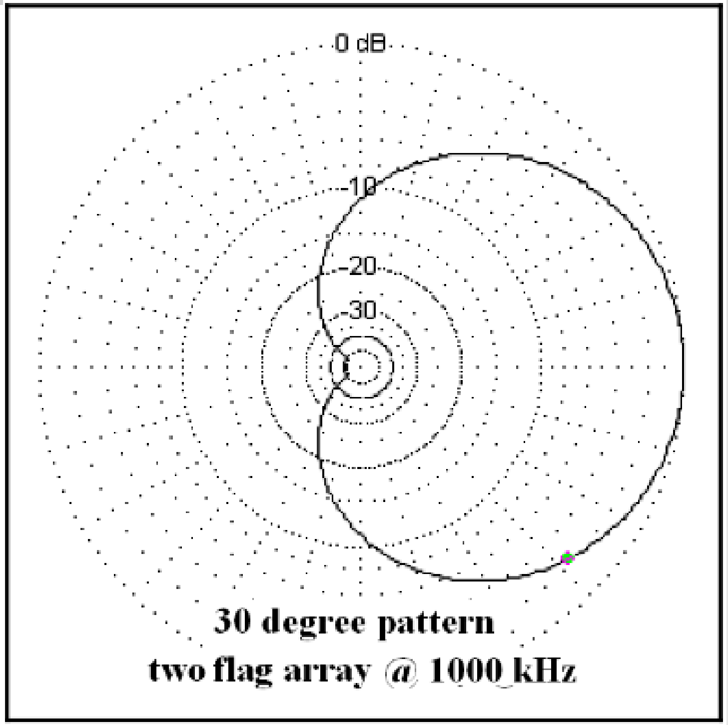
**RDF**: Receiving Directivity Factor (RDF) compares forward gain at a desired direction and elevation angle versus average gain over the entire sphere. RDF includes all areas around and above the antenna, considering noise to be evenly distributed and aligned with the element polarization.

(EZNEC computes antenna RDF)

# Elongated Terminated Loops

- Include Ewe, Flag, Pennant and K9AY
- Terminated loop produces a cardioid pattern
- Depth and angle of null depend on loop shape




Pattern for single Flag
& Endfire Flag Array

| Antenna | Gain dBi | RDF | Front/Back dB | Beam-width |
|---|---|---|---|---|
| Beverage 300 m | -6.4 | 12.3 | 31 | 63° |
| Beverage 150 m | -10.6 | 9.0 | 23.9 | 80° |
| Beverage 90 m | -14.5 | 6.5 | 9.9 | 89° |
| K9AY loop | -25.6 | 7.2 | 11.5 | 163° |
| Flag | -29.7 | 7.4 | 22.8 | 146° |
| Flag array 20x5 m staggered 30 m | -29,6 | 10 | 30,7 | 98° |

# Theory of Operation

- Despite the shape, actually a pair of verticals
- Feedline on top and bottom gives crossfire phasing towards feedpoint when elements closer than ¼ Lambda
- Terminating resistor is equal to feedpoint impedance, and ensures equal current throughout
- Thus, vertical elements have phase difference of 180 deg plus electrical length of connecting wires (slightly more than element spacing)
- This gives the cardioid pattern

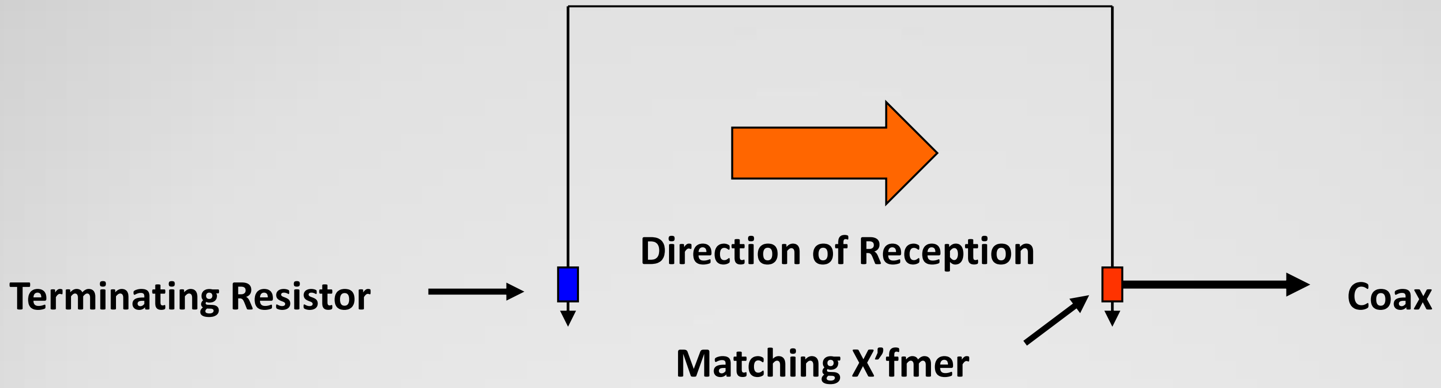
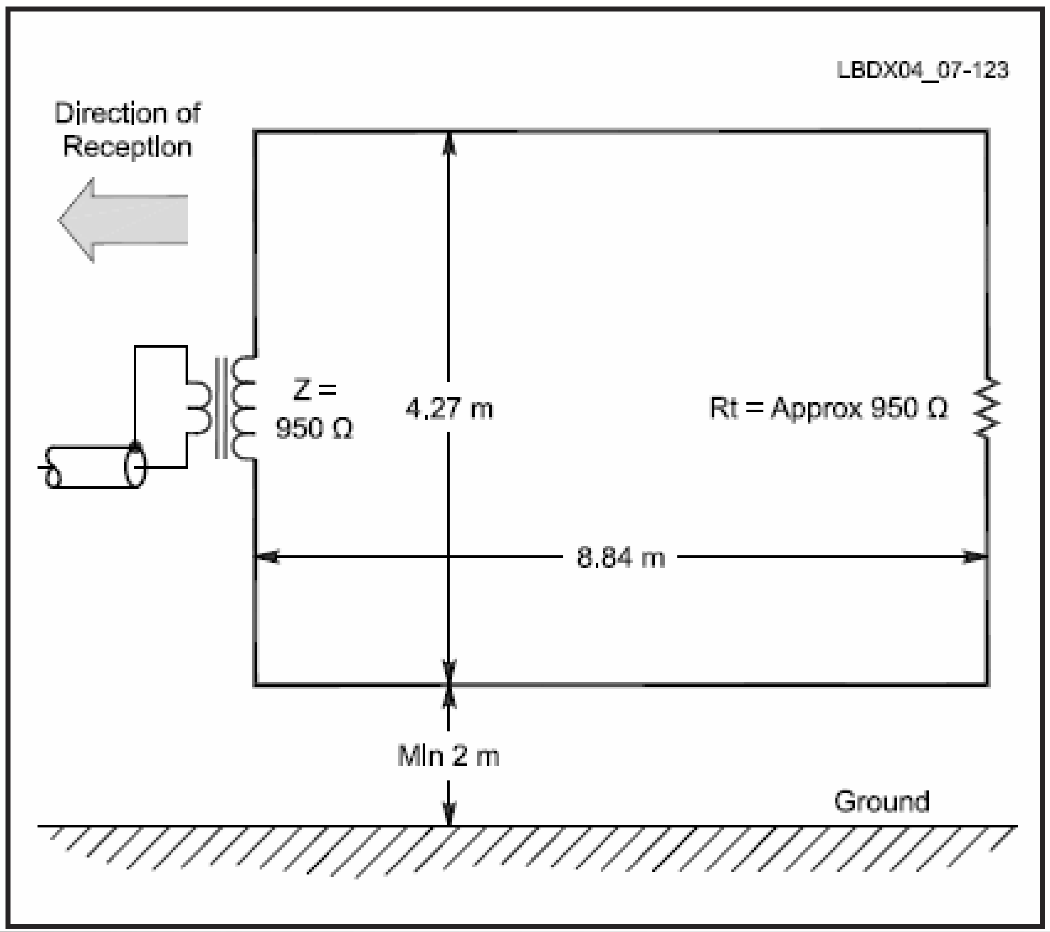
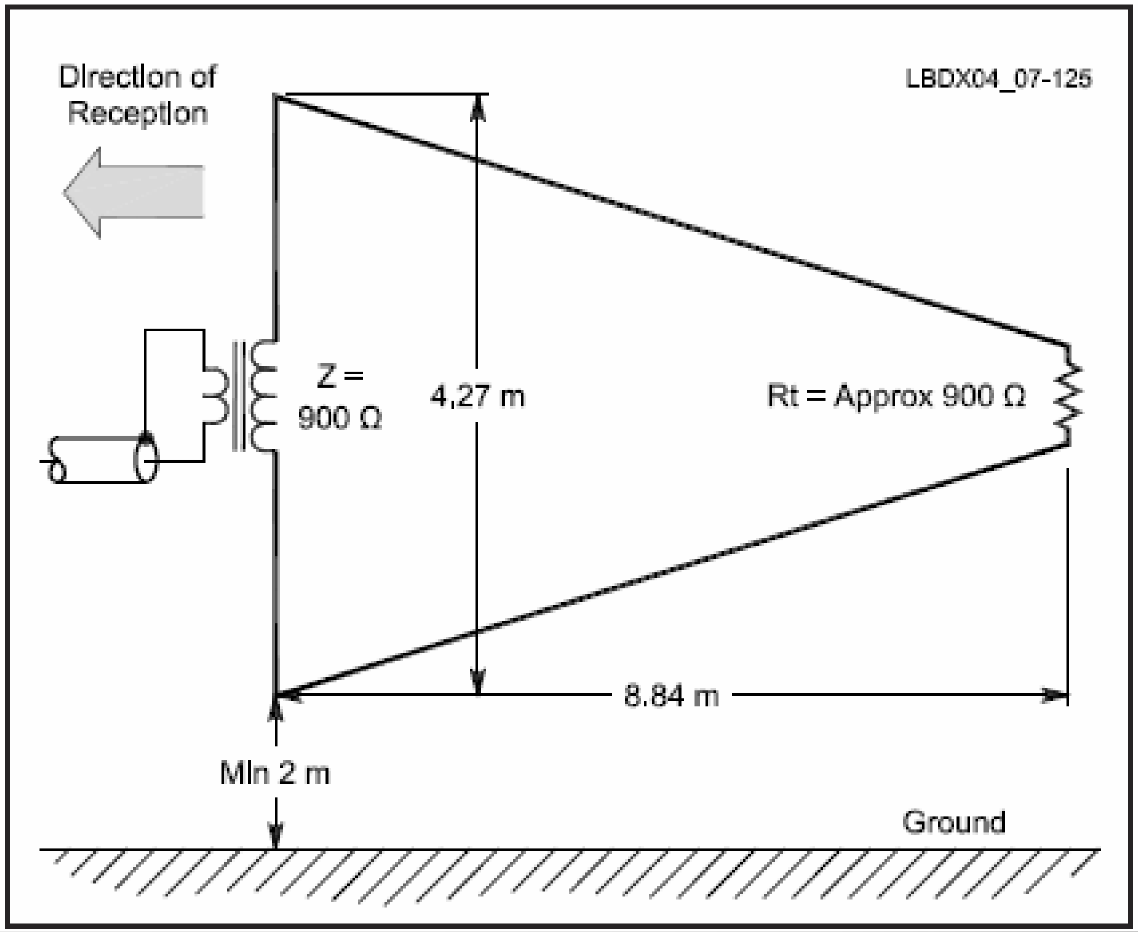


*Diagram from ON4UN's Low Band DXing*

## Flag Antenna

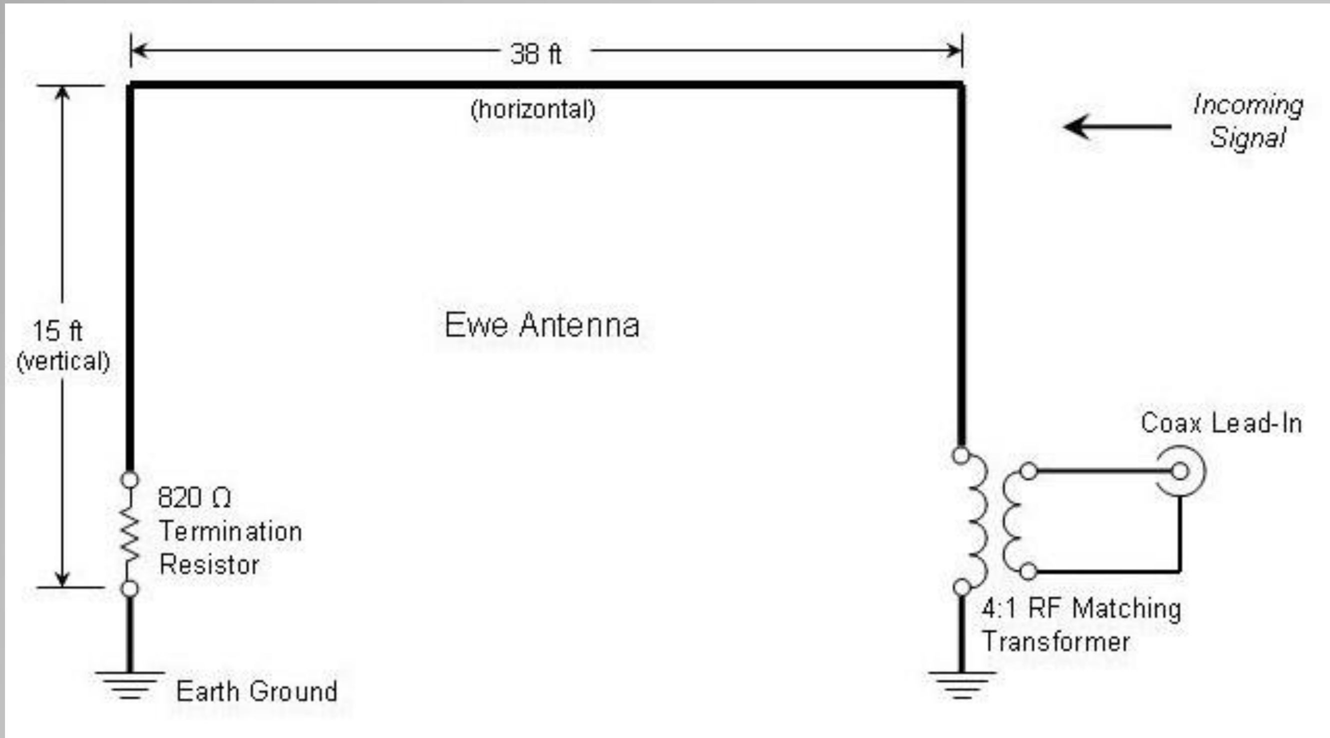



## Pennant Antenna

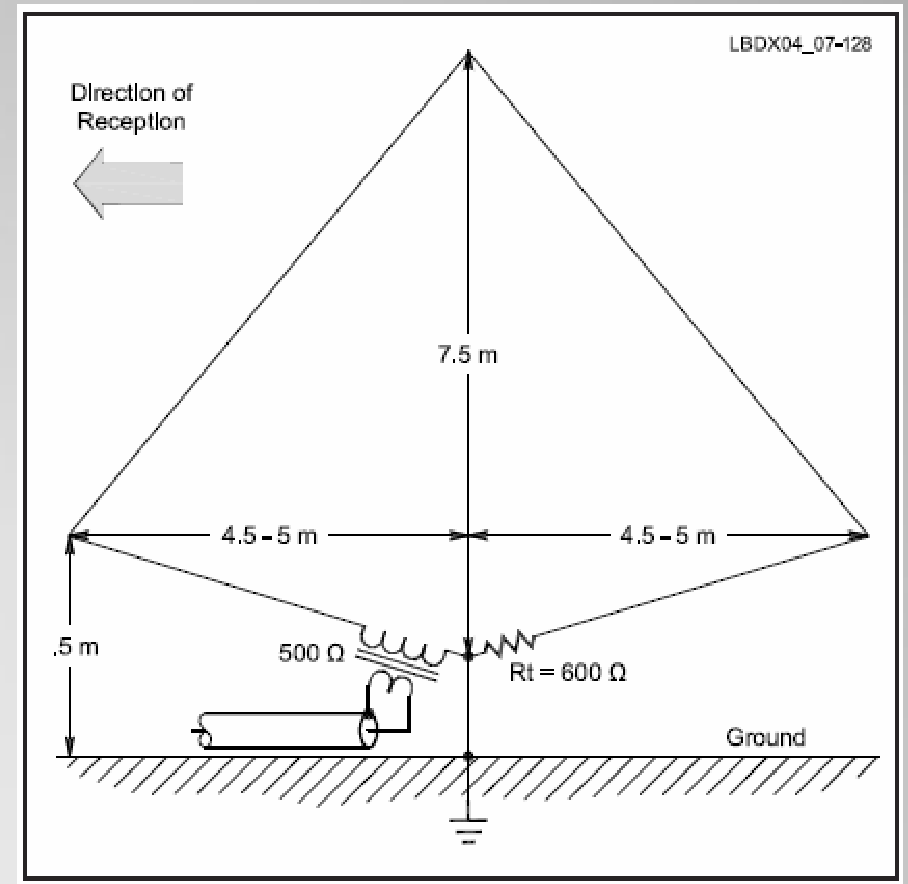



Height of base wire above ground is not a critical value

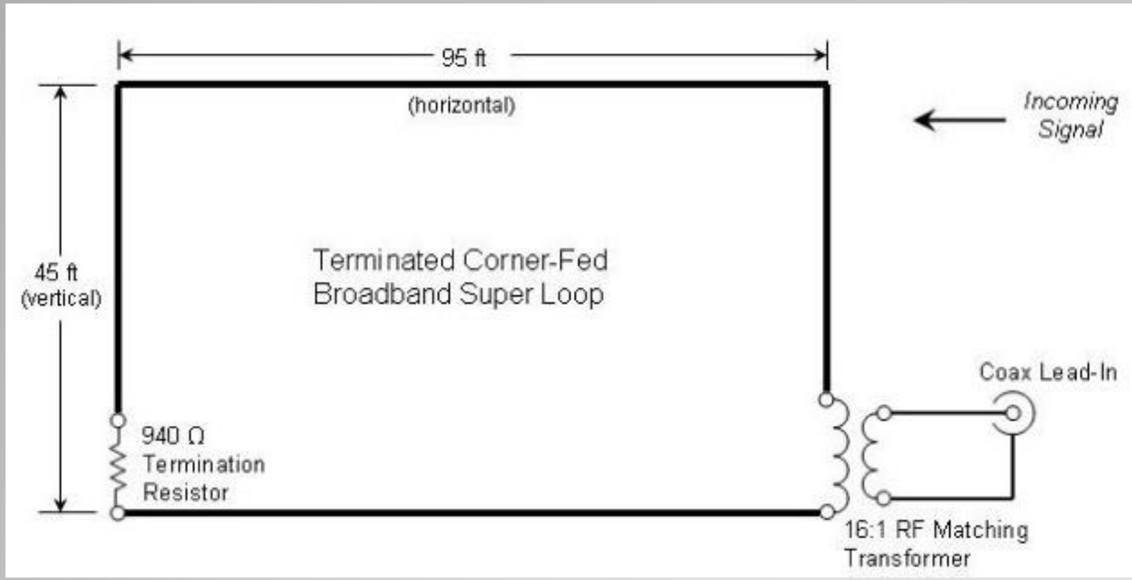
## Ewe Antenna



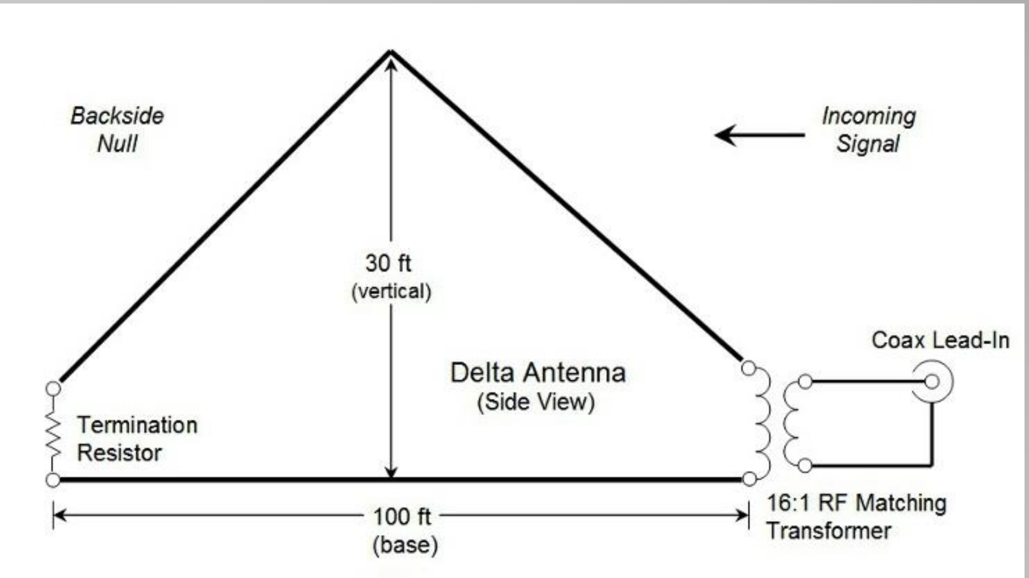

## K9AY Antenna



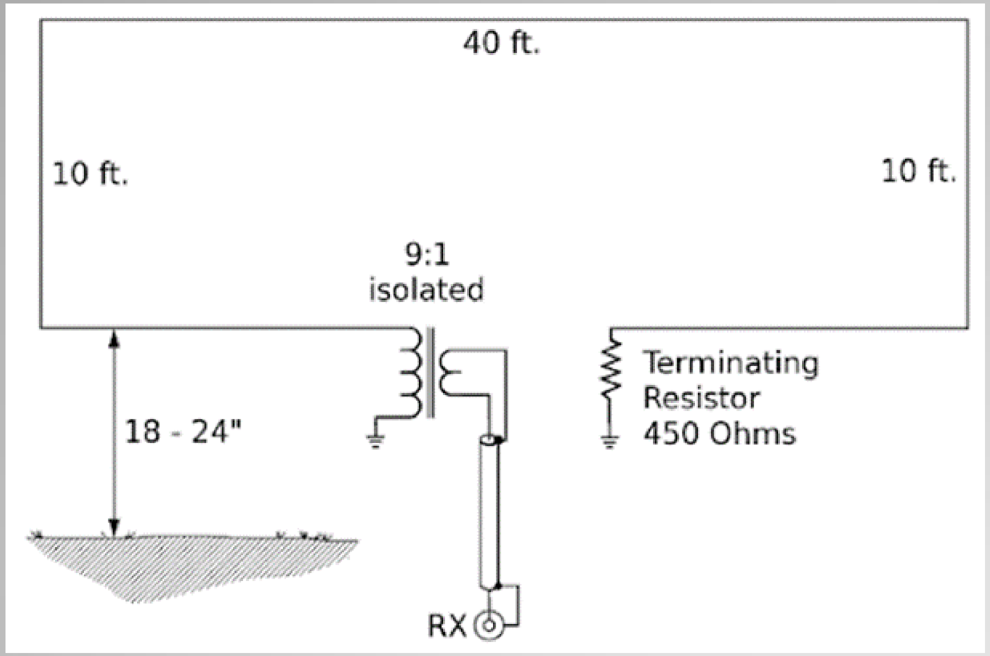
## Broadband Super loop



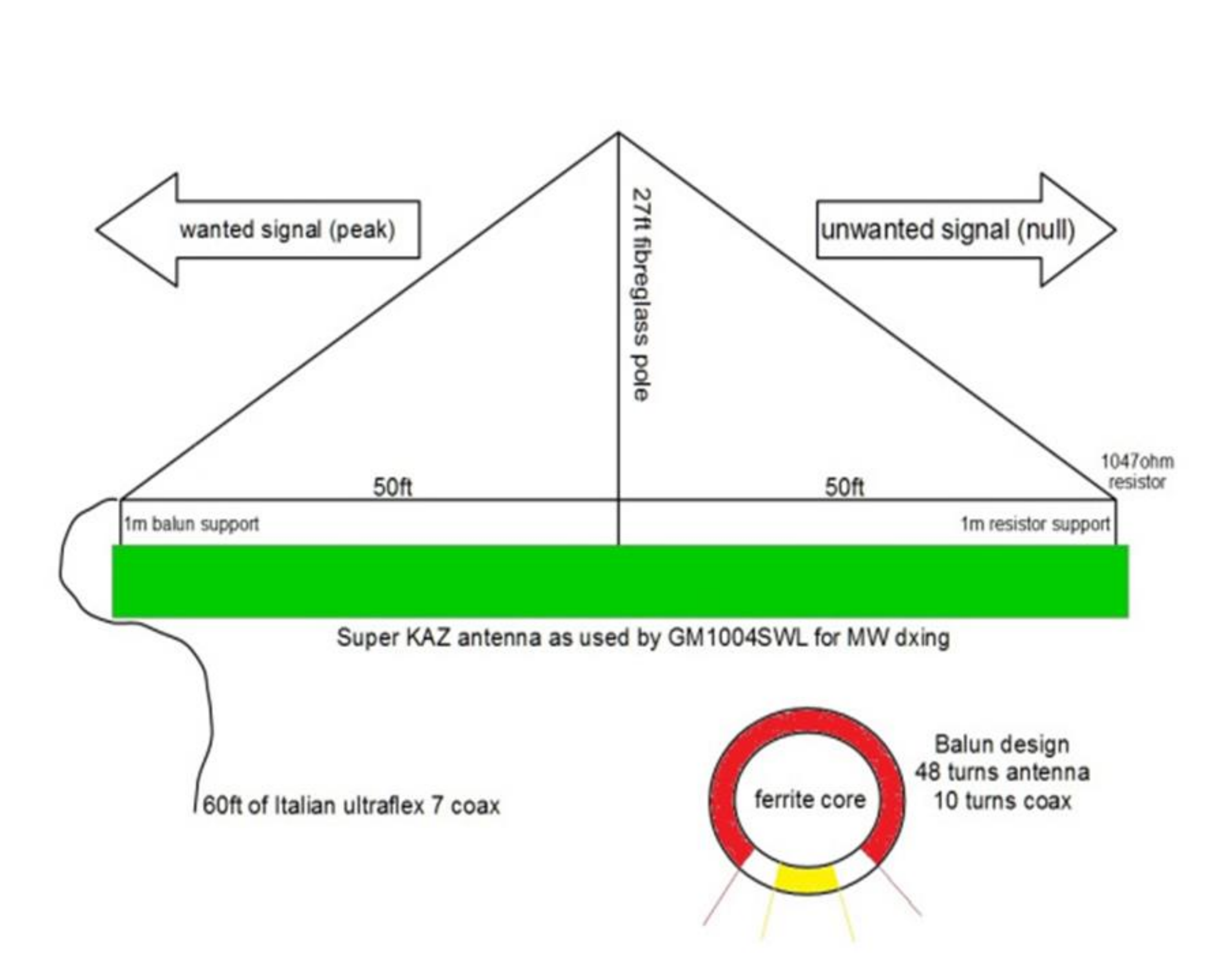

## Delta antenna



## VE3DO Antenna

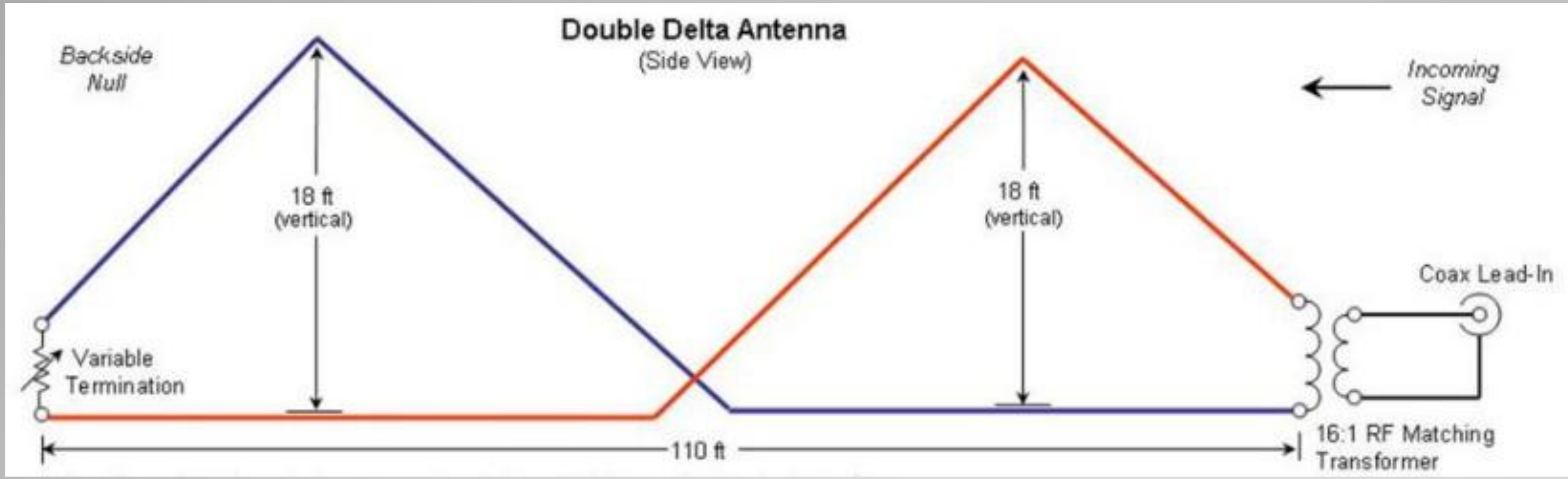


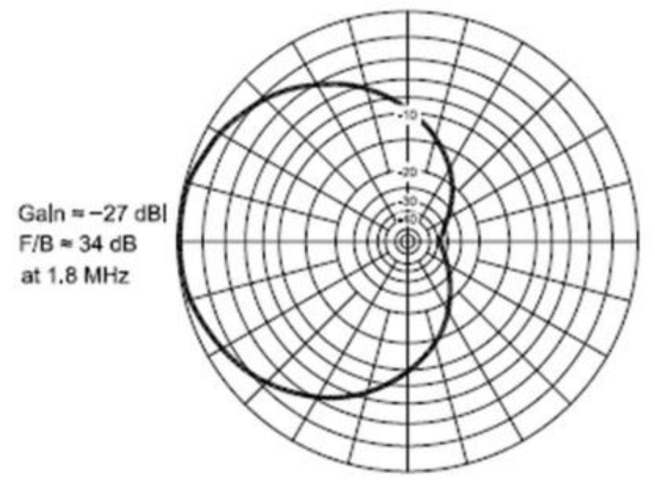

## Super KAZ Antenna




Doubling the loop area: = ~12 dB more gain

# Twisted Double Delta Flag Array (TDDF)

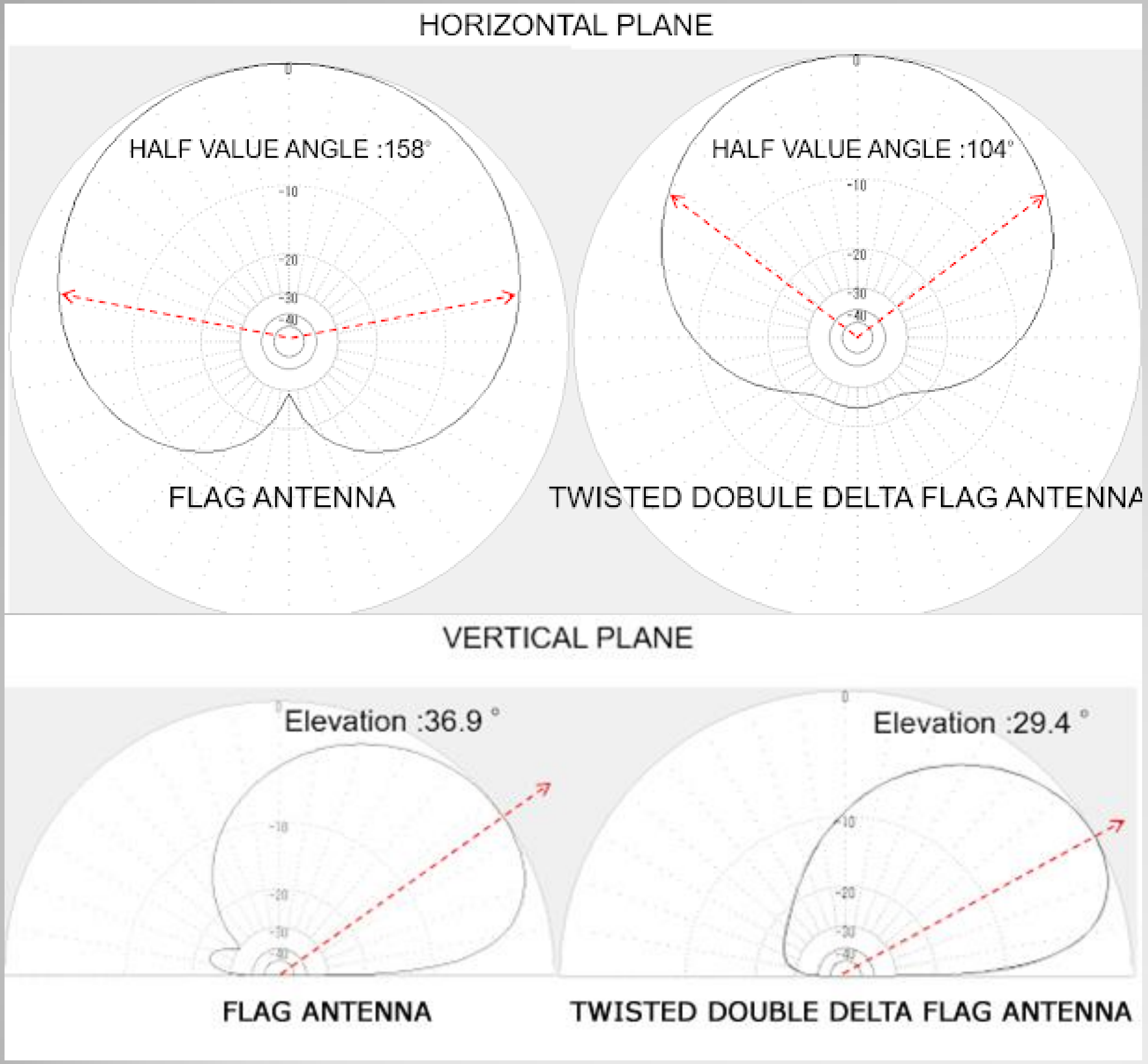



**Thomas Nilsson**: **This TDDF Array can't be recommended** - very poor signal strength and more sensitive to interference than a regular Flag.

**Stefan Wikander**: Exactly, tested one a few years ago. It was bad at just about everything. One cannot understand how anyone can give this positive reviews. **Completely wrong designed**.

# Pattern for Single Flag vs. Twisted Double Delta Flag Array




The figure shows antenna patterns for both antennas in 3D view. The antenna gain of TDDF is 16 dB lower than that of the normal flag antenna. To compensate for the reduction of Gain, a preamplifier with low NF and high IP could be applied.

A properly designed Flag exhibits a high F/B ratio over any type of soil and at virtually any height above ground without need to change the dimensions or termination value.

The Flag antenna is probably the best of all configurations from the standpoint of being broadbanded and having gain.

# Elongated Loop Summary

- **Pros**
  - Small footprint
  - Simplicity
  - Can be phased to improve performance
  - Much better than listening to a vertical!
- **Cons**
  - Insensitive, may require a preamp
  - Directivity not as good as a beverage
  - Feedline prone to noise pickup

Although not as good as Beverage antennas, elongated Loops offer good performance for people who don't have much room.

# K6SE Flag design

**K6SE**: The reason for the Flag designs was to come up with an Ewe-type of receiving antenna which was as  independent of earth ground as possible.

A Flag terminated and fed at its bottom corners was tried when I designed the Flag, but it could only be made to work over a relatively narrow frequency range, which was contrary to my design criteria. Stay with the feedpoint and termination in the centers of the vertical sections and the antenna will work quite well over several octaves.

The Flag antennas are 20' high at the top and 6' high at the bottom. No change in size or termination value over different types of ground. All antennas were modeled at 1830 kHz.

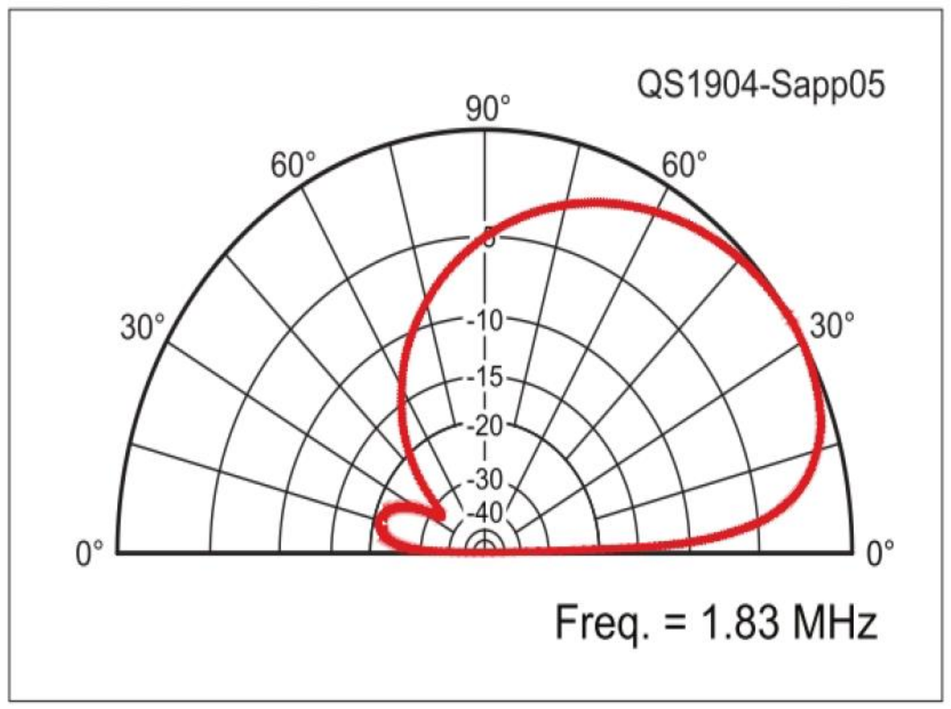
Over soil of better or worse conductivity, that EWE will perform poorly unless its demensions and termination are adjusted for the soil conditions. A properly designed Flag will exhibit a high F/B ratio over any type of soil and at virtually any height above ground without need to change its dimensions or termination value. If you find that the EWE works better with a ground wire beneath it, that means the dimensions are incorrect for the soil conditions there.

# Take Off Angle

The gain figures are in dBi. "TOA" is the take-off angle of maximum gain.
The -3 dB points are the elevation angles where the gain is 3 dB down from maximum.

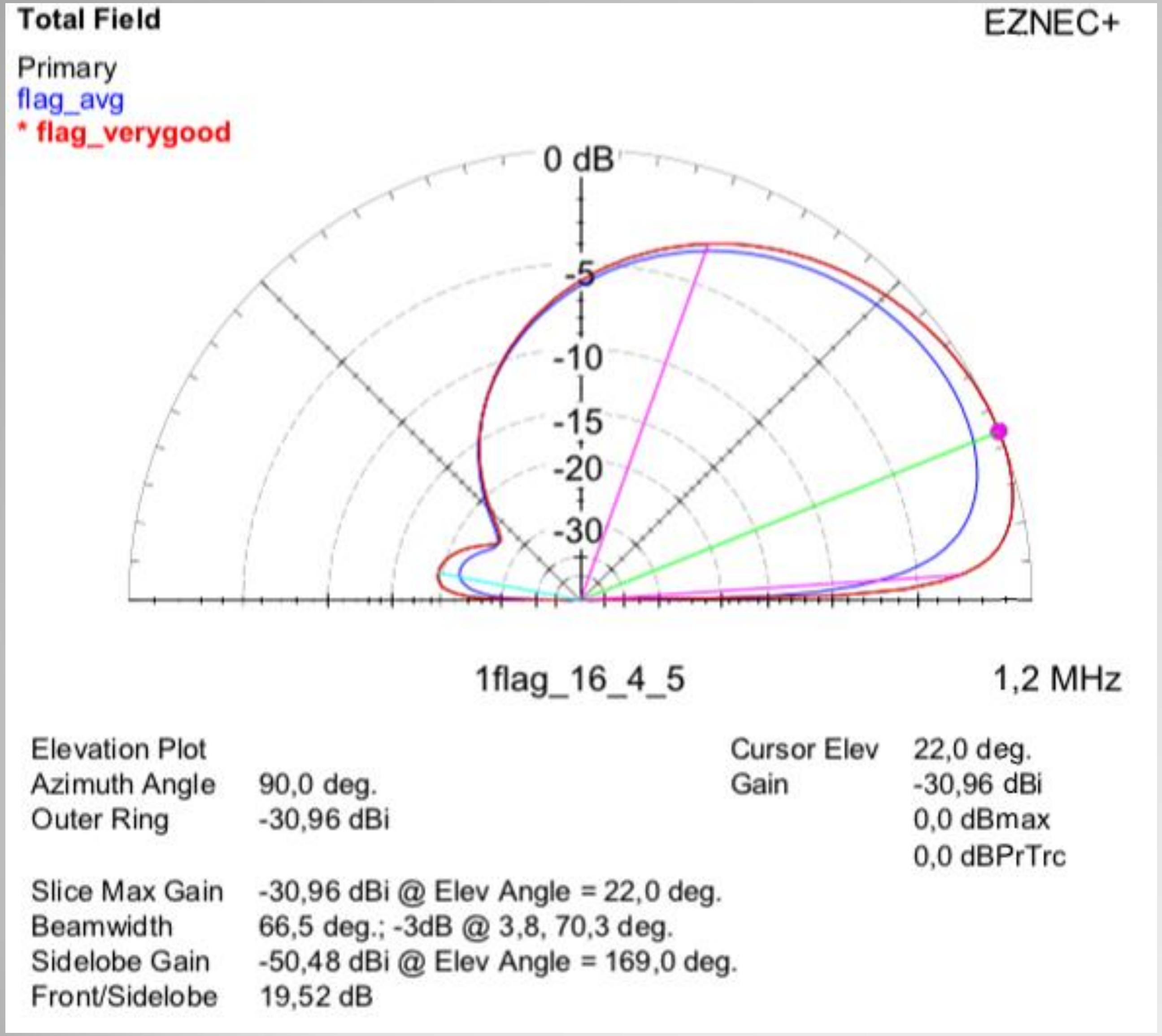
| GROUND | ANT | GAIN | TOA | -3 dB POINTS | |
|---|---|---|---|---|---|
| | | | | | |
| VERY POOR: | OPTIMIZED EWE | -26.38 | 38.6 | 12.8 | 79.2 |
| | FLAG | -31.80 | 38.6 | 12.7 | 79.6 |
| | | | | | |
| POOR: | OPTIMIZED EWE | -24.44 | 38.6 | 10.6 | 78.0 |
| | FLAG | -30.85 | 35.3 | 10.5 | 77.5 |
| | | | | | |
| GOOD: | OPTIMIZED EWE | -24.68 | 31.9 | 8.4 | 76.2 |
| | FLAG | -29.99 | 31.5 | 8.3 | 75.1 |
| | | | | | |
| VERY GOOD: | OPTIMIZED EWE | -23.18 | 25.0 | 4.4 | 74.2 |
| | FLAG | -28.74 | 23.6 | 4.4 | 70.5 |
| | | | | | |
| SALT WATER: | OPTIMIZED EWE | -23.35 | 10.3 | 0.5 | 62.6 |
| | FLAG | -27.60 | 10.1 | 0.5 | 64.3 |

EWE




**dBi**. Antenna gain is measured in decibels. It is the ratio between the gain of the antenna compared to the gain of an isotropic antenna. An isotropic antenna is a theoretical antenna which radiates power uniformly in all directions..

# Influence of soil conditions on Flag

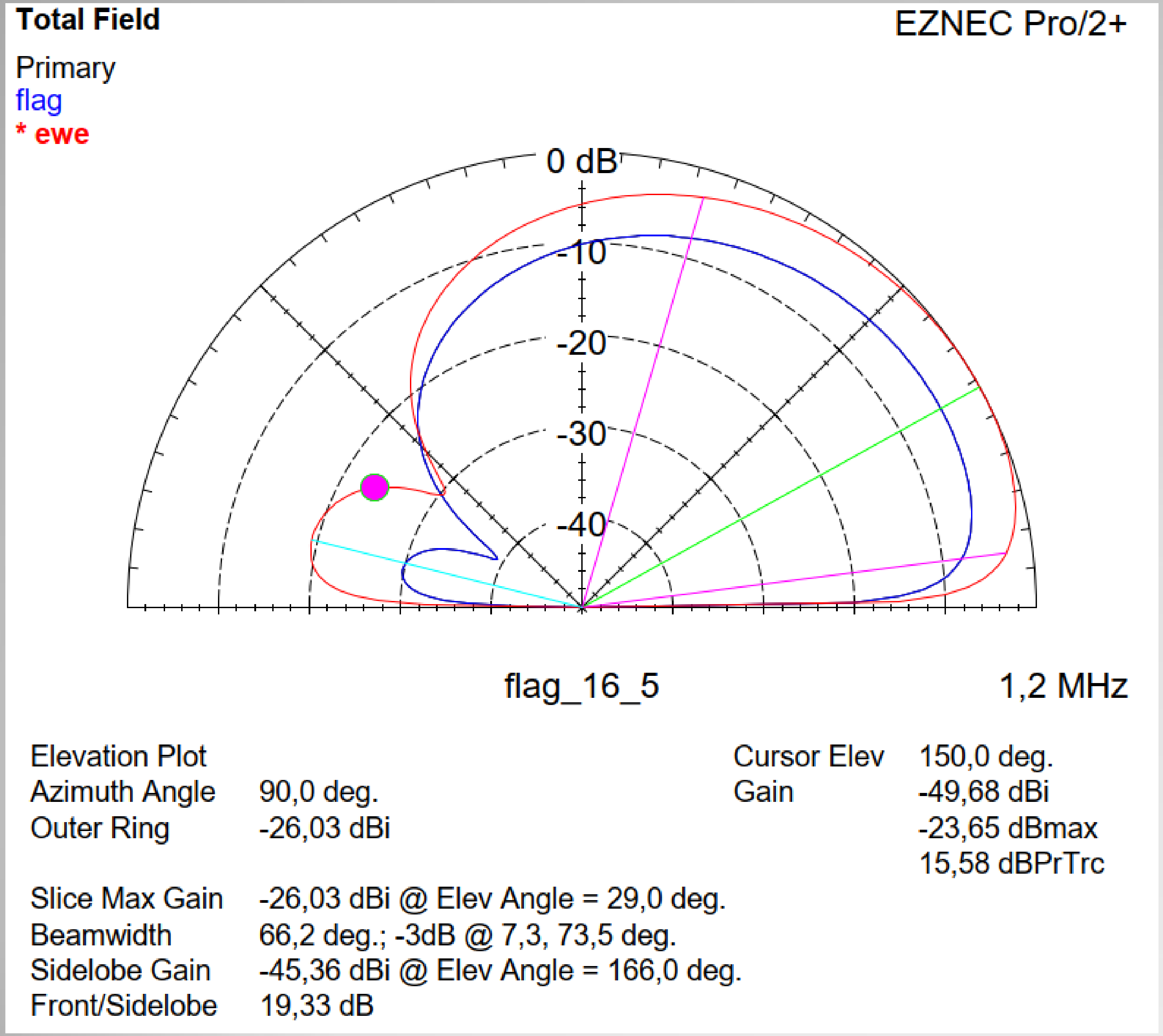



**Stefan Wikander**:
Here is the difference between two identical antennas with the best and worst ground conditions.

The biggest difference: the better the soil, the lower the elevation angle.

Actually, the difference is very small and is basically not noticeable in practice except perhaps during the morning.

# EWE versus FLAG 5 x 16 m

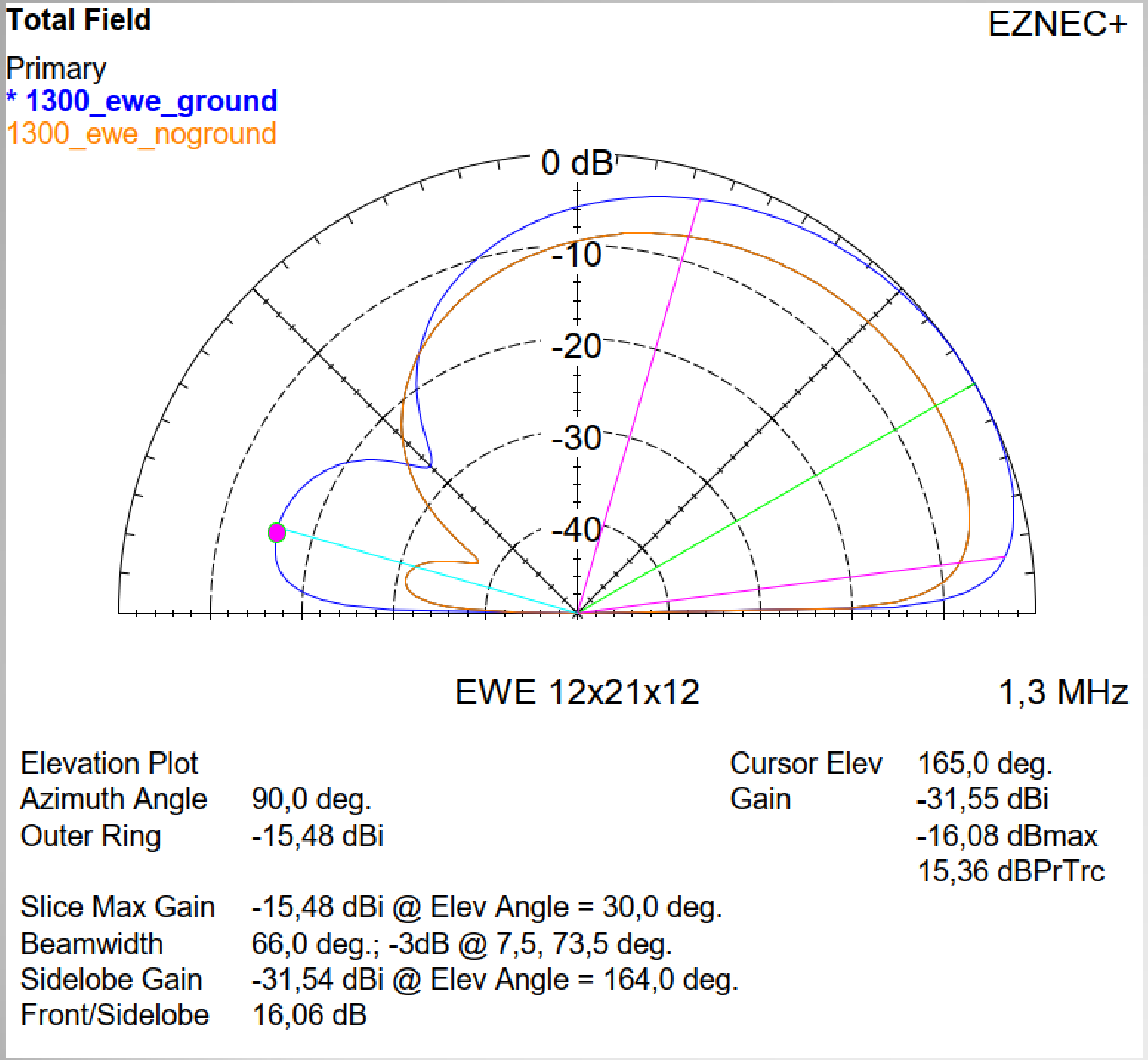



**Torolf Johnsson**:
I did a simulation and compared an EWE and a Flag with the same size, 5x16 meters. The Flag was raised to 2 m and the EWE was earthed at termination and at transformer with 20 mm ground rods.

Antenna patterns are attached, the example is for 1200 kHz but about the same ratio seems to prevail over the entire MW-band. EWE gives better "cream" forward while losing more in poorer back rejection.

I myself would probably start with a Flag because of better F/B ratio and the fact that I don't have to deal with grounding.

# EWE 12 x 21 x 12 m with ground rod or connected as Flag



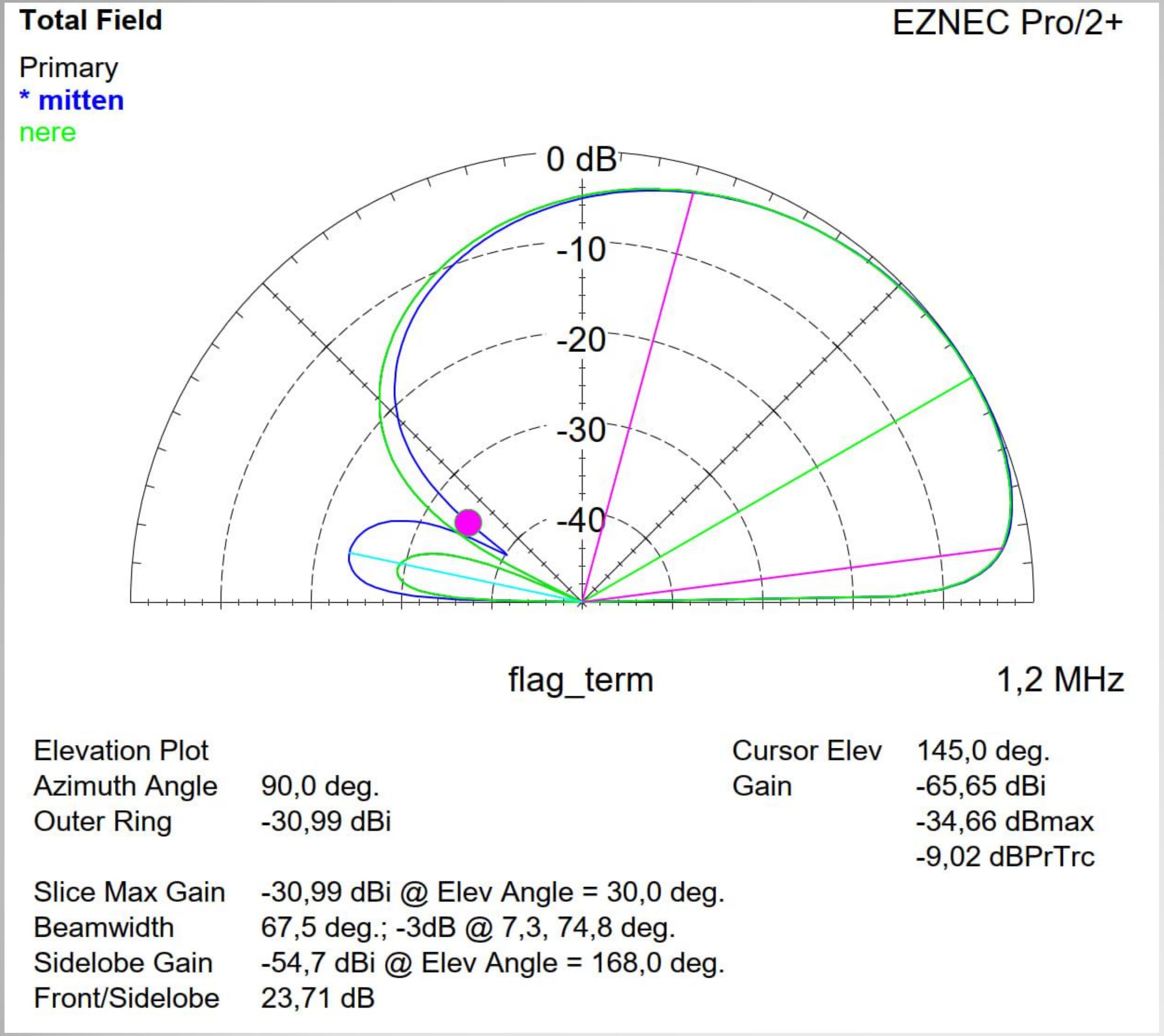

**Torolf Johnsson**:
Interesting this EWE and Flag comparison. I did a simulation of a 12 x 21 x 12 m EWE (with ground) and a corresponding EWE with a horizontal wire in between (actually a Flag).

The signal strength on MW (1300 kHz in this case) was about 5 dB higher for a grounded EWE. BUT attenuation in the back direction was significantly worse for EWE - see attached radiation diagram.

All in all, 5 dB better gain for EWE, but if you calculate signal to noise, a grounded EWE in some cases gives 20dB worse attenuation in the back direction!

The medal always has a flip side.....

# Flags with termination in the middle or at the bottom




**Torolf Johnsson**:
Simulation with a Flag antenna that was terminated with transformer and resistor in the middle or at "bottom".

Attached is a graph showing some difference in the radiation pattern regarding the back lobe - no difference in the front lobe.

Termination in the middle gives better rejection backwards at angles above about 30 degrees, in the example about 9dB better rejection BUT about 9dB worse at 20 degrees.

The same relationship seems to prevail throughout the whole MW-band.

# Comparing the Ewe and the Flag antennas

**by Nick Hall-Patch**

The important observation is that, across the band, the EWE delivered signals that were between 4 and 9 dB stronger than the Flag did on overseas signals. Again, the greater differences in response tended to be at the lower end of the band.

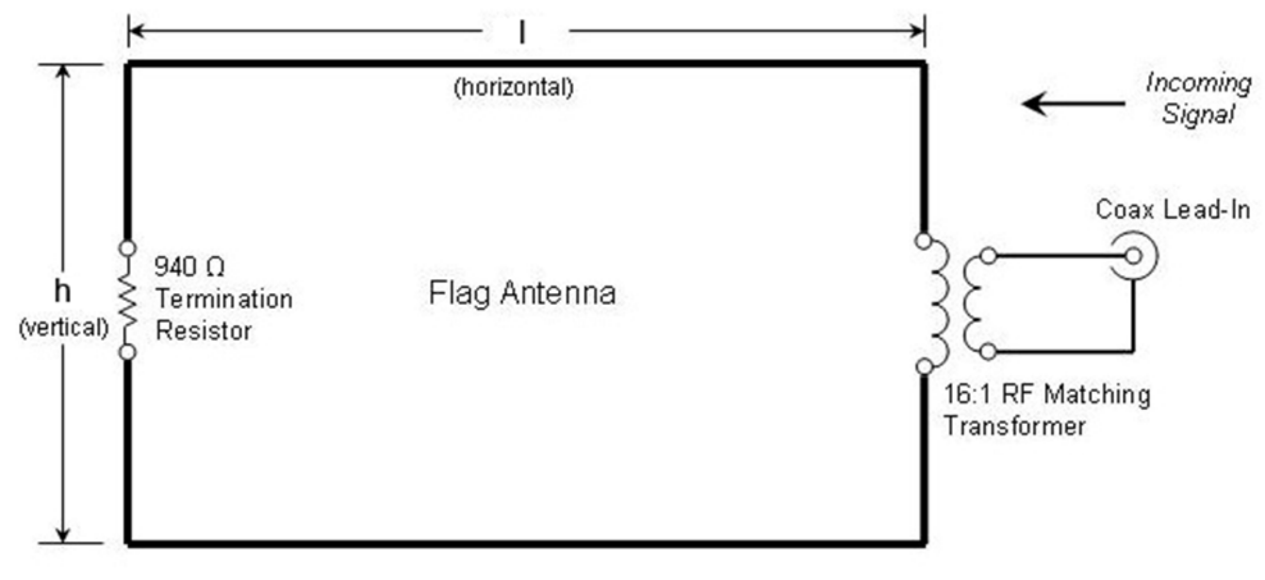
The difference is approximately the 6 dB that one would expect from a short vertical antenna with double the dimensions of another short vertical.

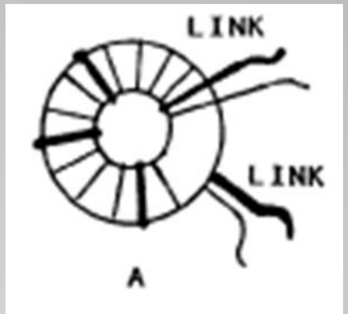
(Remember that it is the vertical sections of both the Ewe and the Flag that pick up signals, and that if the EWE's vertical sections have a ground image, it effectively doubles the length of the vertical section).

While I had both antennas up, I took the opportunity to remove the grounds at each end of the EWE and replaced them with a wire running between the former ground end of the termination, and the former ground end of the matching transformer. The signal strength difference between the antennas dropped to between zero and 6 dB, again with the larger difference at the bottom end of the band.

But it is more sensitive to local electrical noise with this configuration than the Flag.

# Classic Flag Antenna with balun



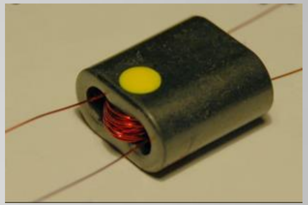

OL (overlay)

**With Epcos N30:**
Secondary
33 turns

Primary
8 turns

Alternative toroids

SS (side by side)

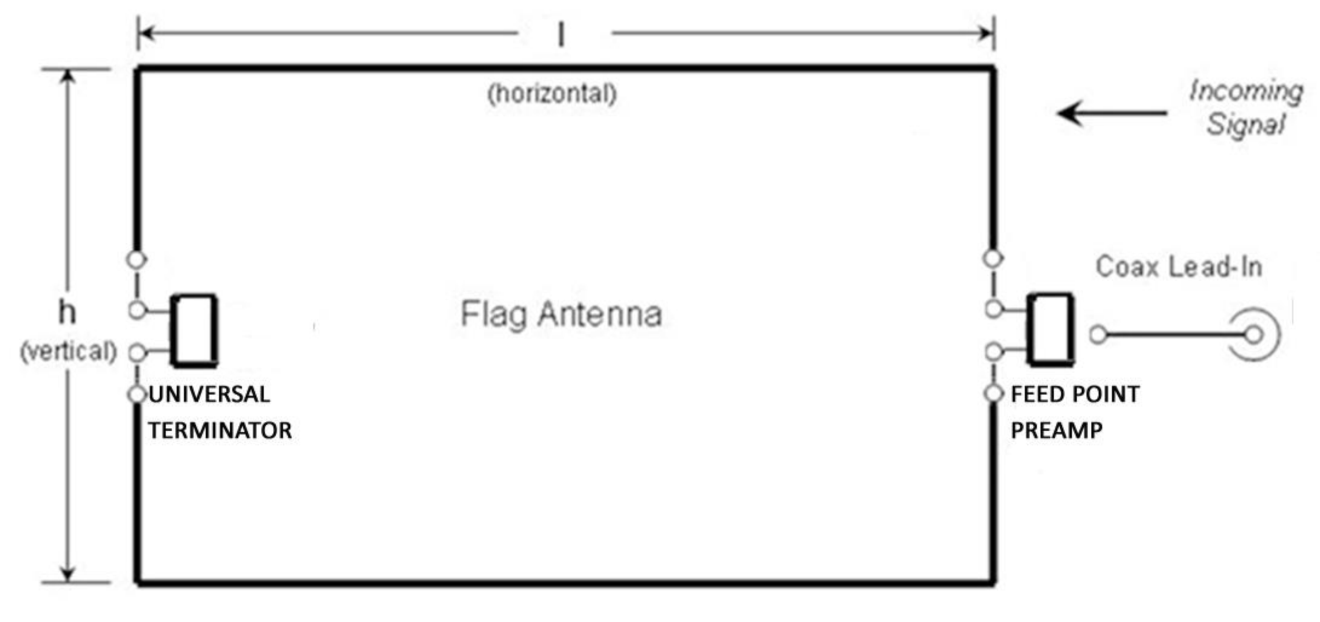


Binocular

**Mark Connelly** has provided a calculation table in Excel for toroids suitable for Beverage and Flag antennas.
The Flag antenna has 950 ohms impedance to be converted to 50 ohms input to the radio.
Example with an Epcos toroid is shown here:

| Min. Freq, kHz | High-Z winding (ohms) | 4 * ohms | winding L, uH | Core | AL | # of turns | Z ratio 50 ohms | # low-Z turns |
|---|---|---|---|---|---|---|---|---|
| 100 | 950 | 3800 | 6048 | Epcos N30 | 5600 | 32,86 | 19 | 7,54 |

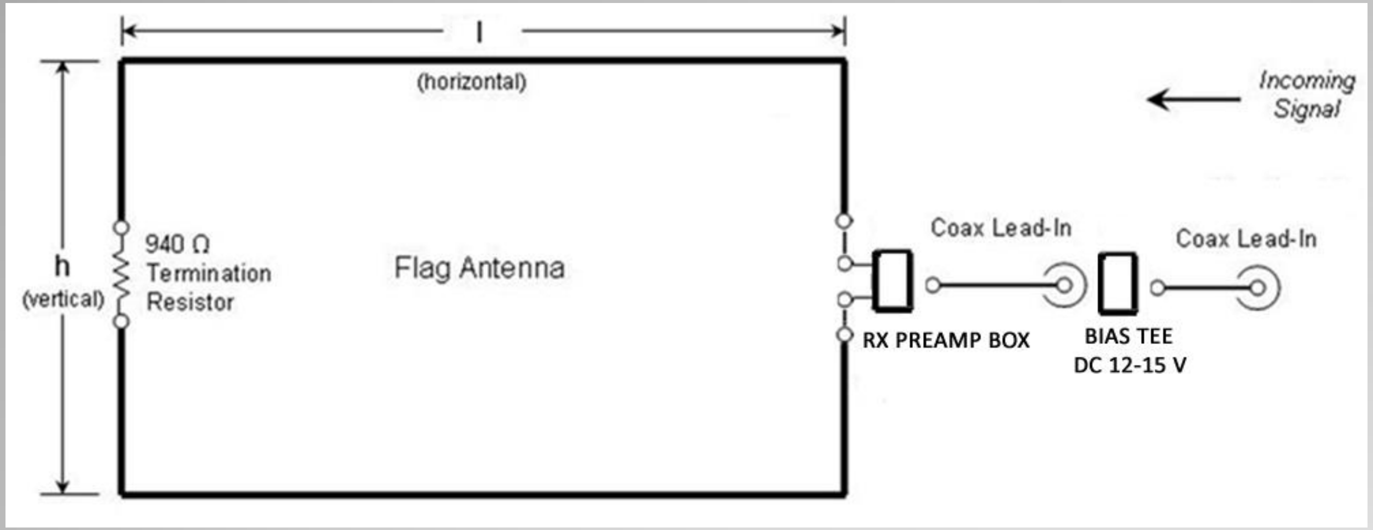
# Flag Antenna using RemoteQth Feed Point Preamp + Universal Terminator




**Universal Terminator** - is a small box designed to terminate RX antennas like beverage, K9AY and other loops. This terminator allows you to change the value in three ranges: typ. 900, 450, 230 and 320 Ohms with the possibility of adding + 50 Ohms to each value. It includes current overload protection as well as voltage protection using GD and Neon lamps at approximately 80V AC.

The **Feed Point Preamp** combines universal transformer, preamplifier, simple Low Pass Filter, internal Bias Tee, front-end protection and common-mode output filter.
The transformer allows you to set three ratios: 1:4, 1:9 and 1:16. This allows the Feed Point Preamp to be connected to most RX antennas: Beverage (classic and BOG), loops like K9AY, DHDL, Flag etc. The input is isolated from the coax ground.
The preamplifier has a maximum gain of about 18 dB and a variable ATT, which allows you to control the overall gain as needed.
The preamplifier can be powered via coaxial cable (internal Bias Tee) using an external Bias Tee in hamshack or via a cable connected directly to the box.

# Cross Country Wireless Flag Antenna amplifier & Bias Tee

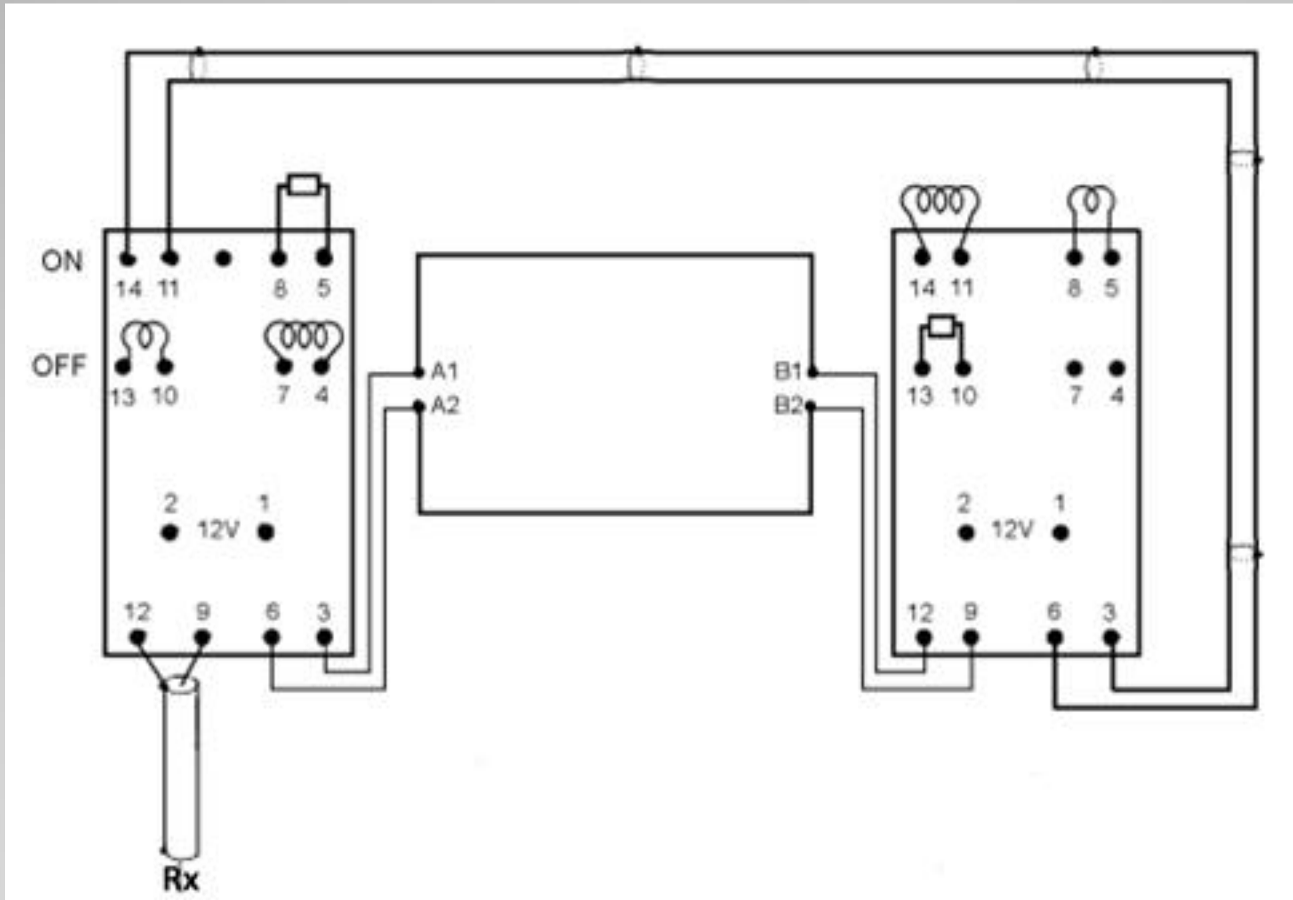



The advantage of using this amplifier in a Flag antenna over a 9:1 transformer is that, as well as having extra gain at the antenna the amplifier, has RF filtering and a common mode choke to reduce the effect of common mode RF noise entering the antenna down the coax feeder.

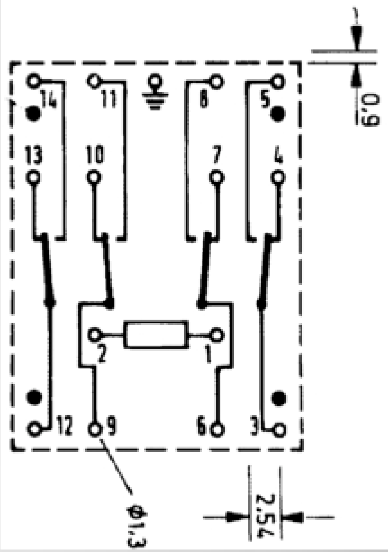
The Antenna Interface (Bias Tee) is used to insert DC power into the coaxial cable to power remote antenna amplifiers or other devices. It is usually positioned at the receiving end of the coaxial cable to pass DC power from an external source to the amplifier.
(For 12-15 V DC power input)

# How to reverse a Flag Antenna

## Connection of the relays for reversing directions 180°








12 V DC control supply is connected to pin 1 & 2

Picture showing the 1,8 m impregnated pole with a 3,4 m fir rod (27 mm) attached to the impregnated pole with long, wooden screws in the top. In the middle there is a 20 x 10 cm plexiglass board with the two boxes attached with screws.

At the bottom the two 20 mm flexible plastic tubes for the coaxial cable and 12 V supply cable coming up from the ground soil. Those are secured to the pole with plastic strips.
All cables are buried in the ground in black flexible plastic tubes.
The bottom horizontal antenna wire is about 50 cm above ground.

Don't try to use 16 mm flexible tube. It's almost impossible to pull the coaxial cable through this small diameter.
Instead use two 20 mm flexible tubes for the coaxial cable and the 12 V supply cable.

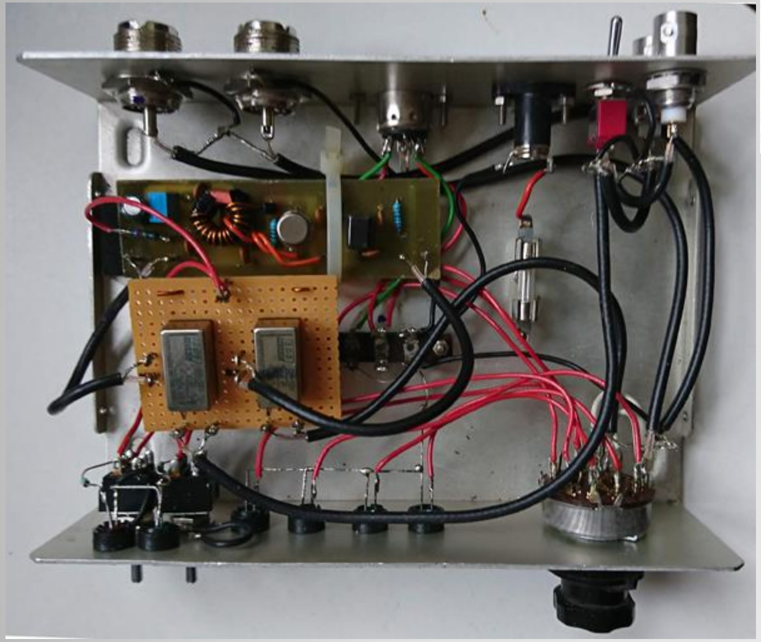
**Installation of the relay & toroid boxes:**

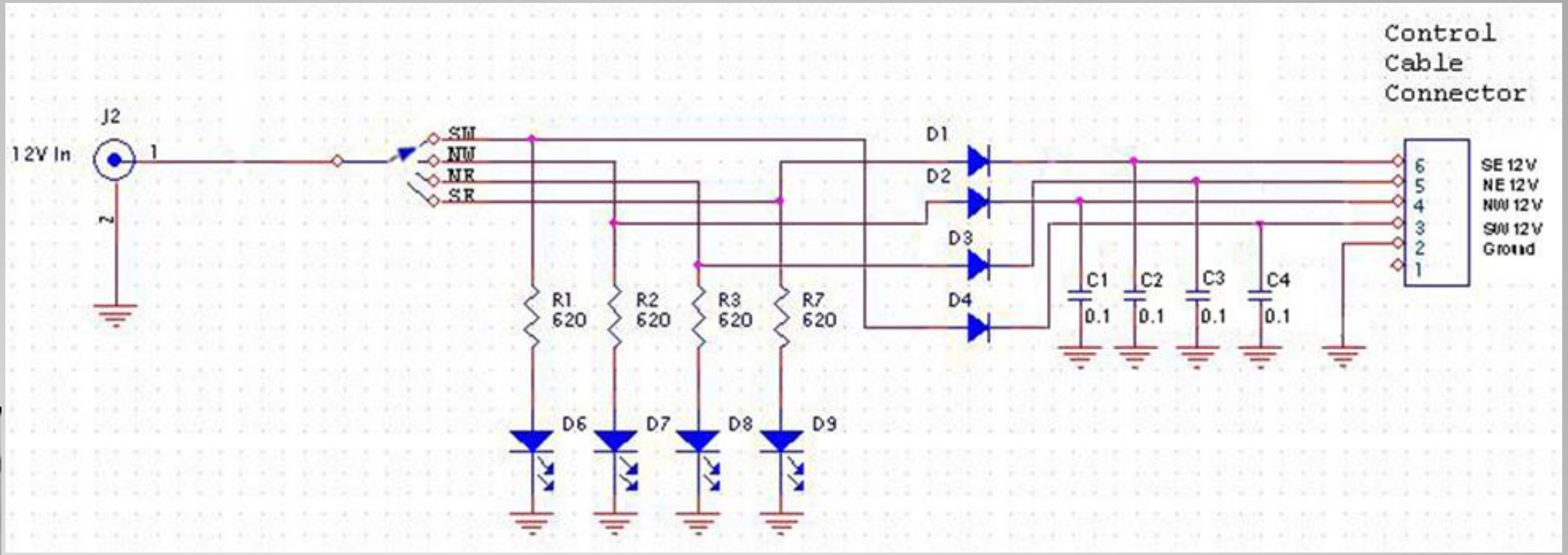
Picture showing the two plastic boxes (10 x 10 cm) with relay and toroid attached to a small plexiglass board

Interior view of the 10x10 cm boxes on the right antenna side. The left box contains the relay and termination blocks, the right box contains the balun.
The coaxial cable and 12 V supply cable is connected to the circuit board in the left box.

Interior view of the 10x10 cm boxes on the left antenna side. The left box contains the relay and termination blocks, the right box contains the balun.
One of the two pairs of coaxial- and 12 V supply cable controls the relay on the right antenna side. The other pair goes to the shack in the house.

# Control box



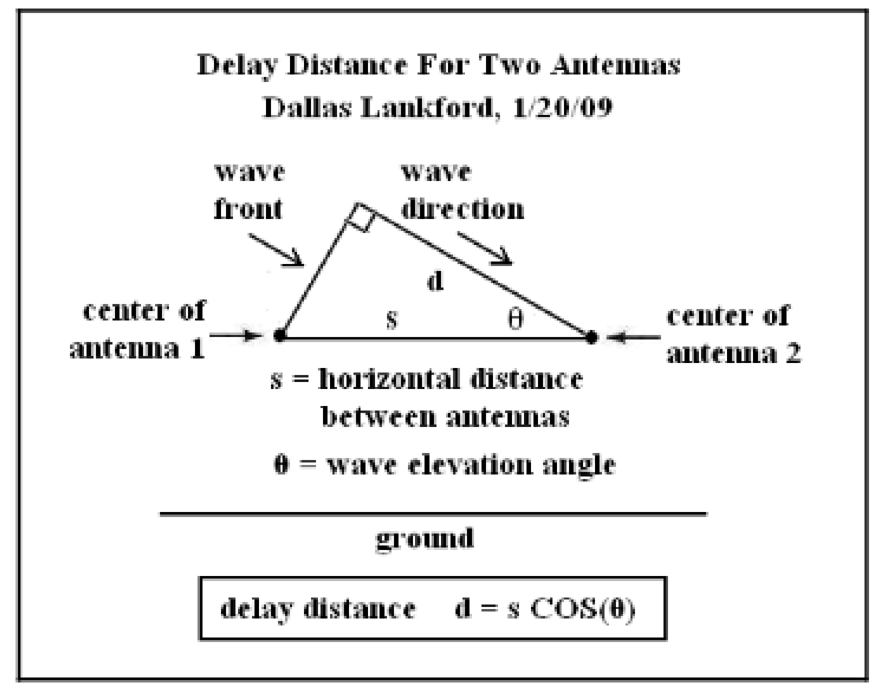



The schematic shows a principal layout which can be used to control the four separate relays. Of course, you also must switch the two antenna inputs accordingly.

In my case only SW & SE are connected to 12 V to activate the relays. For NW & NE directions no supply voltage is applied because the relays are inactivated in those positions.
/Thomas Nilsson

# Flag Antenna Array theory by Dallas Lankford

The goal is to orient the array so that as many undesired signals as possible are nulled as deeply as possible.
All antennas should be **identical** and all antenna lead ins should be **equal lengths** for the antenna arrays and phasers discussed in this article.




**Example: Calculating delay with 30 m spacing**
The first fixed phasers I developed were coax delay line phasers which have been said to be linear provided the coax used is good quality and matched to its characteristic impedance.

The principals of coax phasers are based on the diagram at right.

The delay distance is **d = s COS(θ)** for an arrival angle θ, where **s** is the horizontal spacing between the centers of the individual flagantennas.
For s = 30, d = 30 COS(30°) = **26,4** m.

The time delay T is the time difference between the arrival of a wave front at antenna 1 and the arrival of that same wave front at antenna 2.
The speed of electromagnetic radiation is approximately 2.99 x 10^8 meters per second in air, so the time delay per meter in air is 1/(2.99 x10^8) = 3.34 nS/m. **Thus the time delay T = 3.34 x 26.4 = 88.3 nS.**

# Coax Delay

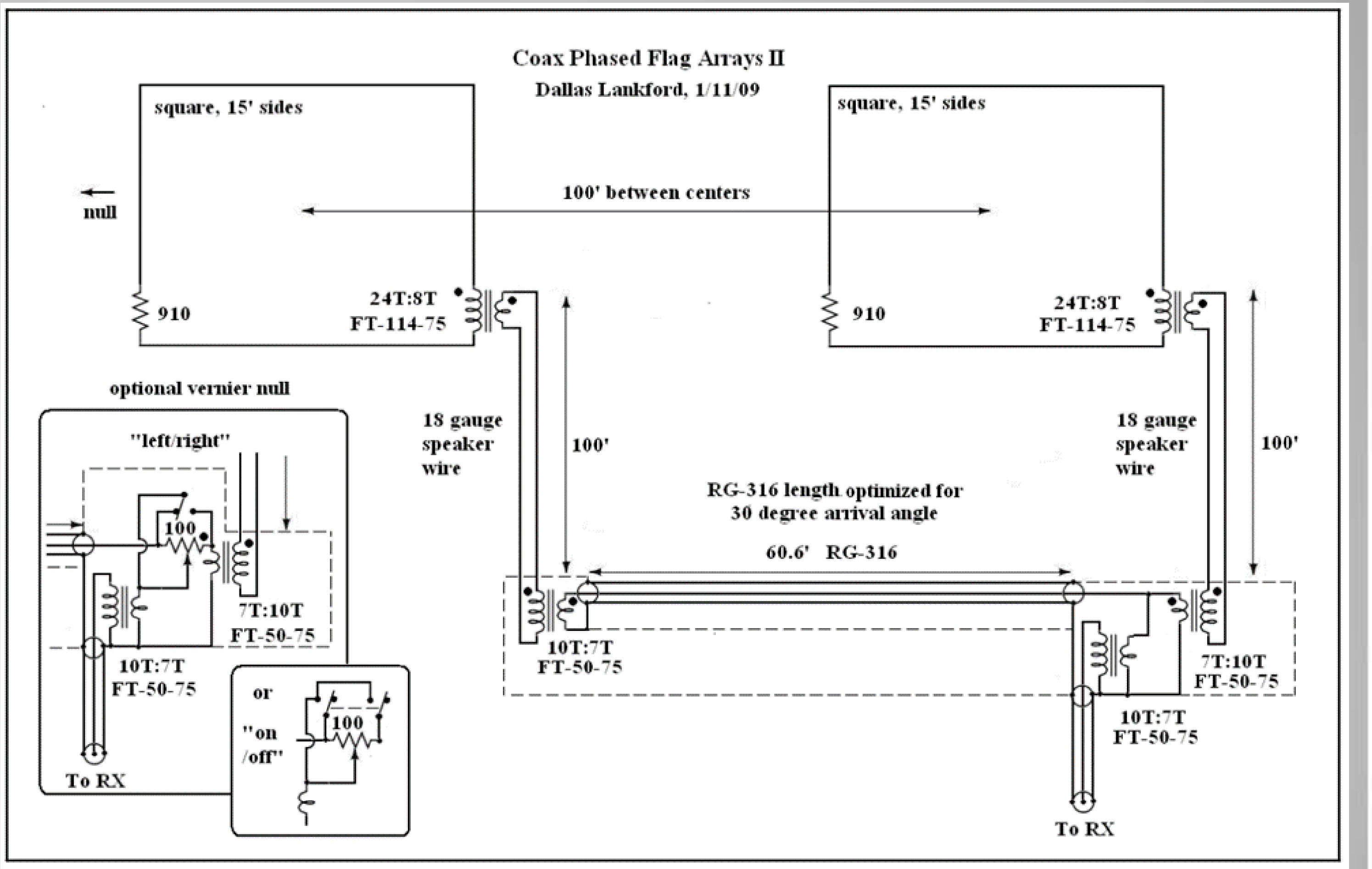
The time delay per meter of electromagnetic radiation in a coax is 3.34/VF nS per meter, where VF is the velocity factor of the coax.

The velocity factor of coax varies from one type of coax to another, and even from one manufacturer to another. RG-316 is typically more uniform than other kinds of coax, and its VF = 0.7 nominally.

Thus the time delay per meter of RG-316 is 3.34/0.7 = 4.77 nS/m.

From this it follows that the length L of RG-316 required for a 88.3 nS delay is L = 88.3/4.77 = 18.51 m.

The time delay T in nS along a ray with arrival angle θ connecting two antennas with centers spaced a distance s apart in feet is: T = 1.02 s COS(θ) (nS), which is a simplification of several formulas above.



# LC Delay

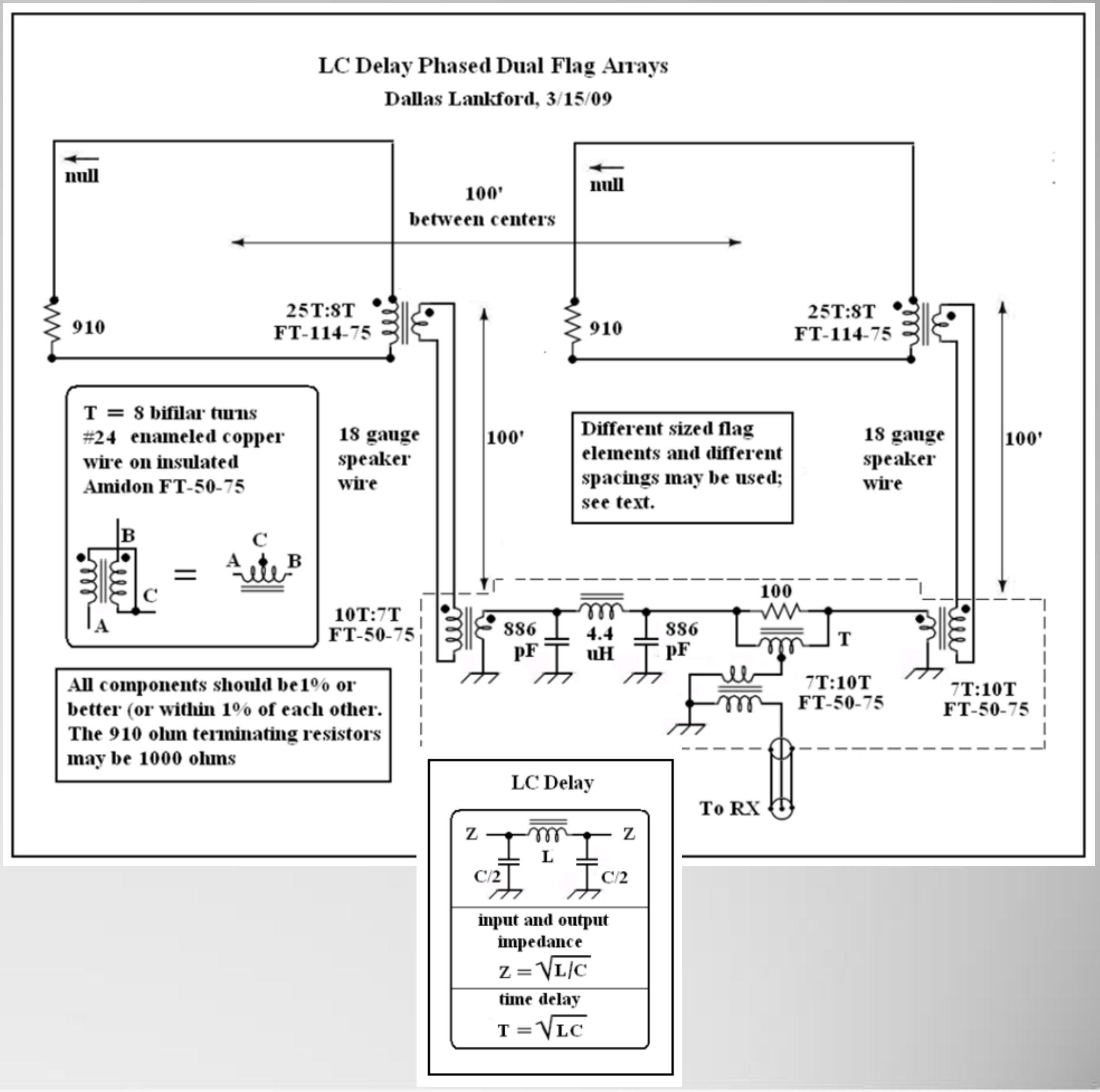
Now, however, the coax length is replaced by an LC delay circuit at right above, which resembles a low pass LC filter. Its input and output impedances Z are the same.

For a 50 ohm system, take Z = 50 which gives 2500 = L/C, or L = 2500 C.

Taking T = 88.3 x 10^−9, which was calculated above, both sides of the time formula at right are squared, namely 7796 x 10^−18 = LC, after which substitution of 2500 C for L by the equation above gives 7796 x 10^−18 = 2500 C^2, or C = 1766 pF. Thus C/2 = 883 pF, and L = 2500 x 1766 x 10^−12 = 4.4 µH.

The capacitors should be mica, and the inductor may be two series 2.2 µH inductors.

L and C/2 values for other frequencies can be obtained by multiplying the values for 100' spacing by the ratio of the spacings.
For example, for 70' spacing, L = (70/100) x 4.4 = 3.1 µH, and C = (70/100)883 = 620 pF.



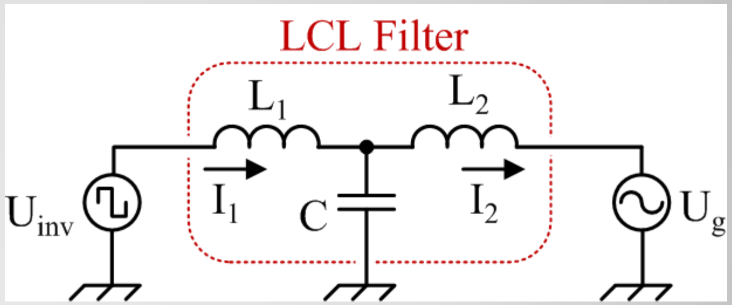
**Stefan Wikander regarding LC Delay**: I have measured and tested Dallas Lankford's CLC filter for my staggered Beverage. It worked at the low MW band but didn't function well at the higher end. Also, I didn't achieve the gain I got with a coax delay. I brought out the signal generator and the oscilloscope and first measured the phase shift for 28 and 32 m RG-58U at 650 and at 1650 kHz.

Then I recalculated the components to these lengths for the Dallas filter.
Then I adjusted the capacitors // connected several to get as close as possible. The same with the coil where I tried with winding several cores and hope that one of them will be near 3.6 uH as it should be.

The phase shift followed the coax length but the filter attenuated higher MW frequencies just as I experienced when listening live.

The CLC filter that Dallas uses is not optimal for low impedances. A T-filter (LCL filter) is better.

I made a couple of those LCL-filters instead and according to the measurements, they don't attenuate anything on high MW and maintain 50 ohm impedance from below MW up to 2 MHz. The filter was exactly 50 ohm and had only 0.1 dB attenuation when I measured with the VNA.

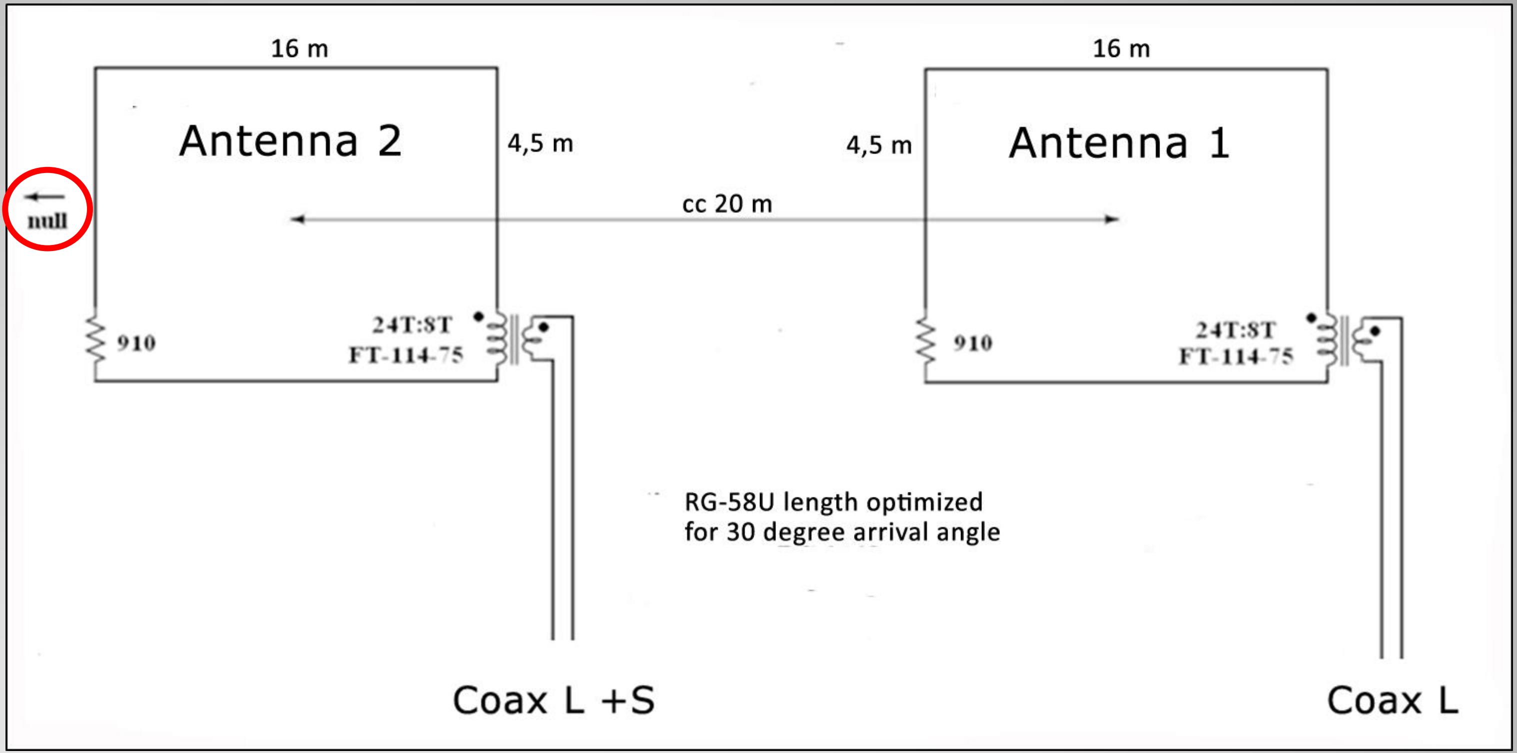


# SW: Phased Flag Array with 50 ohm coax delay phaser

**Stefan Wikander**: I've tested both types of delay, but I think the coax delay is easier to handle. Can't say which is better. I can just see that the coax delay in reality matches the simulations that TJ made for me and then I'm satisfied.

The length of the coax delay plays a big role in how well stations are attenuated from backside. Then there is something called taste and liking and there you have a chance to find your balance.

I use RG-58U. I think it works well. There is a cheap junk type of RG-58 with AL conductors that cannot be soldered.




I use rectangular antennas. Have also tried triangle shape but don't think they are as good. Have also tried the DHDL type but that one was taken down quite quickly.
A Phased Flag Array rejects backward signals better than a single Flag, but in the forward direction there is no difference.

# Theoretic calculation of delay-length:

**RG-58U with Flags staggered 20 m:**

For s = 20 m, d = 20 COS(30°) = **17,32 m**.    (Cos(30°) = 0,866)

The velocity for electromagnetic radiation in air is about 2.99 x 10^8 m/sec so time delay per m in air is:  1/(2.99 x 10^8) = **3.34 nS/m**.

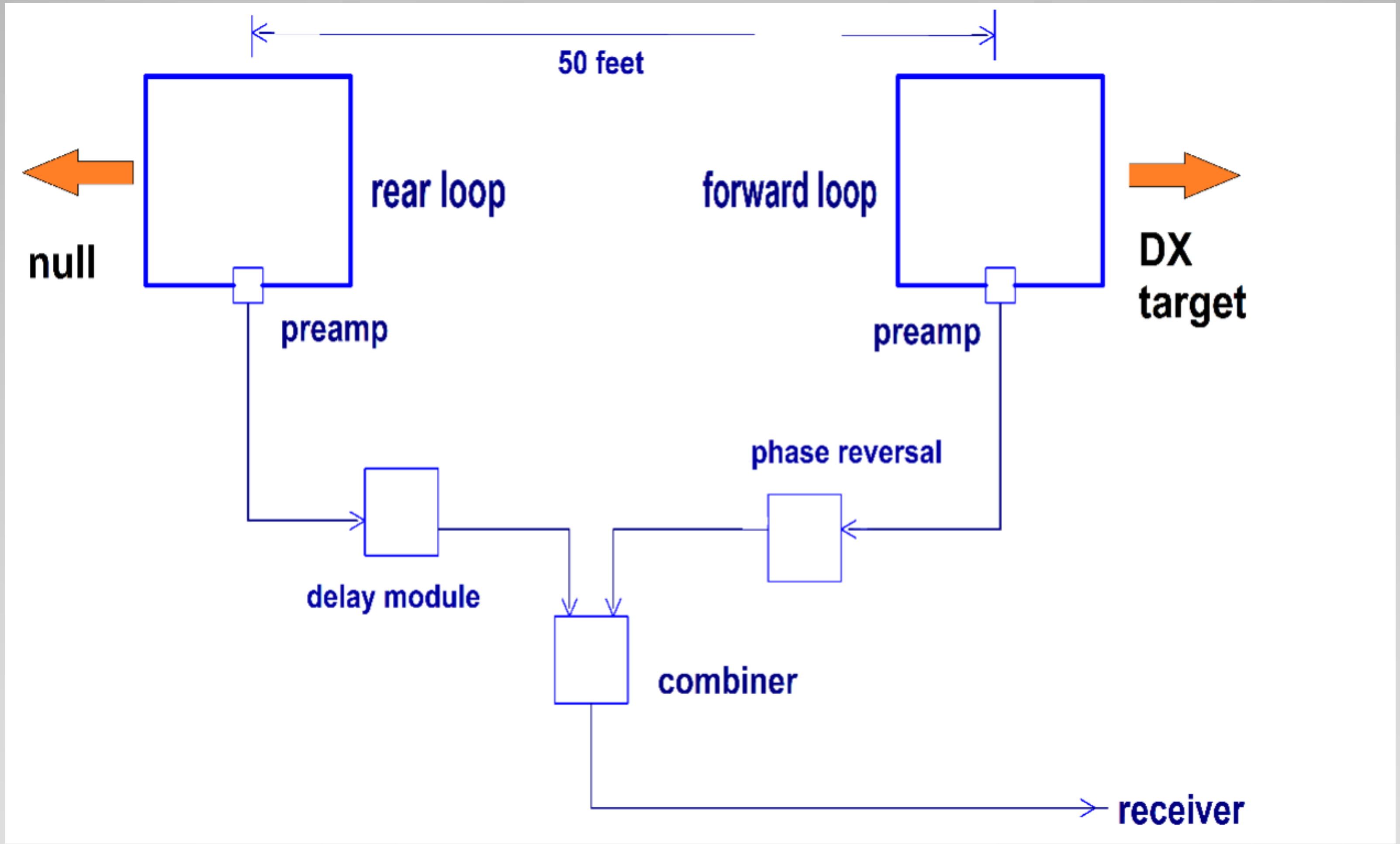
**Accordingly time delay is:  T = 3.34 x 17,32 = 57,85 nS.**

For RG-58U is VF = **0,66**, which gives 3,34/0,66 = 5,06 nS/m, which gives L= 57,85/5,06 = **11,4 m**.

**Stefan Wikander**: I have shortened the coax delay length quite a bit after a lot of testing. I now have approx. 11 meters because it provides clearly better back rejection.
Then the angle of maximum back rejection is raised. It gives a little lower forward gain but it is negligible.

Looks like theory and practice match.....

# Dave Aichelman, N7NZH, Phased Flag Antenna Array



Radio waves travel more slowly through coaxial cable than they do through the air; for the RG58 it is generally specified as a "velocity factor" (VF) of 0.66.
In air, radio waves take 1.03 nanoseconds to travel 1 foot, and therefore will take 51.5 nanoseconds to travel between the two antennas. With RG58, however, those waves will take 1.56 nanoseconds to travel one foot, so a length of RG58 that will provide 51.5 nanoseconds of delay would be:

$51.5\ ns/1{,}56\ ns$
$= 33\ feet$

Why am I using only 26 feet of RG58 for the delay line, then? Remember that the delay line is "optimized for an arrival angle in the 30-40 degree range".

I generated a set of numbers for the length of RG58 delay line that would be needed for an array of two antennas at 100 foot spacing, for arrival angles of 20 degrees (62 feet), 30 degrees ( 57.2 feet), and 40 degrees ( 49.7 feet).
To derive the length of delay line needed for antennas of less than, or greater than, 100 feet, simply multiply my derived lengths of delay line by the ratio between the actual separation of your antennas and 100 feet.
For example, my 50 foot antenna separation is one-half of 100 feet, and you can see that a 26' delay line falls between one half of 57.2 feet (for 30 degrees arrival angle) and one half of 49.7 feet (for 40 degrees arrival angle)

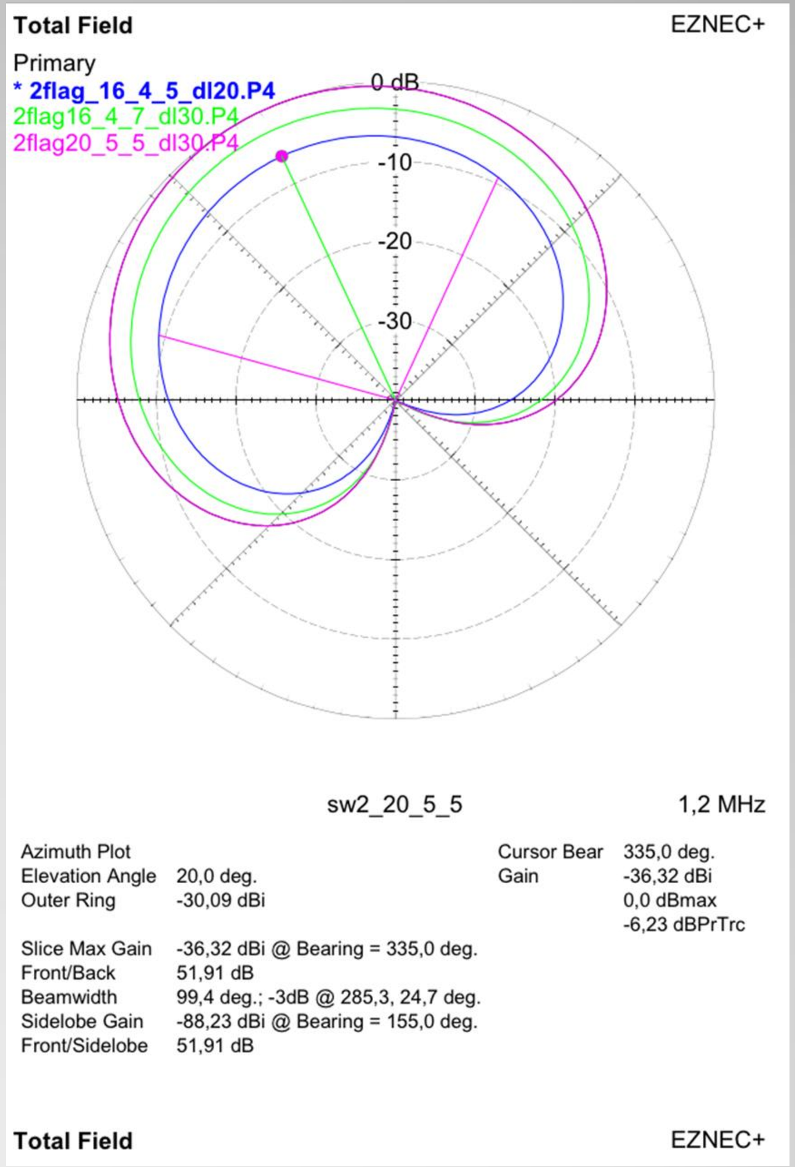
# Phased Flag Array - Stefan Wikander

**Stefan Wikander**: Here is a picture of my Phased Flag Array simulated by Torolf Johnsson.

Mine is the blue (16 x 4,5 m, spacing = 20 m).

Two other simulations are also included:

Green: (16 x 4,7 m, spacing = 30 m)
Purple: (20 x 5,5 m, spacing = 30 m)



# Flag has a smooth pattern over the entire MW-band

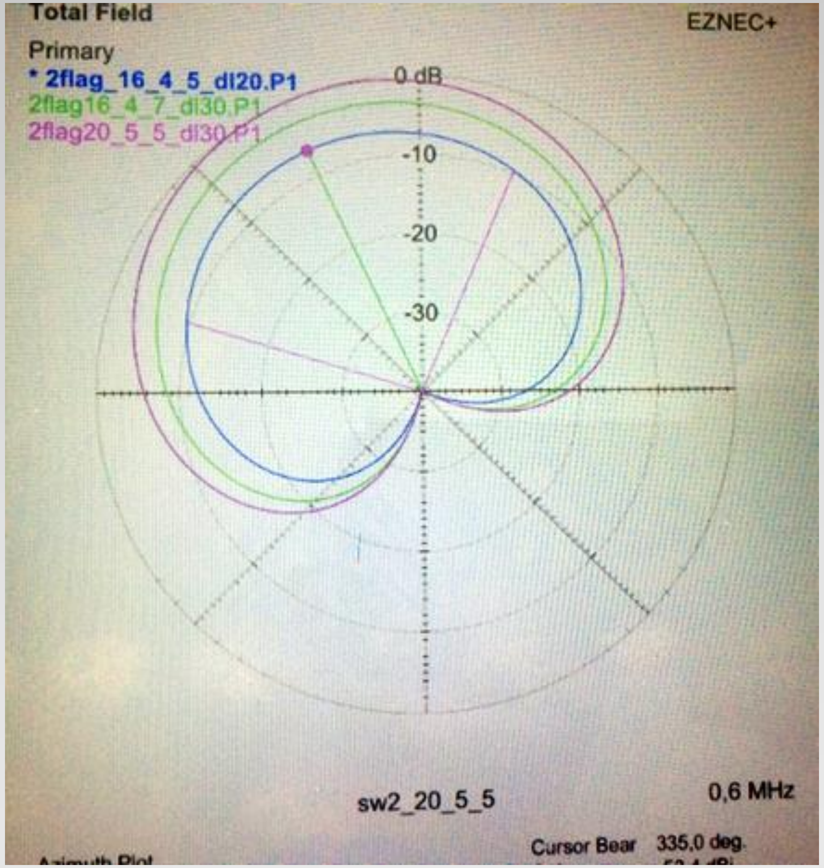
**Stefan Wikander**: Another thing that is probably never mentioned is that the pattern look pretty much the same across the entire MW. It almost does not change at all depending on the frequency, such as the pattern for a beverage, where the pattern becomes narrower the higher up on MW you go.

Pattern for a Beverage becomes wider the further down in frequency you go.

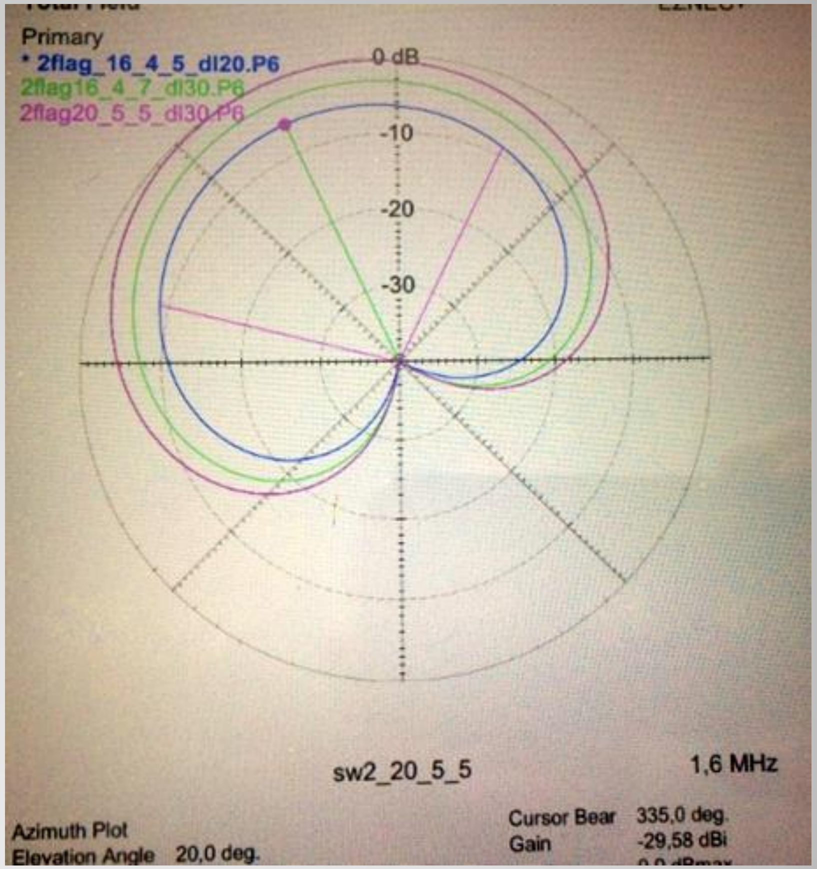
For a Flag there is basically no difference.

Here you have two patterns for a Phased Flag Array at 600 kHz and 1600 kHz. As you can see, the pattern is almost identical.

EZnec simulation done by Torolf Johnsson.




600 kHz




1600 kHz

# Phased Flag Array in my cabin – Stefan Wikander

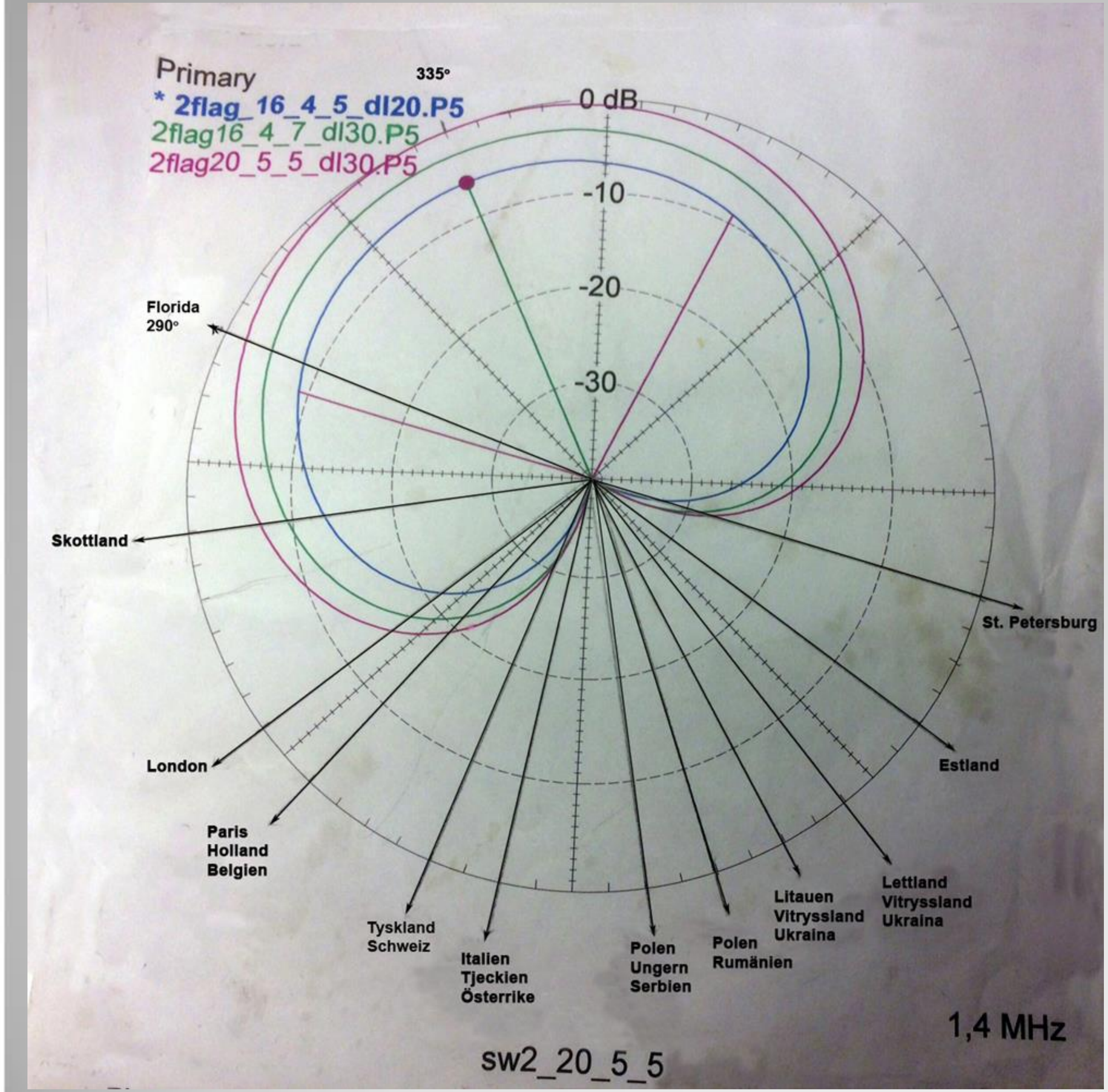
I have put up a Phased Flag Array in my cabin about the same size as at home. (L 15.8 m x H 4.7 m with offset 20 m between the start points of the antennas).
Both antennas are within a decimeter equal. Have adjusted both transformers so that the SWR is below 1:1.1.

I did some comparison against my Double Beverage last night. A preamp is always connected to my Phased Flag Array. Still, the strength of the NA stations is 10-25 db stronger on the Double Beverage without any preamp on it.

If I connect so that the Phased Flag Array has two preamps in series, the upper part is about the same on both antennas, but at low frequencies the Phased Flag Array gives approx. 15 db lower level on NA stations. All the time the Double Beverage provides better readability. There is also a completely better "cream" on the stations with the Double Beverage. Most stations were also heard on the Phased Flag Array but with poorer readability. During mid-morning, nothing is heard on the Phased Flag Array, where you still had readable stations on the Double Beverage. With two preamps in series, the Phased Flag Array is a decent performer at night.

It's so quiet here in my cabin that when I have 20 db preamp on the Phased Flag Array, the S-meter is motionless. At home I have S-2 with 10 db preamp.

## 2flag_16_4_5_dl20-P5, means two antennas: L 16 m x H 4,5 m with spacing s = 20 m.




My Phased Flag Array is aimed primarily towards NA at 340° and I have utilized the rear attenuation to attenuate as much of Europe as possible. Then Florida is 2 db down and then it covers all of NA up to 30 degrees east of north. The antenna is broad forward, about 110 degrees within 3 db attenuation. Then the whole of Eastern Europe is attenuated by more than 30 db and Germany by more than 20 db.

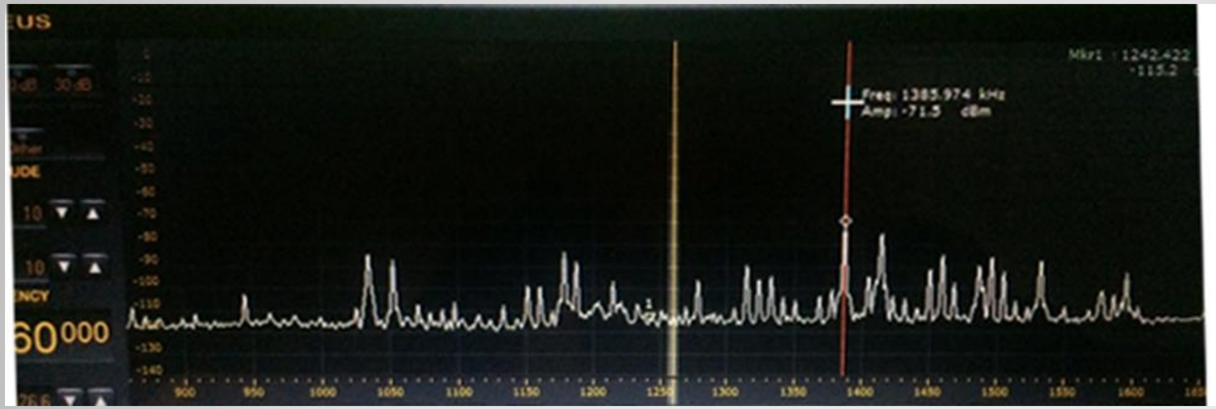
I made a long list in the cabin of the difference between the Double Beverage and Phased Flag Array at night. In order to get approximately the same level of NA stations on both antennas, I must have 20db gain on the Phased Flag Array.
I started at 1600 kHz and tuned down to 790 kHz. For about 35 frequencies the stations were pretty similar on both antennas. Mainly on really free frequencies. At about 25 frequencies it was clearly better on the Beverage but audible also on the Phased Flag Array. About 5 frequencies were better on the Phased Flag Array, mainly frequencies with Eastern Europeans nearby. Mainly the Phased Flag Array loses on frequencies with stations from GB nearby.
Now it was pretty good conds which gives an advantage to Phased Flag Arrays. For weaker stations, the beverage wins by a larger margin.
During the day, the Phased Flag Array doesn't have a chance.

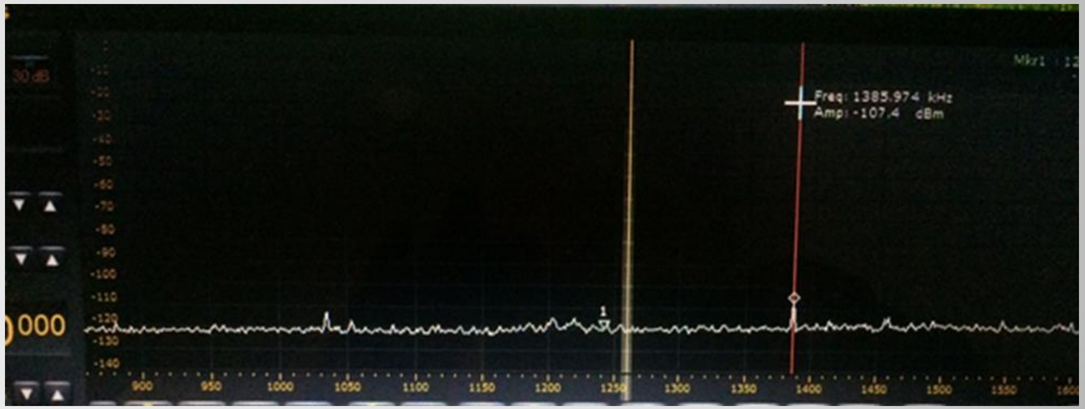
# Comparison Loop and Phased Flag Array – Stefan Wikander

Here is the difference in attenuation at 19:30 between my Phased Flag Array and an equally large single Flag where the resistance is bridged **(= loop)**, which means it is directed both forward and backward. Both are aimed at 340 degrees.

For example. 1385 kHz is attenuated over 35 dB with the Phased Flag Array and on 1413 kHz over 40 db. In forward direction there is no difference between the two antennas. This after having “adjusted" the flag array on all planes.

The left picture is what the band looks like in the early evening with European stations on a simple Flag with the resistor short-circuited **(= loop)**, i.e. is basically an omnidirectional antenna. The right picture is how the band looks at the same time with the Phased Flag Array. Here you can see how well the Phased Flag Array attenuates the stations.



# Flag versus Beverage - Stefan Wikander

I have never experienced that the Flag has any special property or advantage at sunrise.

In comparison to a Beverage, a Flag doesn't have a chance to keep up during the day or when there are some half-bad conds. If, on the other hand, there are slightly better signal strengths, most of what is heard on a Beverage can also be heard on a Flag. Often with a better and more stable signal on the Flag although the signals can be weaker.

In the early morning there can be full of stations on the Beverage but hardly anything can be heard on the Flag even though it has 20 db amplification.

The Beverage has always been superior to other daytime antennas.

I know that they set up a Flag in Parka for testing and at night stations were heard, but during the day it was more or less "dead".

There are many factors that come into play. For example local noise can totally destroy daytime listening even with a Beverage.

**Stefan Wikander**: I have not made any theoretical calculations for Phased Flag Arrays, but only for Staggered Beverage Array. I just "listened in" the Flag.

You should know how many times you have hit "right" by just listening to how it sounds. It's just a matter of knowing what to listen for and what a change is expected to do.

But as always, there are many parameters to be combined, so there will always be a compromise. For example, with a short delay coax, the forward gain decreases somewhat, but the backward attenuation is many times greater than the forward loss. Eventually you reach a limit when there is no improvement but it gets worse. Then it's just a matter of "backing off" a bit.

It is much more difficult to make reality agree with theory for two long Staggered Beverage Arrays than for two small Phased Flag Arrays. The Flags nicely follow all changes linearly and as expected according to simulations.

As I said, the Staggered Beverage Array is considerably more difficult to get good results. This is probably due to minor differences between the two antennas, but also other things such as the fact that it has a number of side lobes that change in size and number depending on frequency and antenna length.

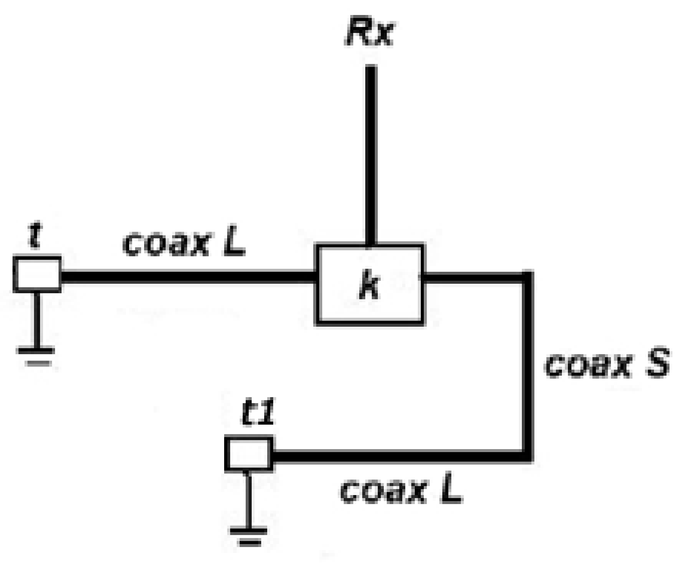
It may dampen well within a certain frequency range. Better in one direction etc. Then it's important to take advantage of the advantages and try to make what is worse have as little impact as possible. The sidelobes of the beverage may be made to misalign with some strong unwanted station, etc.

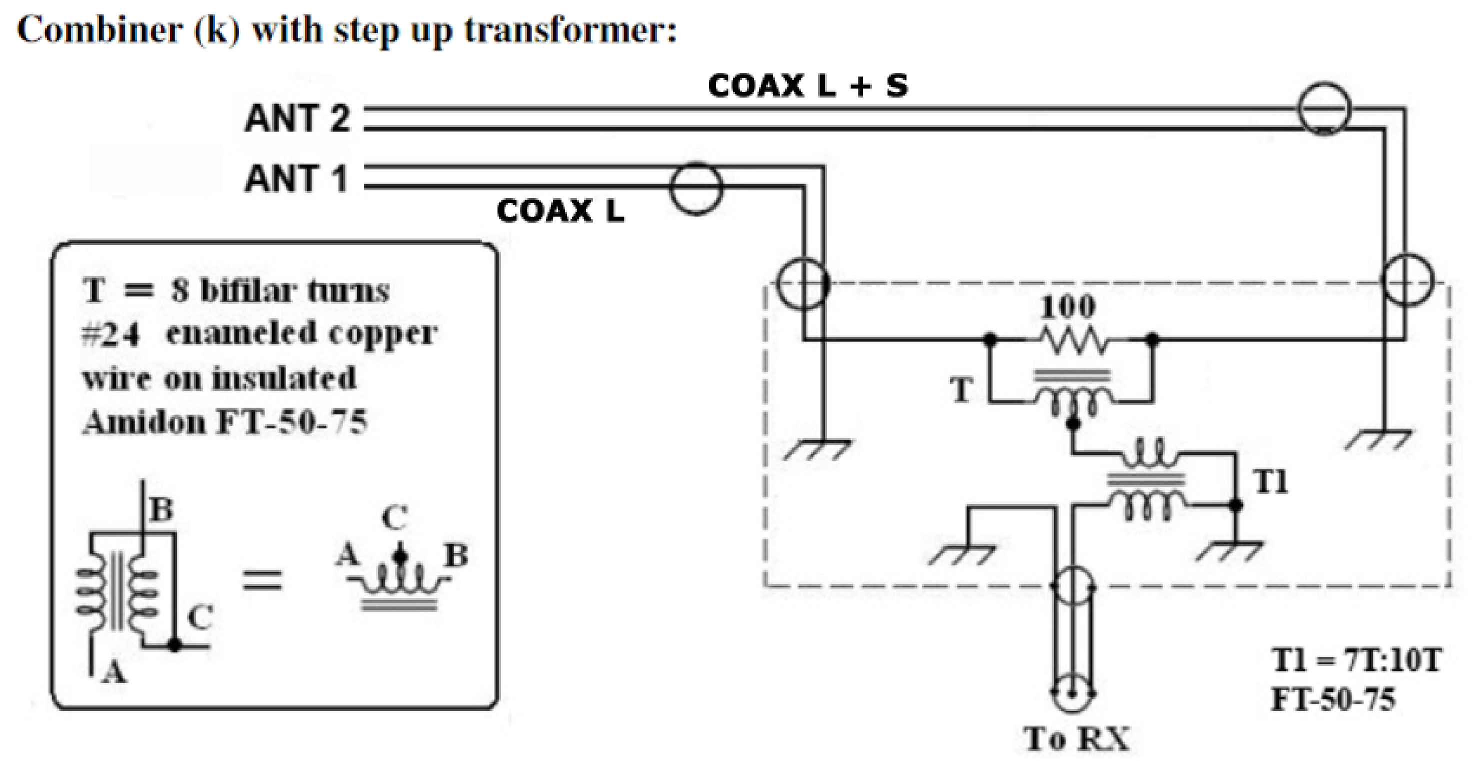
It takes time, but it's fun.

# Combiner

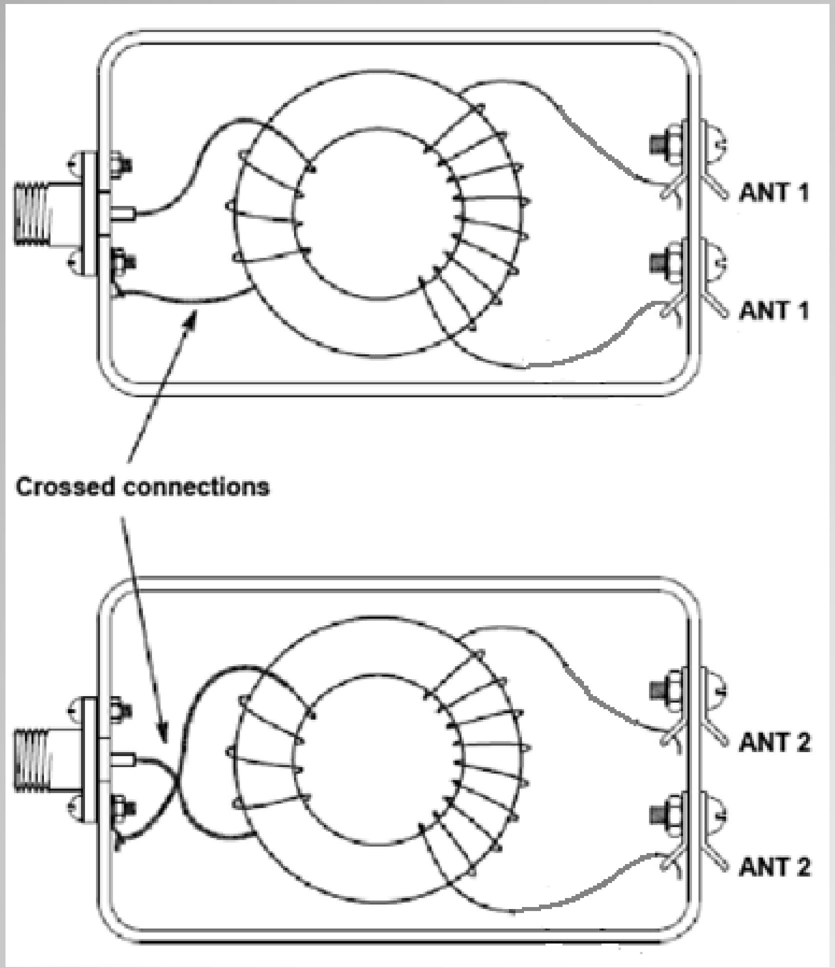
The signals are combined in such a way that one balun reverses the polarity by 180 degrees while the coaxial cable from the rear antenna to the combiner is longer.

**Coax L** = exactly the same length to both antennas.
**Coax S** = phasing coax to the rear antenna, the length is determined by how long the stagger distance is.
Note! don't forget to reverse the polarity of one balun.



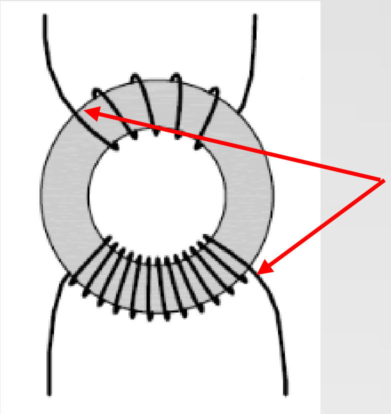
# Guidelines for the Combiner baluns




Here is how to make the two phase-inverting transformers (t) & (t1). Use baluns with minimal capacitive coupling and use a plastic box as cover.

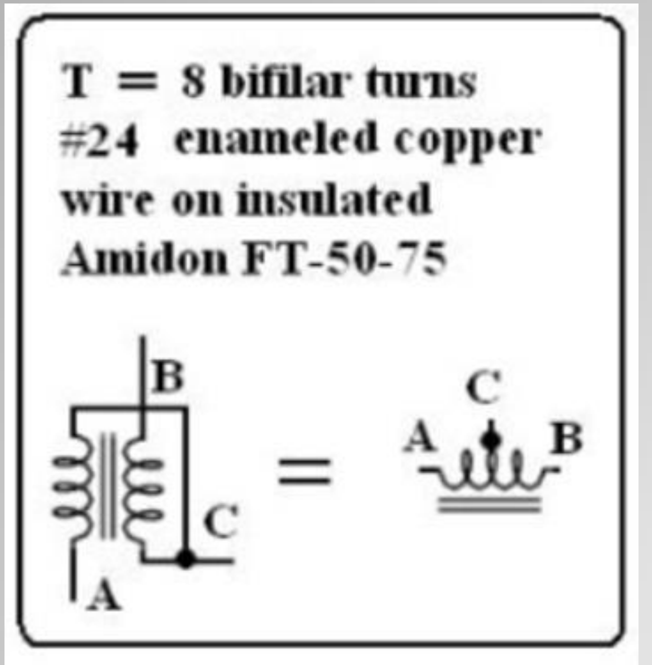
**Antenna baluns:**
If you want to work from 0.5 MHz to 30 MHz, select "Type 43" material. This material also gives "reasonable" performance on LW.

If you are certain that your interests are limited to LW, MW and Tropical Bands, 0.2 to 15 MHz, then "Type 75" ferrite is what you need.

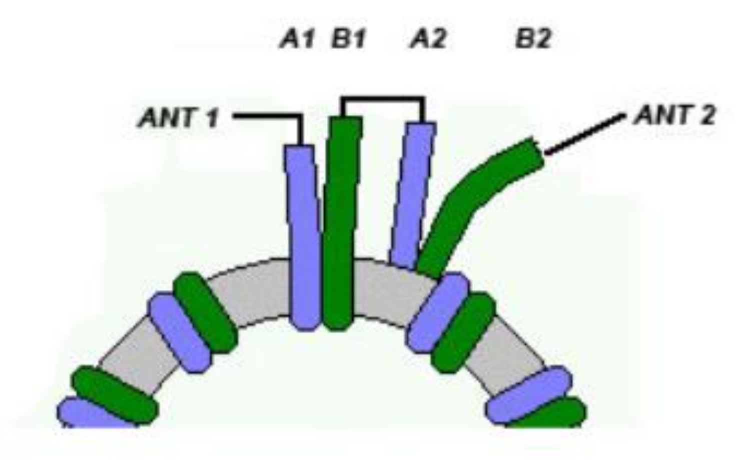


Winding directions must be the same for both windings.

# Step up balun, T, from combiner to antenna (25/50 ohm)




The 8 bifilar turns are connected acc. to the picture below.




**NB! Combining signals before amplification reduces circuit complexity**

# Fabricating toroid baluns

**John Bryant**: When fabricating a transformer with OL winding it is important to first wind the larger coil, (secondary), and then the smaller, (primary), coil over the larger. Both windings **must** be evenly distributed around the full circumference of the toroid and all windings of each coil should be evenly spaced.

**Mark Connelly** has provided a calculation table in Excel for toroids suitable for Beverage and Flag antennas.
The flag antenna has 950 ohms impedance to be converted to 50 ohms input to the radio, ie ratio 9: 1 = Z ratio 19.
An example with an Epcos & FT50-75 toroids are shown here:

| Min. Freq, kHz | High-Z winding (ohms) | 4 * ohms | winding L, uH | Core | AL | # of turns | Z ratio 50 ohms | # low-Z turns |
|---|---|---|---|---|---|---|---|---|
| 100 | 950 | 3800 | 6047,89 | Epcos N30 | 5600 | 32,86 | 19 | 7,54 |
| 100 | 950 | 3800 | 6047,89 | FT50-75 | 2725 | 47,11 | 19 | 10,81 |

# Preamplifier – Stefan Wikander

A must, I think, if you have a reasonably quiet QTH, is to have a 10 db preamp switched on, even at night, and the possibility of switching on two preamps in the morning. One preamp is placed at the antenna and is powered by a car battery. The other placed inside near the radio is also powered by battery. The batteries are charged only once a month.

# Common mode current choke – Stefan Wikander

Both in the cabin and at home, I need to have a couple of 3 mH chokes on the coax to the antenna to remove interference that comes with the coax from QTH. One is placed just after the radio and the other just before the combiner.

For me it makes a big difference and that also applies to my double Beverage. Flags give weak signals and are more sensitive to such disturbances than an antenna that has a higher gain.

# Fabricating the Choke

The design of ferrite toroid-based RF chokes of the type needed for this application is fairly straightforward. It seemed to make sense to provide 1500 ohms of impedance (the **minimum** that Devoldere recommended) at 150 kHz. This would give me sanitary lead-ins from below the bottom of the long wave broadcast band upwards in frequency until the choke “ran out of legs” well above the Tropical Bands.
I decided to use Type 75 ferrite material and selected the size FT-140. The AL figure for this toroid is 6736. The inductance needed to produce 1500 ohms impedance at 150 kHz is 1.6 millihenries.

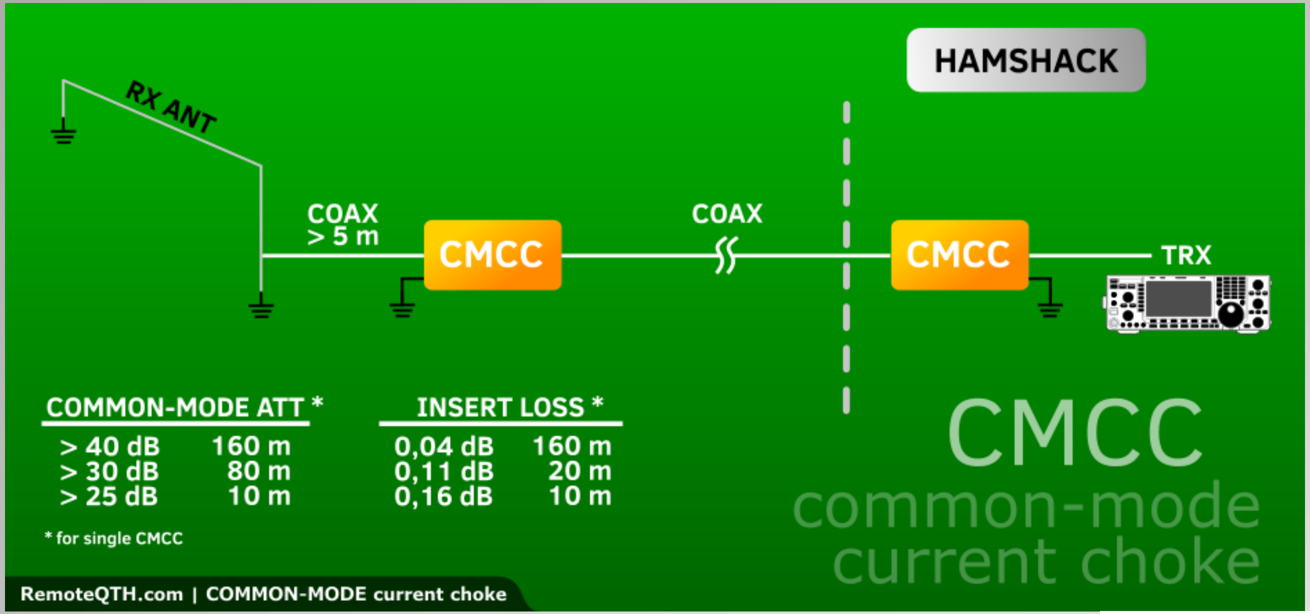
$$N = 1000 \sqrt{1.6/6736} = 15.4 \text{ turns}$$

The turns count comes out to be 16. After fabricating a number of these, I’m happy to report that 16 or 17 turns is about as much RG-174 coax as you can close wind in a single layer on the FT-140 toroid.

J material has low volume resistivity and low core loss from 1 kHz to 1 mHz. Used for pulse transformers and low level wideband transformers. Excellent frequency attenuation from 0.5 mHz to 20 mHz.

| Toroid | Turns | mH | Inner dia | Outer dia | Height | AL |
|---|---|---|---|---|---|---|
| FT-140A-J | 16 | 1,6 | 23 | 36 | 15 | 6736 |
| FT-140A-J | 21 | 3,0 | 23 | 36 | 15 | 6736 |

# Common mode current chokes

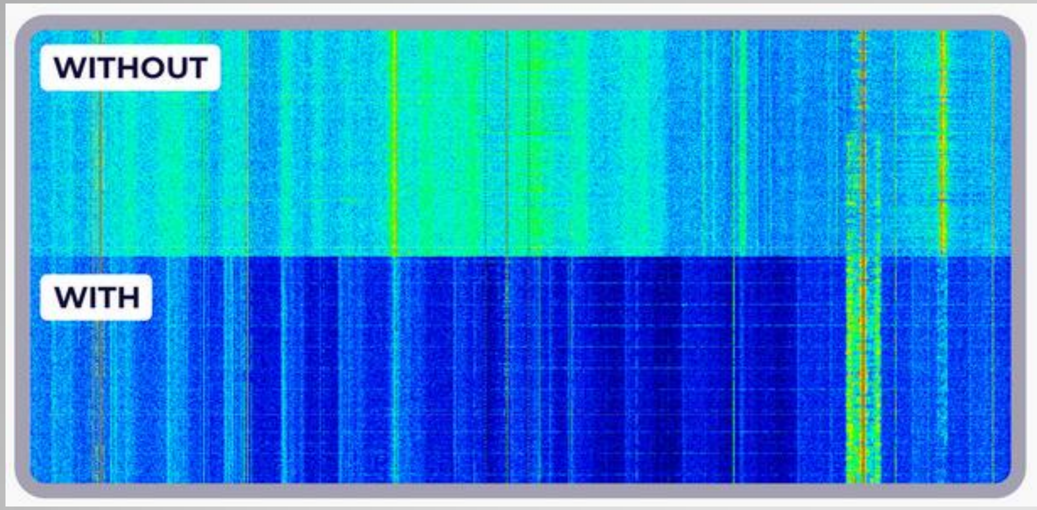



Common mode choke coils work as a simple wire against differential mode current (signal), while they work as an inductor against common mode current (noise).

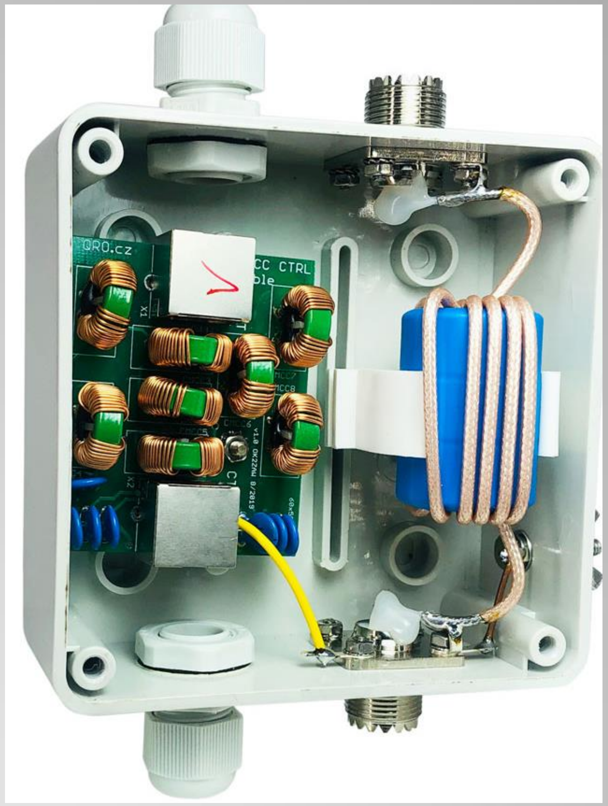
- High Noise insulation
- Low Loss
- 1-3 ports

# Effect of common-mode current choke CMCC

RemoteQTH.com







Common-mode choke coils work as a simple wire against differential mode current (signal), while they work as an inductor against common-mode current (noise). This box is designed as a common-mode filter for RF cable and also for analog AC/DC controller wires. This version is directly designed for K9AY++ antenna system.

# Feed Point Preamp + External Bias Tee




**Feed Point Preamp** **External Bias Tee**

The **Feed Point Preamp** combines universal transformer, preamplifier, simple Low Pass Filter, internal Bias Tee, front-end protection and common-mode output filter.
The transformer allows you to set three ratios: 1:4, 1:9 and 1:16. This allows the Feed Point Preamp to be connected to most RX antennas like Beverage (classic and BOG), loops like K9AY, DHDL, Flag etc. The input is isolated from the coax ground.
The preamplifier has a maximum gain of about 18 dB and a variable ATT, which allows you to control the overall gain.
The preamplifier can be powered via coaxial cable (internal Bias Tee) using an external Bias Tee in hamshack or via a cable connected directly to the box.

# Universal Terminator



**Universal Terminator**

The **Universal Terminator** - is a small box designed to terminate RX antennas like beverage, K9AY and other loops. This terminator allows you to change the value in three ranges: typ. 900, 450, 230 and 320 Ohms with the possibility of adding + 50 Ohms to each value. It includes current overload protection as well as voltage protection using GD and Neon lamps at approximately 80V AC.

# K9AY One Direction RX antenna

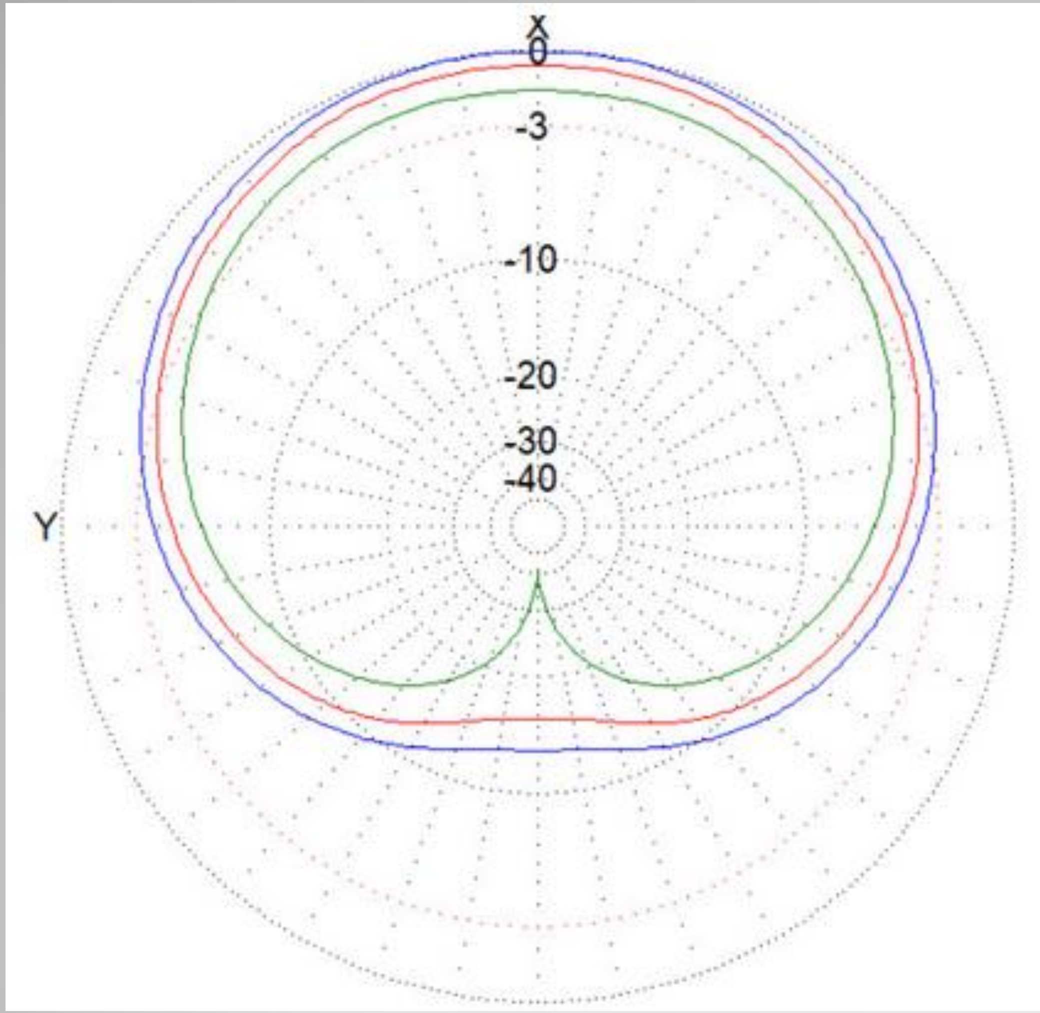
RemoteQTH.com


## Main functions:

- Broadband 0,2 MHz to 30 MHz
- 1 direction
- Designed for Multi-Receivers - sharing direction
- 50/75 ohm feed line - jumper switch inside
- Variable Rload in 8 steps by jumpers.
- High voltage electrostatic protection with neon lamps.
- High power IN/OUT protection with PTC.

The **K9AY RX loop antenna** is terminated by the resistor. This is ONE direction antenna. There is no directional switching relay. Impedance matching transformer is connected from one end of the loop to the ground and load resistor is connected the other end of the loop to the ground. Favoring signals are arriving from the feed point end. You can set different values by the jumpers. There is also common-mode current choke.

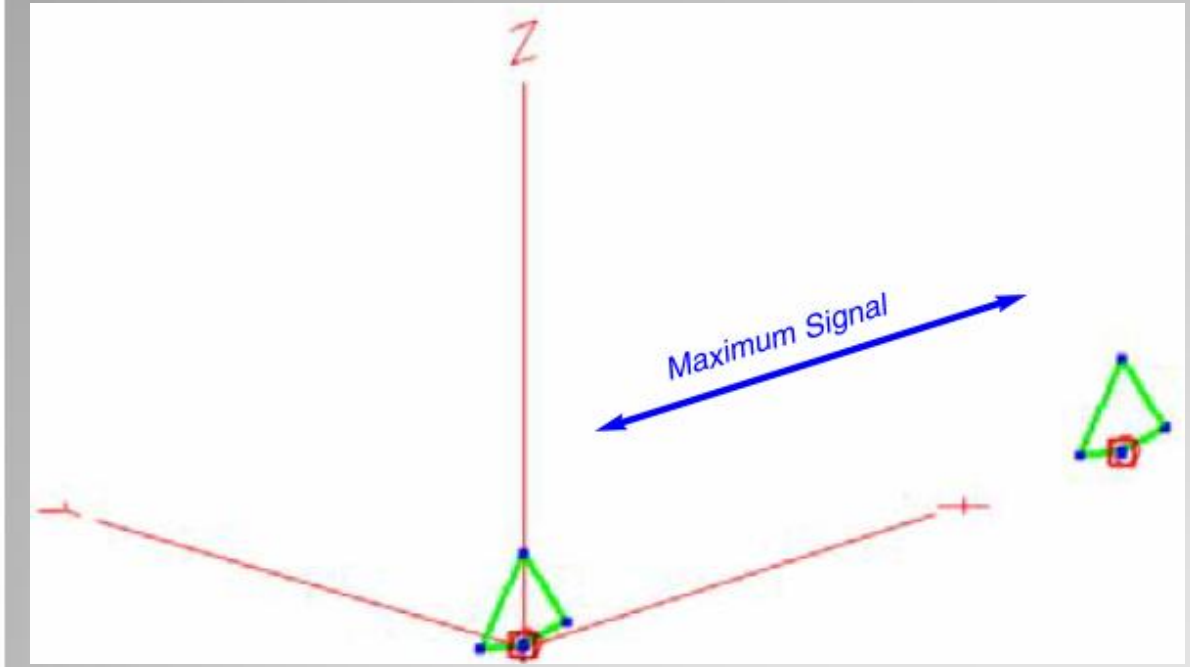
# K9AY Ground distance

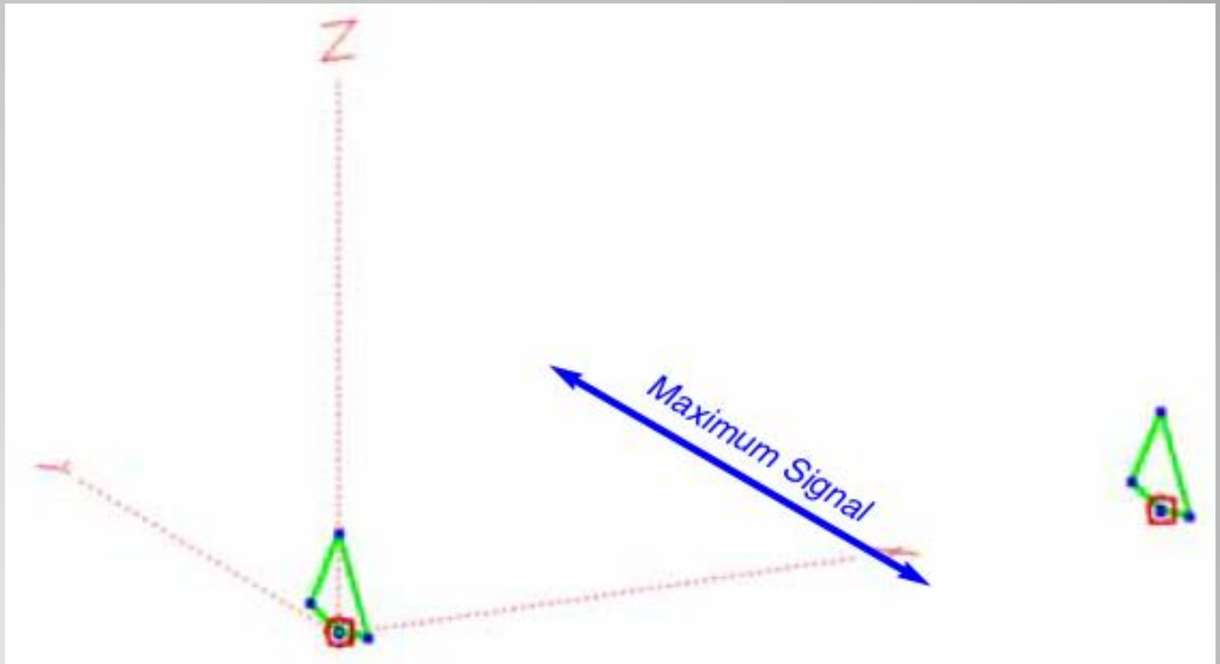



## effect of low part of loops

Place loops as low as possible. GREEN = on ground, RED = 0.5m, BLUE = 0.8m

# K9AY Endfire / Broadside ½ wave spacing

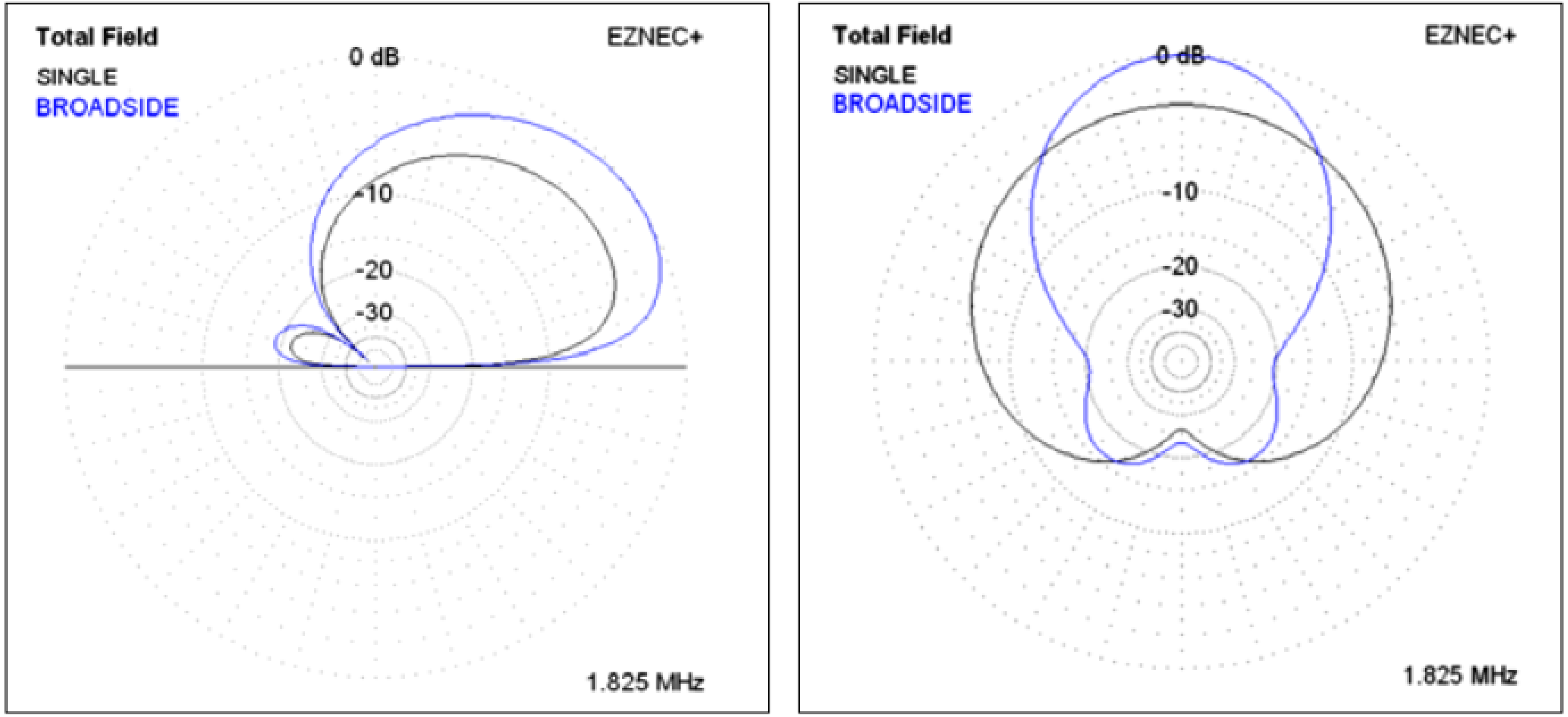



**Endfire Array at 160 m (1825 kHz)**
**Recommendation: 1/2-wave spacing**

**Broadside Array at 160 m (1825 kHz)**
**Recommendation: 1/2-wave spacing**

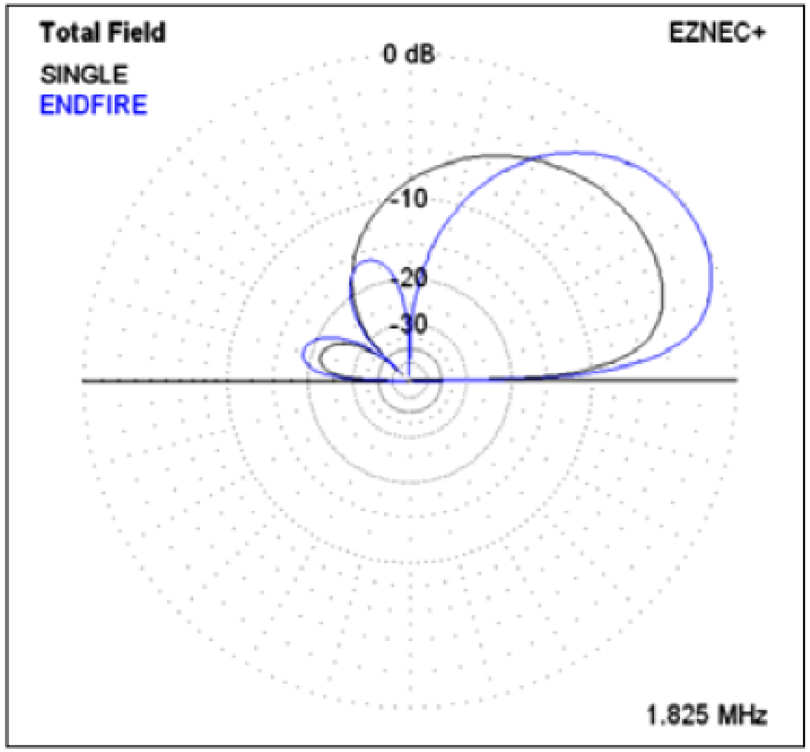
# K9AY broadside radiation pattern



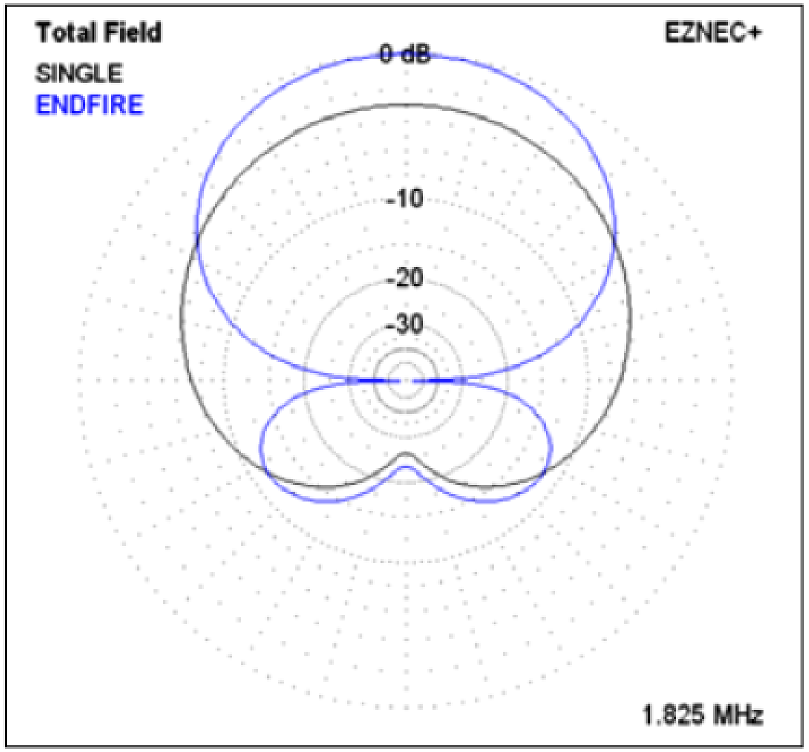

Vertical Pattern    Horizontal Pattern (at 30º elevation angle)

The figure shows the patterns for the broadside pair, compared to a single K9AY Loop. As you can see, the vertical pattern is exactly the same shape, although the signal level is increases between 3 and 4 dB due to the gain of the array.

# K9AY endfire radiation pattern



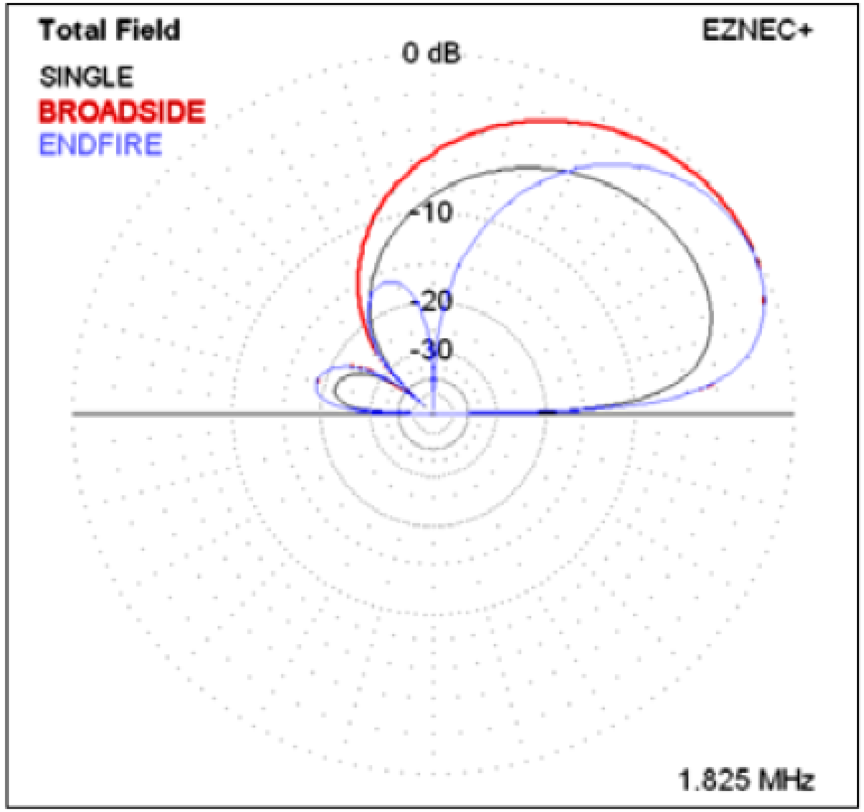

**Vertical Pattern**



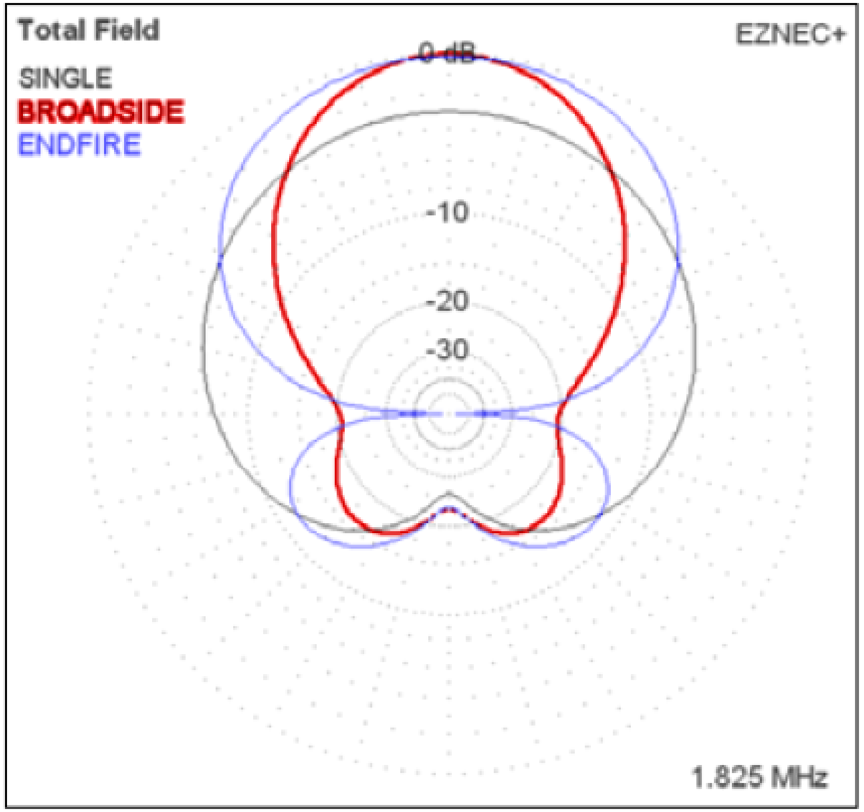

**Horizontal Pattern (at 30° elevation angle)**

The endfire pattern is much different than the broadside pattern. First, both patterns show the 3 dB gain due to combining the signal capture of two antennas. Next, the vertical pattern is improved over a single loop, with greatly reduced response at very high angles. This will reduce sky noise a bit, but more important, will reduce “short skip” signals from close-in stations. The horizontal pattern adds two deep, but narrow, nulls off the sides. It is still very wide in the main direction — certainly better than a single loop, but not as narrow as the broadside pair.

# K9AY broadside/endfire radiation pattern



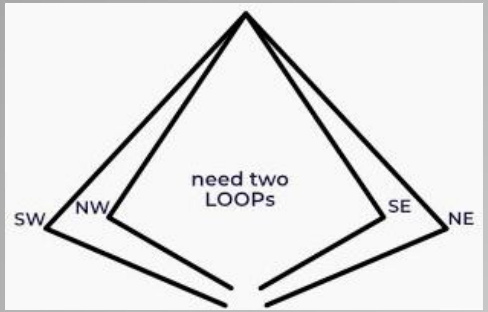

Vertical Pattern



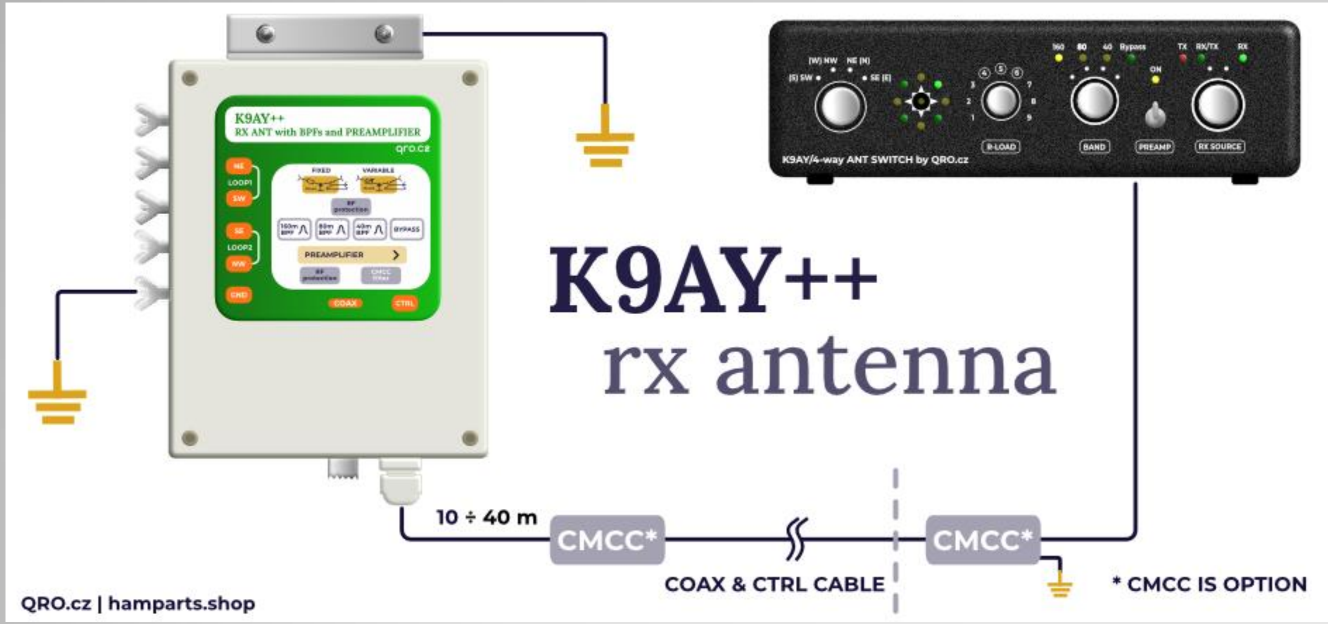

Horizontal Pattern (at 30º elevation angle)

To summarize, the broadside pattern is narrow, but tall, while the endfire pattern is wide but flat. The endfire array also has the side nulls. The figures below combine the patterns into one plot for comparison.

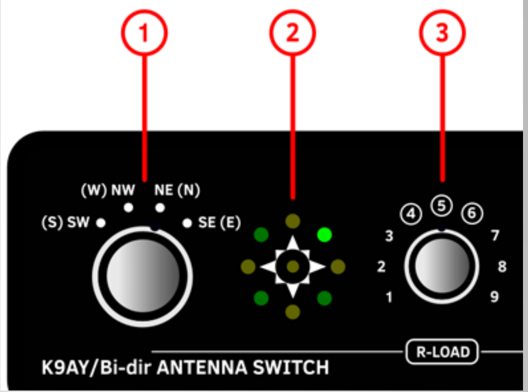
# K9AY++, feeder- & controller box



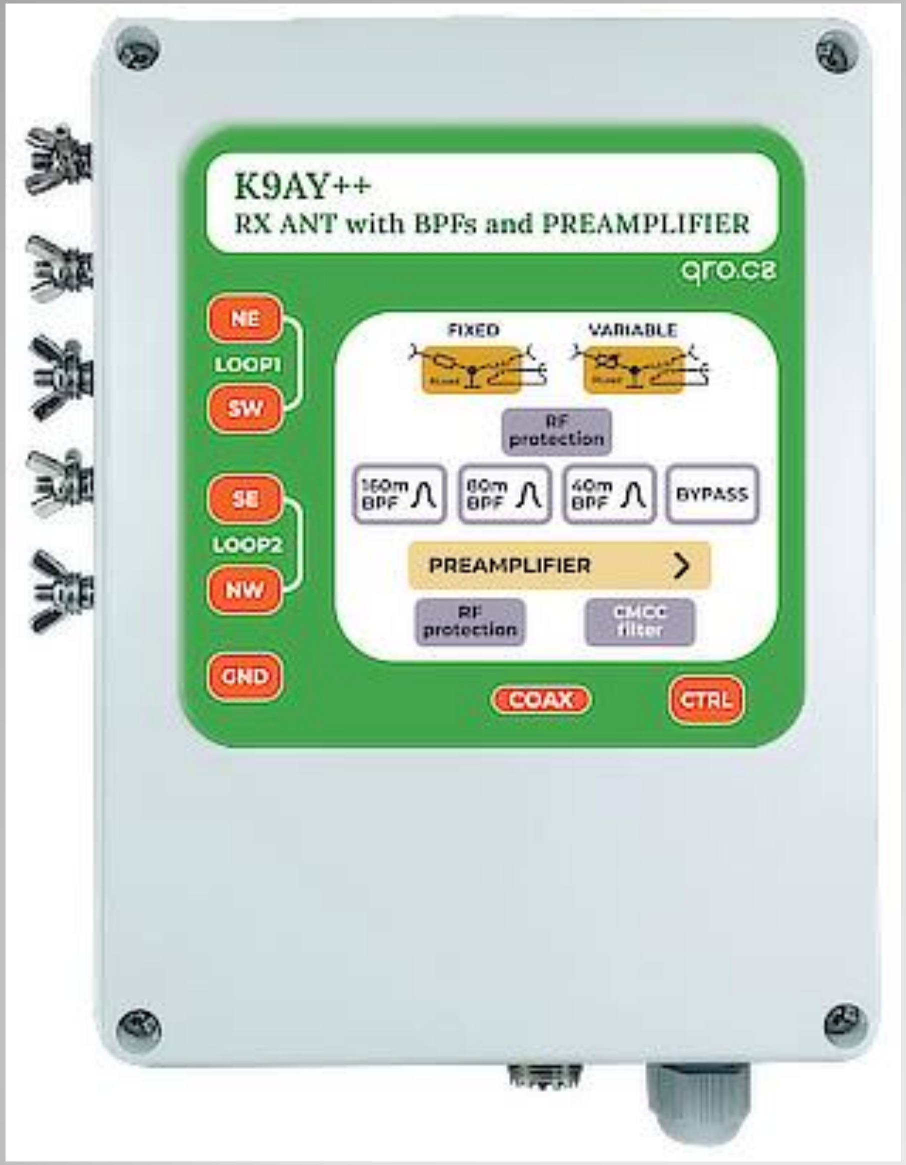

The K9AY is terminated loop. A 9:1 impedance-matching transformer is connected from one end of the loop to the ground and a terminating resistor is connected the other end of the loop to the ground.
You can change the antenna far field by changing RLOAD (RTERM) of the loop.

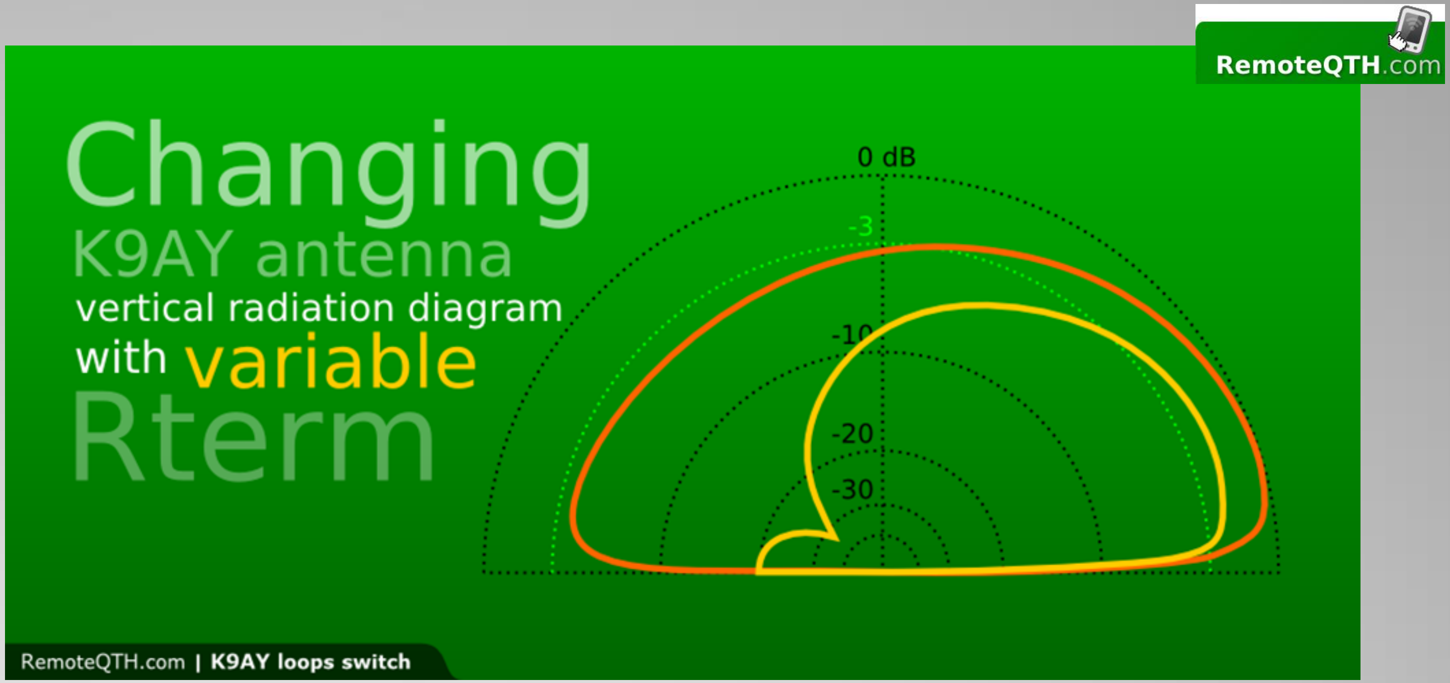


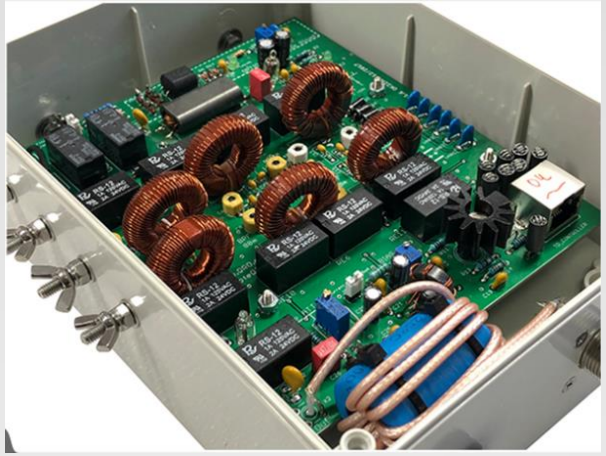

1 - 4 direction switch
2 - Direction LED
3 - Variable Rload




**Grounding:** A 4-foot ground rod (3/4" dia. copper pipe) is often sufficient. If the earth is very dry, a longer ground rod is advised, to reach permanently moist earth - or four or more 15 – 20 feet long radial wires for better coupling to ground. K9AY has several advantages over ground-independent versions (Pennant and Flag), including simpler switching, no feedline isolation problems, and greater signal capture for the same size loops.



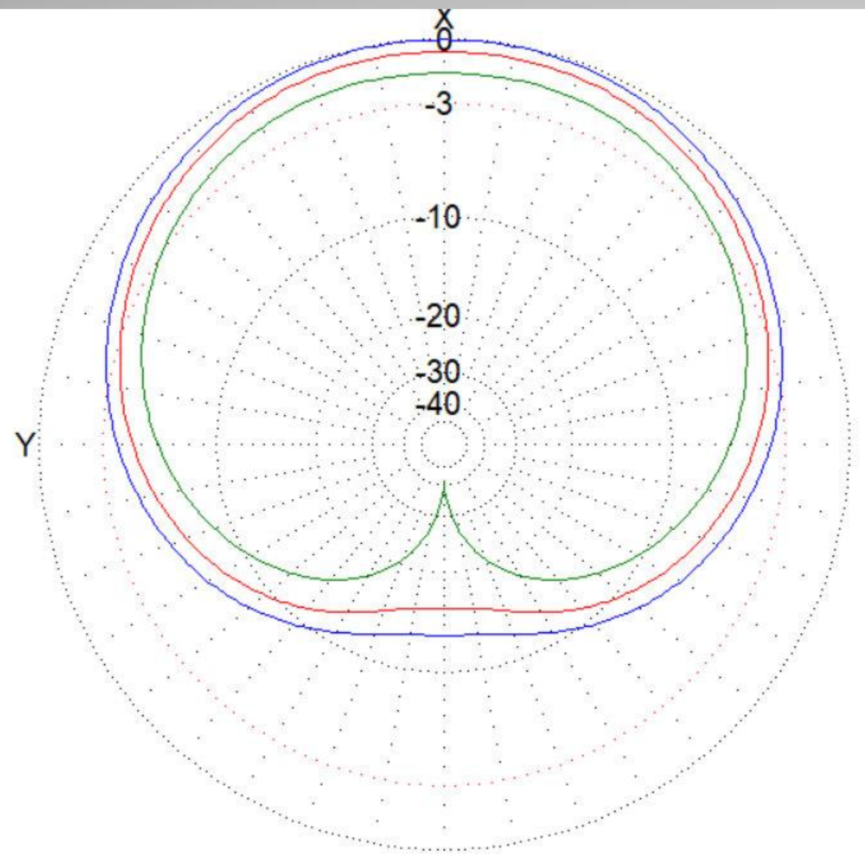



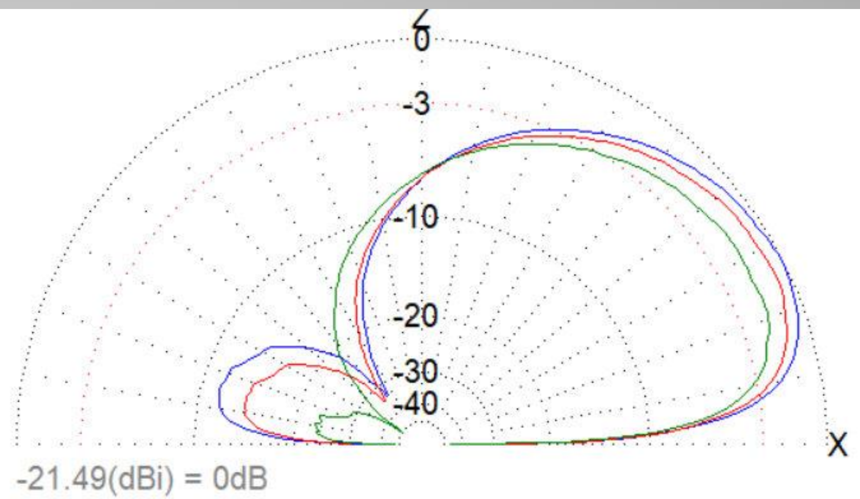



**Lisette Åkesson**: R-load makes a difference 2-3 times out of 10 by improving zeroing and also the strength of the desired signals.

R-load is the switch knob where you change the vertical angle to listen from. But there are also several different trim points in the outdoor box that you can play with..

# Antenna radiation pattern vs Rload on 1825 kHz




Field(s)

○ V ○ H ◉ Total ○ V+H

Load *.mab file | Clear | Colors | Return

| No. | F (MHz) | R | jX | SWR | Gh | Ga | F/B | Elev. | GND | Height | Pol. | File | name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.825 | 512.873 | 25.691 | 1.15 | --- | -21.49 | 11.42 | 26.8 | Real | 0.0 | V | this | |
| 2 | 1.825 | 507.827 | 23.685 | 1.14 | --- | -22.0 | 13.31 | 25.4 | Real | 0.0 | V | D:\Dokumenty\-- | |
| 3 | 1.825 | 467.66 | -0.731 | 1.04 | --- | -22.97 | 21.26 | 30.7 | Real | 0.0 | V | D:\Dokumenty\-- | |

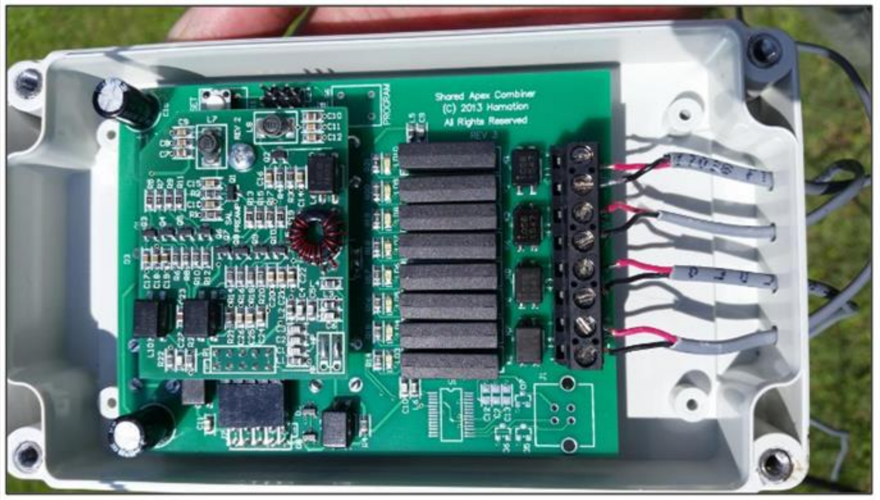
# SAL-XX - Shared Apex Loop Receive Antenna System

ARRAY SOLUTIONS


Controller

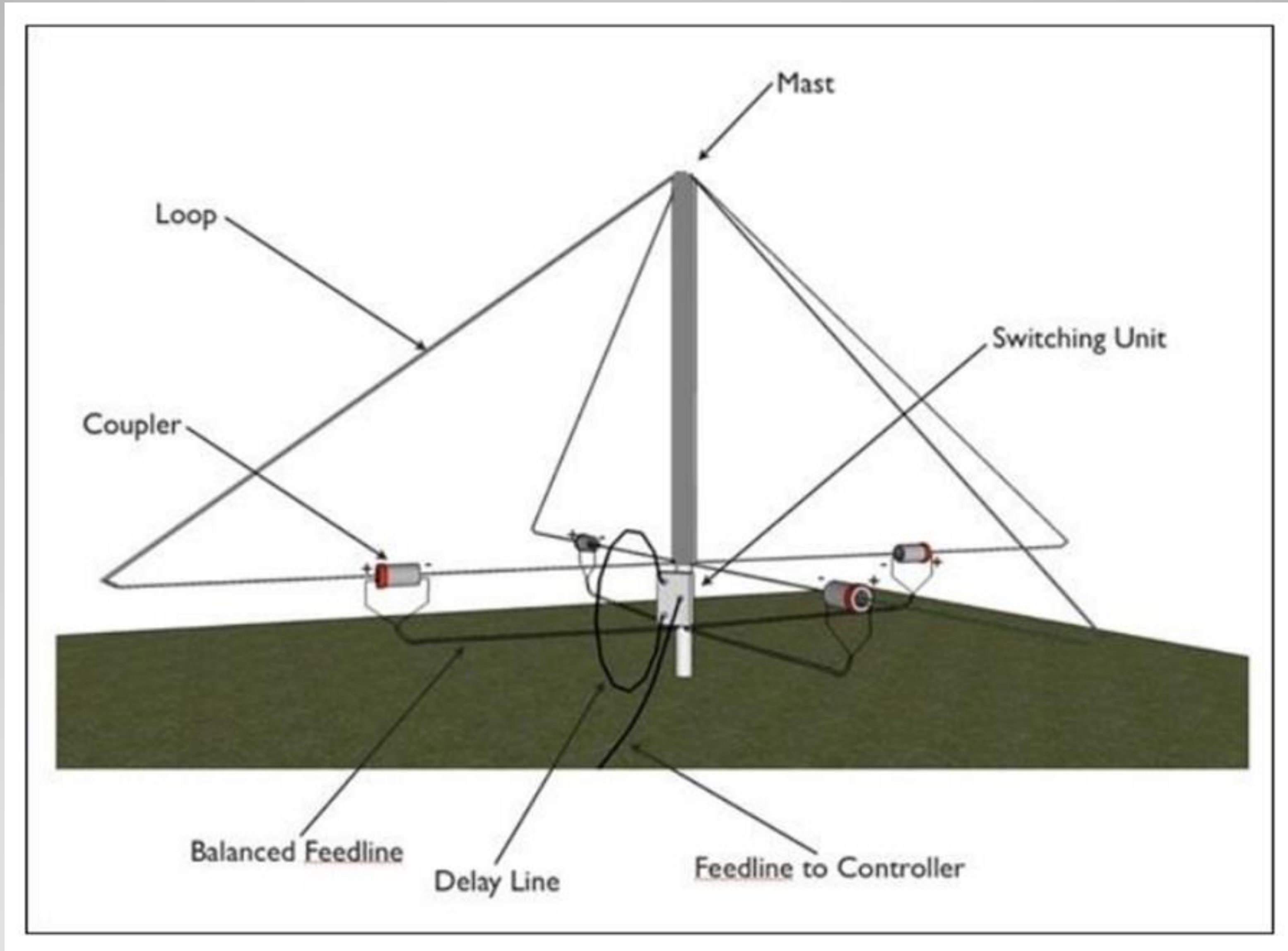

Combiner

Interior of combiner



ARRAY SOLUTIONS

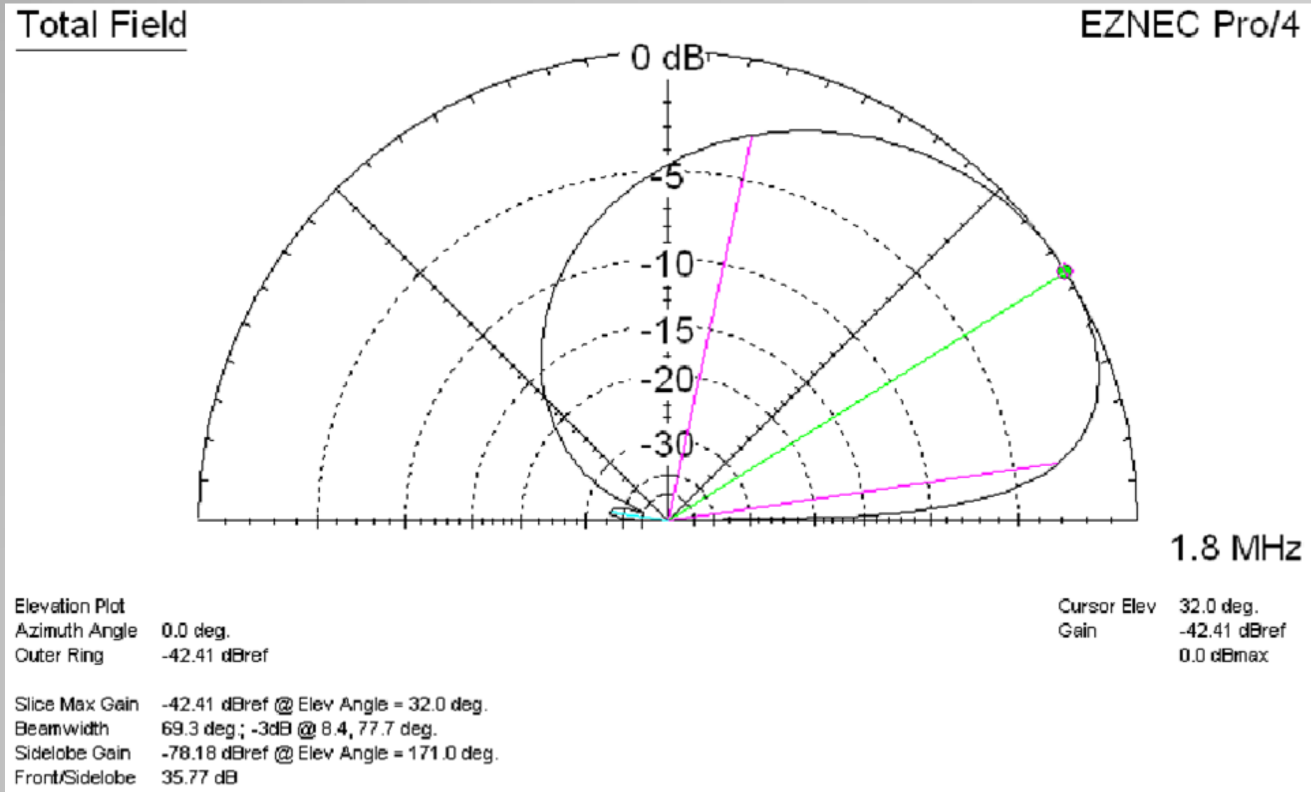
# Shared-Apex loop array



ARRAY SOLUTIONS

# AS-SAL-30 Mark II-DX

**Without Power supply, mast and stakes to make reasonable overseas shipping costs.**



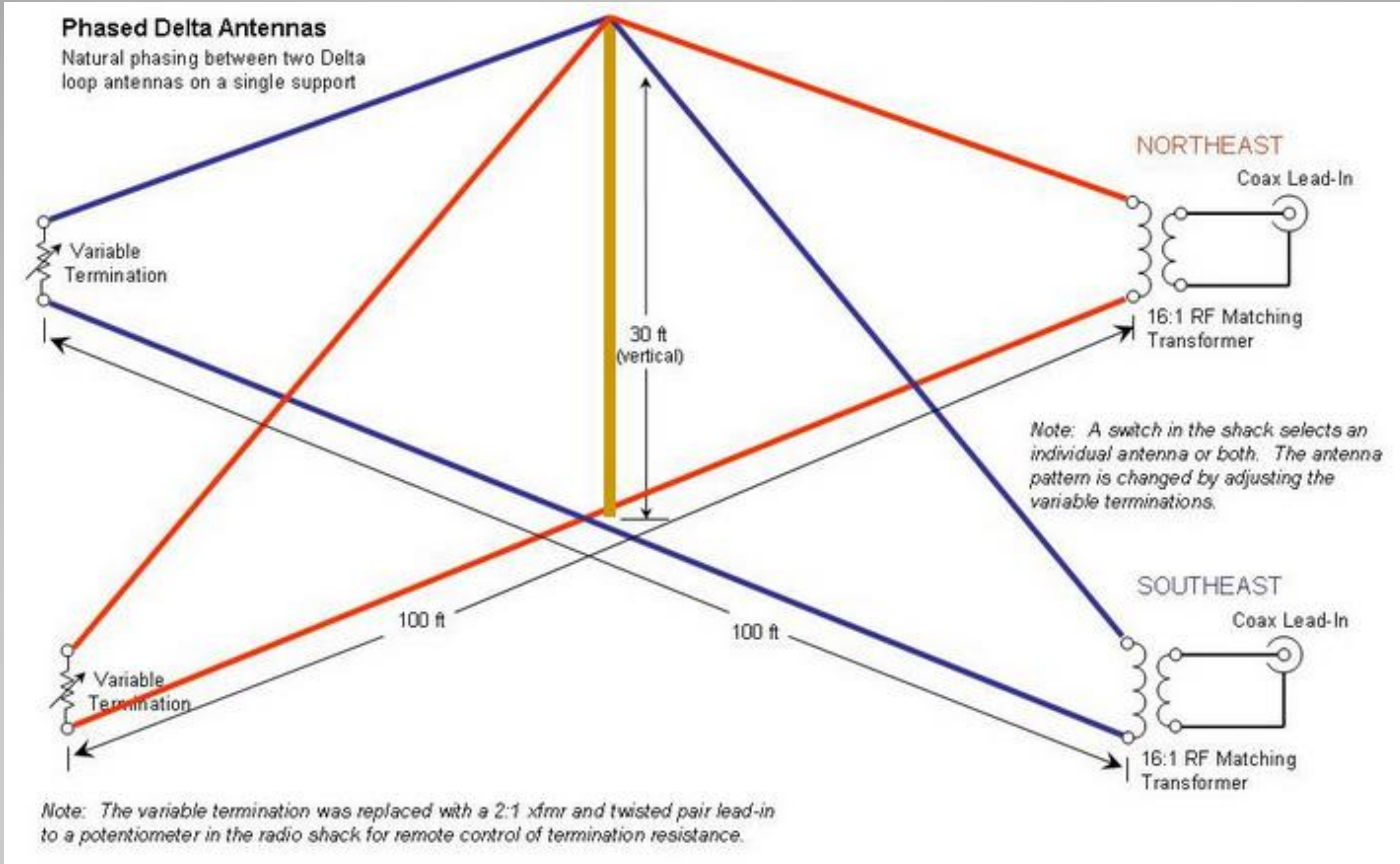

## Shared-apex loop array

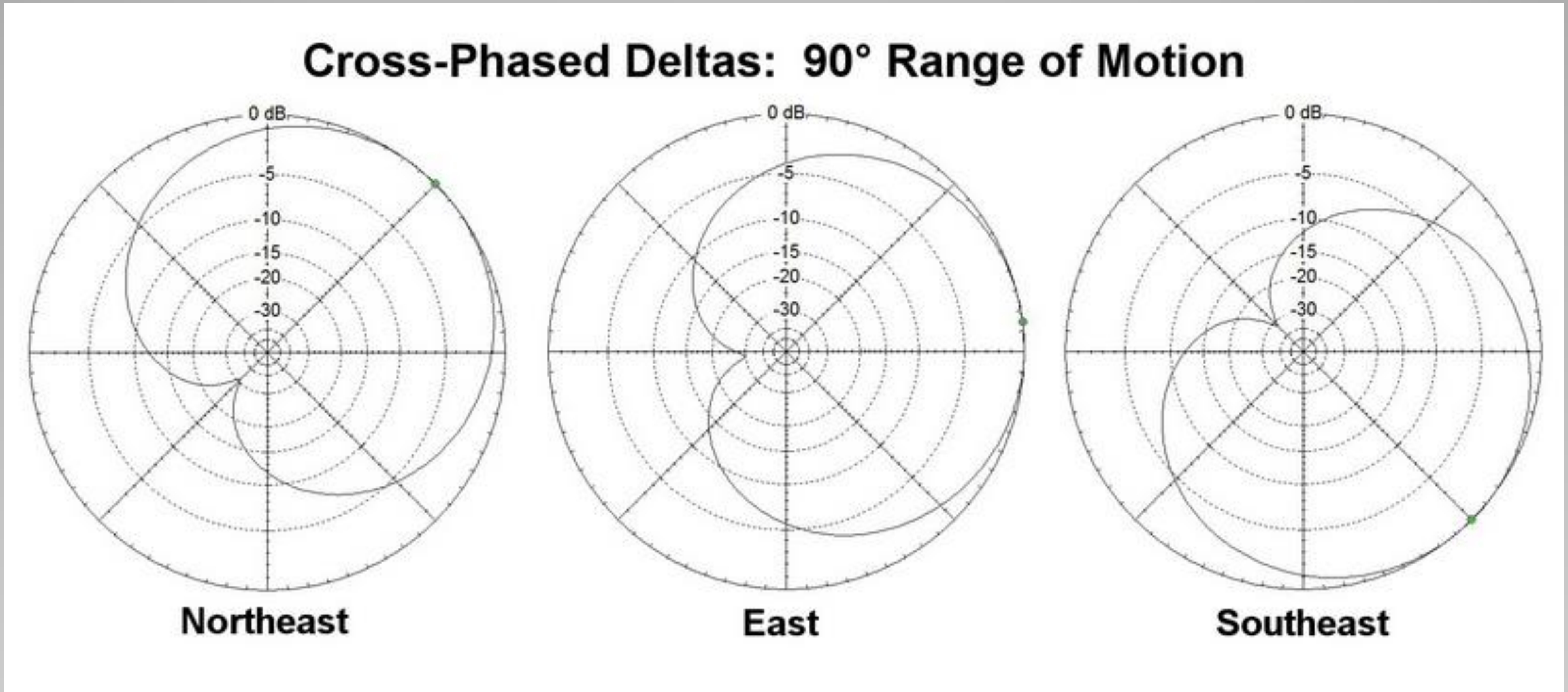
- -switchable to 8 directions
- -high front-back ratio
- -rejects much of atmospheric noise

## Combiner Features:

- Four balanced loop inputs
- Operating Range: 100 kHz - 30 MHz
- Very low noise dual differential pre-amp
- Now delivered with a High Pass AM Broadcast Band Filter

Gain & elevation patterns significantly affected by ground conductivity values

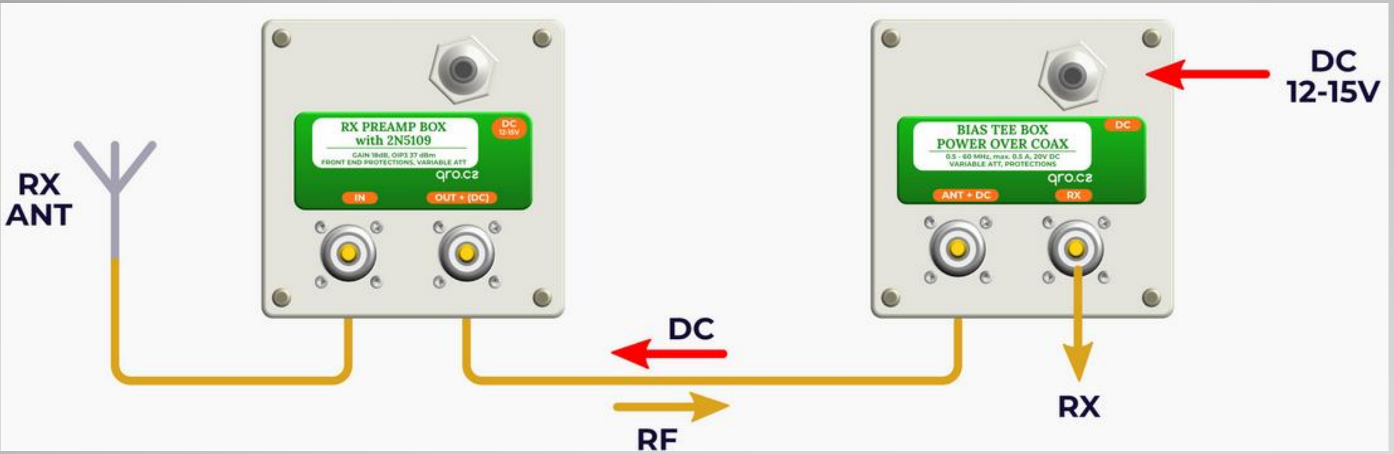

Phased Delta Antennas
Natural phasing between two Delta loop antennas on a single support
Variable Termination
30 ft (vertical)
NORTHEAST
Coax Lead-In
16:1 RF Matching Transformer
Note: A switch in the shack selects an individual antenna or both. The antenna pattern is changed by adjusting the variable terminations.
SOUTHEAST
Coax Lead-In
100 ft
100 ft
Variable Termination
16:1 RF Matching Transformer
Note: The variable termination was replaced with a 2:1 xfmr and twisted pair lead-in to a potentiometer in the radio shack for remote control of termination resistance.




An antenna switch allows for selection of an individual Delta antenna or connection to both.
When both antennas are selected, termination resistances are adjusted to steer the beam within the northeast to southeast quadrant, usually by reducing the termination resistance of one Delta while slightly increasing resistance of the other.
In the above EZNEC model results, the northeast Delta termination resistance is 400 ohms, and the southeast Delta 1420 ohms, to produce an easterly beam with a westerly backside null.

# RX Preamp box with Bias Tee

RemoteQTH.com




This is very simple preamplifier module with 2N5109 transistor based on W7IUV design.

You can use it as high IP preamplifier, buffer amplifier or small driver.

Gain is up to 18dB and there is also a built in variable ATT.

You can easily set gain as high as you need!
As well you can set correct transistor bias with the multi turn potentiometer.

Power over coax cable with the Bias Tee Box.

# The Classic Beverage Antenna

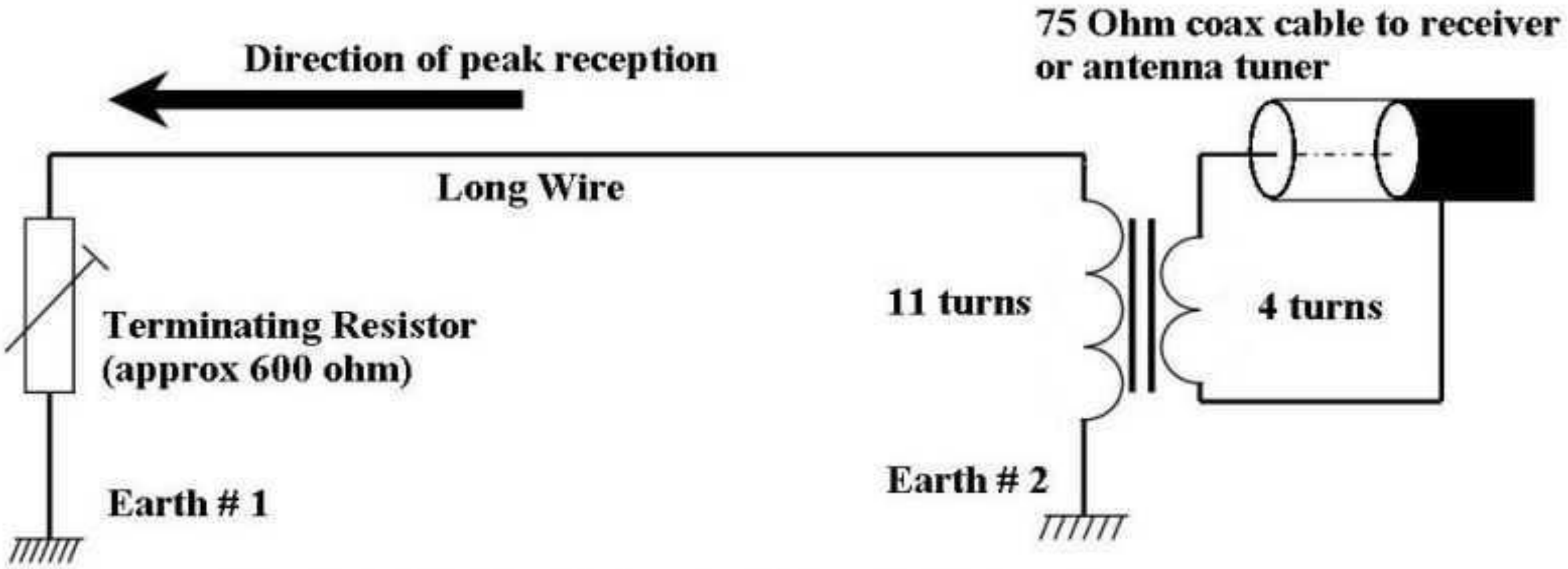



**Figure 1:** *A basic uni-directional Beverage antenna*

| **Length:** | **RDF:** | **Beamwidth:** |
|---|---|---|
| 75 to 120 m | 4 to 6 dB | $100^{o}$ |
| 150 to 210 m | 10 to 11 dB | $70^{o}$ |
| 240 to 270 m | 12 dB | $60^{o}$ |

# Phasing Beverage Antennas

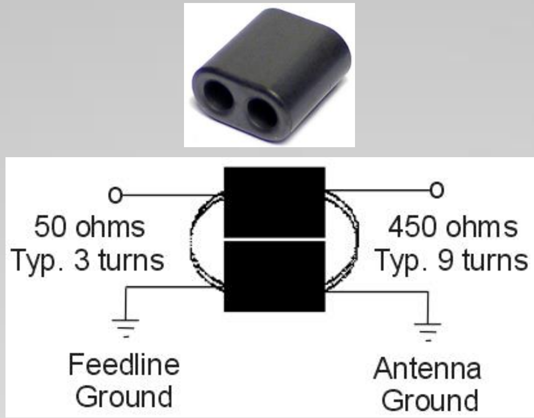
To improve directivity without using long antennas, you can phase individual beverages.

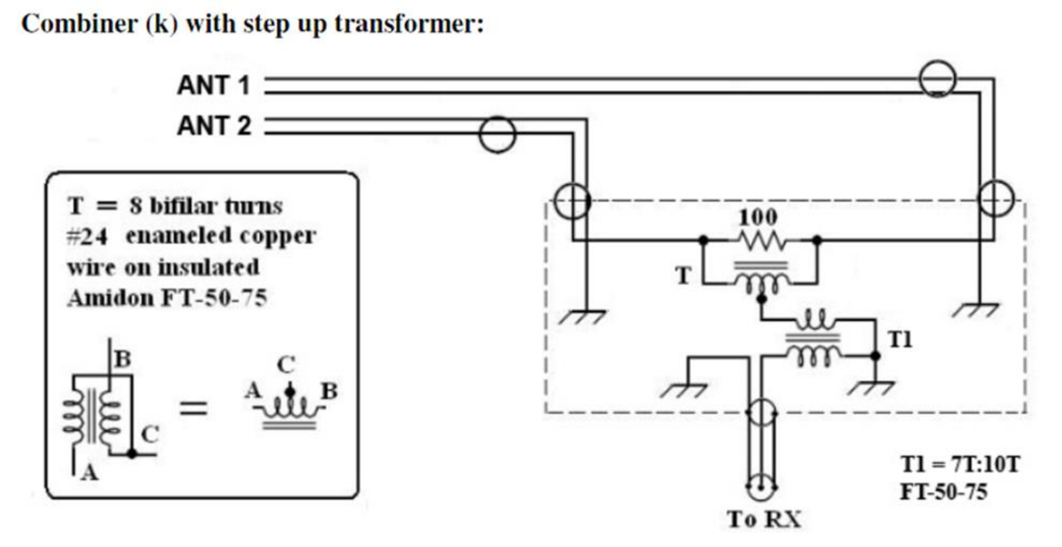
- Two methods:
  - Broadside
  - End-Fire (or Staggered)
- Each has its own advantages

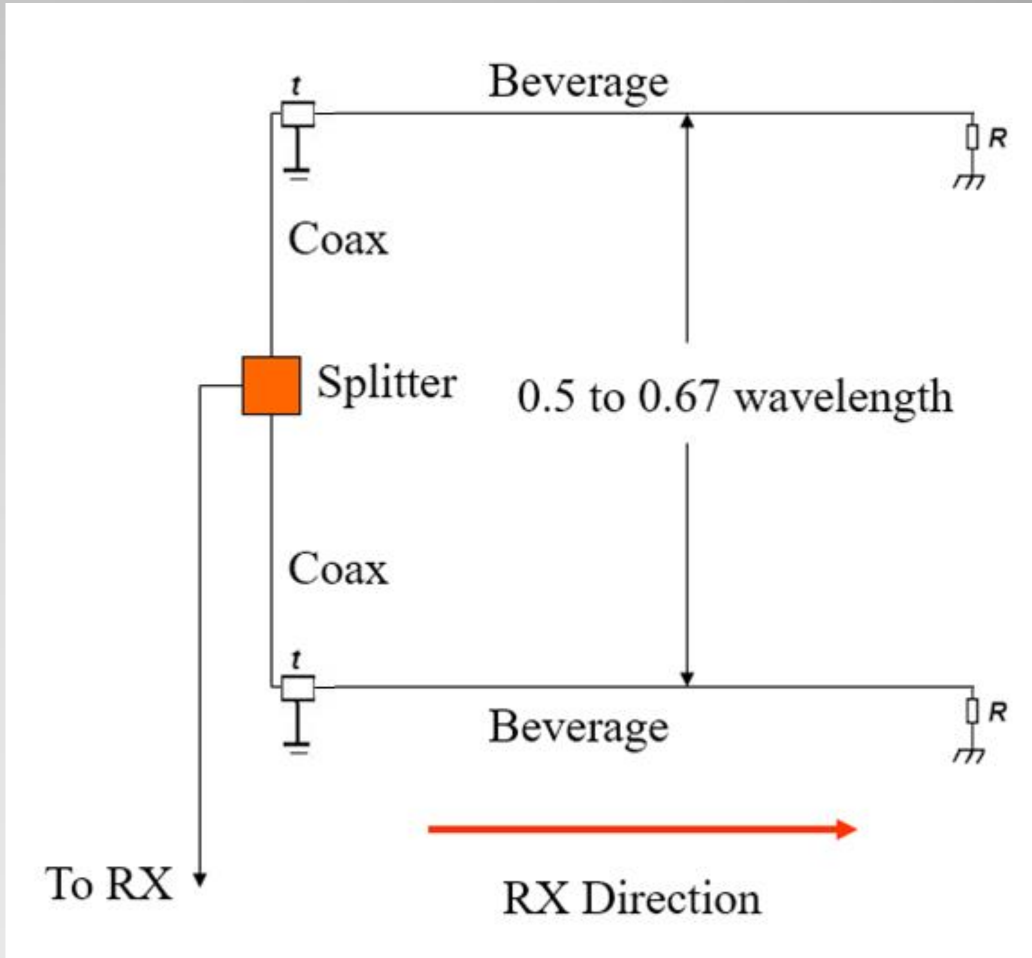
# Broadside Phasing

- Narrows frontal lobe
- Front/Back remains the same
- Fed in phase
- Coax = same length
- Multiband
- Require wide spacing
- 0.5 wavelength spacing good
- 0.67 wavelength excellent!

Balun ***t***



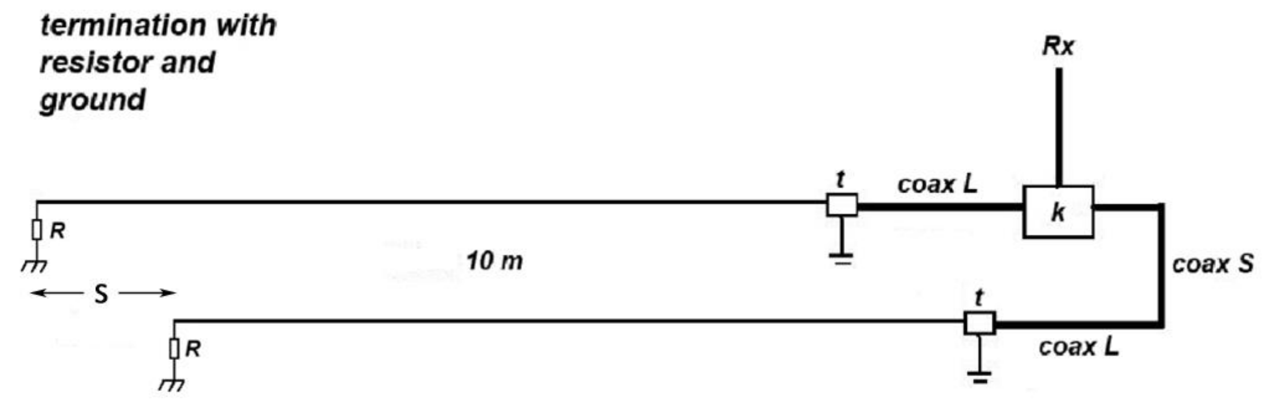



# End-Fire Phasing

The figure shows a staggered beverage array where the desired signals are coming from the left. The offset is 30 m and the distance between the beverages is 10 m.

- **coax L** exactly the same length of coax to both beverages, length optional
- **Coax S** phasing coax to the rear beverage, the length L = stagger distance (S)
- **K** combiner / splitter
- **t** balun, NB! do not forget to reverse the polarity of one of baluns




The signals are combined together so that one of the "baluns" reverses the polarity (= 180 degrees), at the same time as the coax from the rear beverage to the combiner is slightly longer.

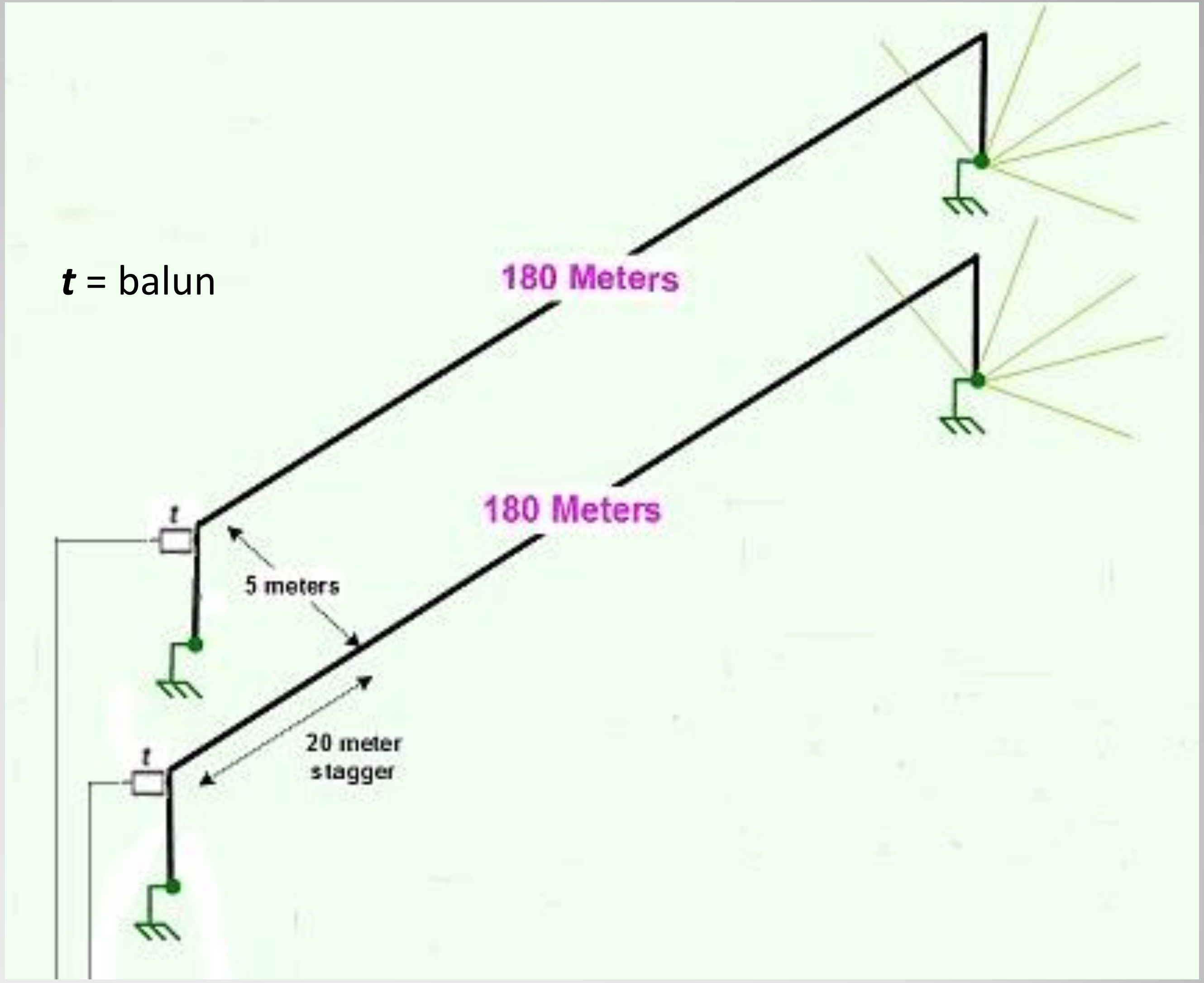
**Stefan Wikander**: The advantage over a simple antenna is more forward gain and that the side lobes are smaller.
It does not attenuate as much backwards as a Staggered Beverage Array, but the side lobes can probably be attenuated just as well.

# End-Fire Phasing

**Stefan Wikander**: The distance between the antennas does not have to be that big, 5-10 meters is enough.

The greater the distance, the more the front lobe skews, and backwards it attenuates more in one direction.

It can be an advantage to widen the distance between the antennas if you want to attenuate more on one side slanted backwards than for the other side.



*Diagrams from ON4UN's Low Band DXing*

# Broadside Phasing

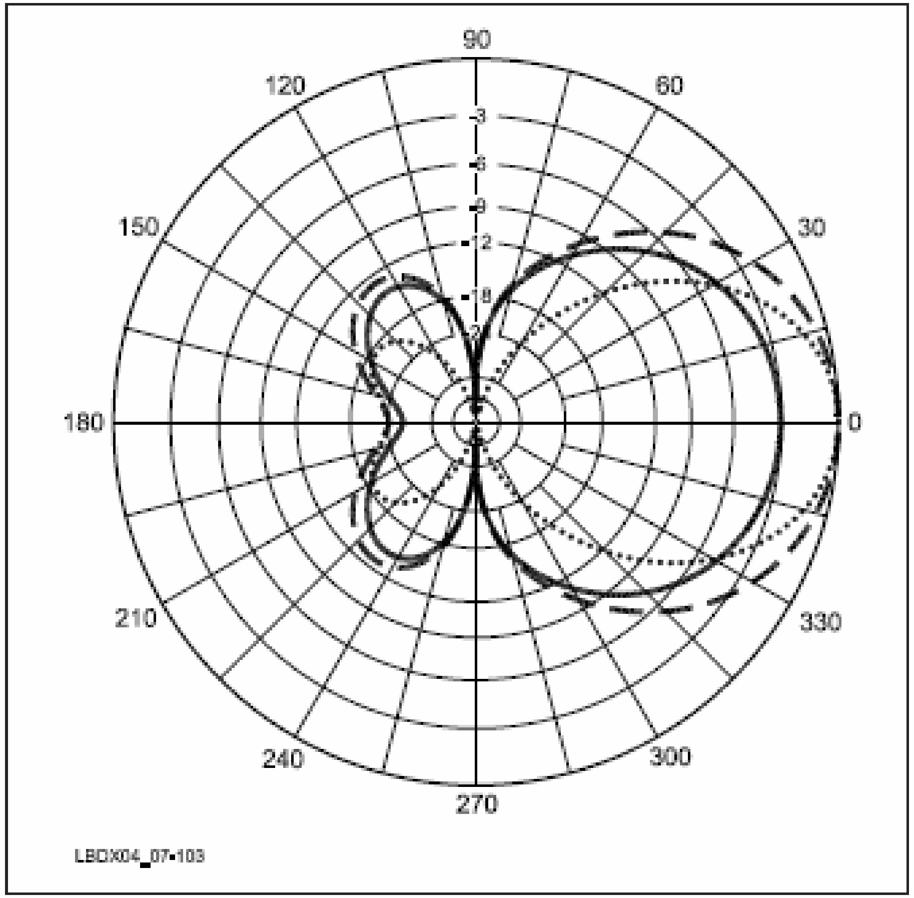



Fig 7-103—A single 160-meter long Beverage (solid line); two such Beverages in phase, side-by-side, spacing 40 meters (dashed line) and 90-meter spacing (slightly over λ/2, dotted line). Actual gain is irrelevant for receiving.

# End-Fire Phasing

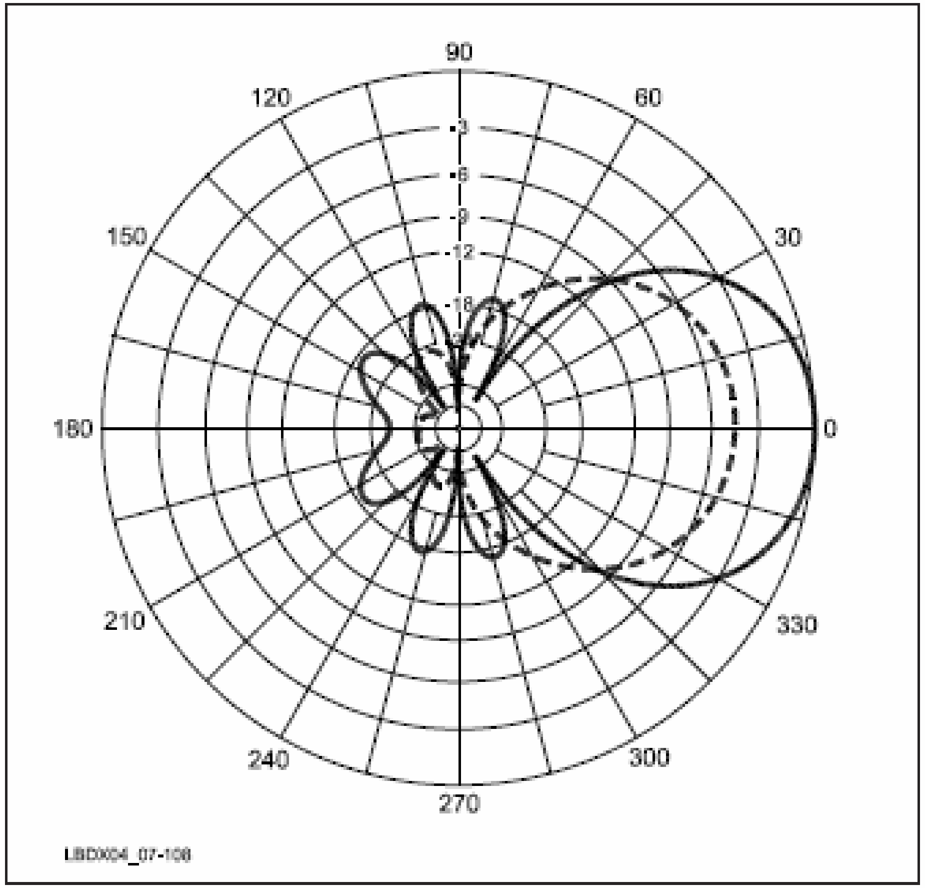
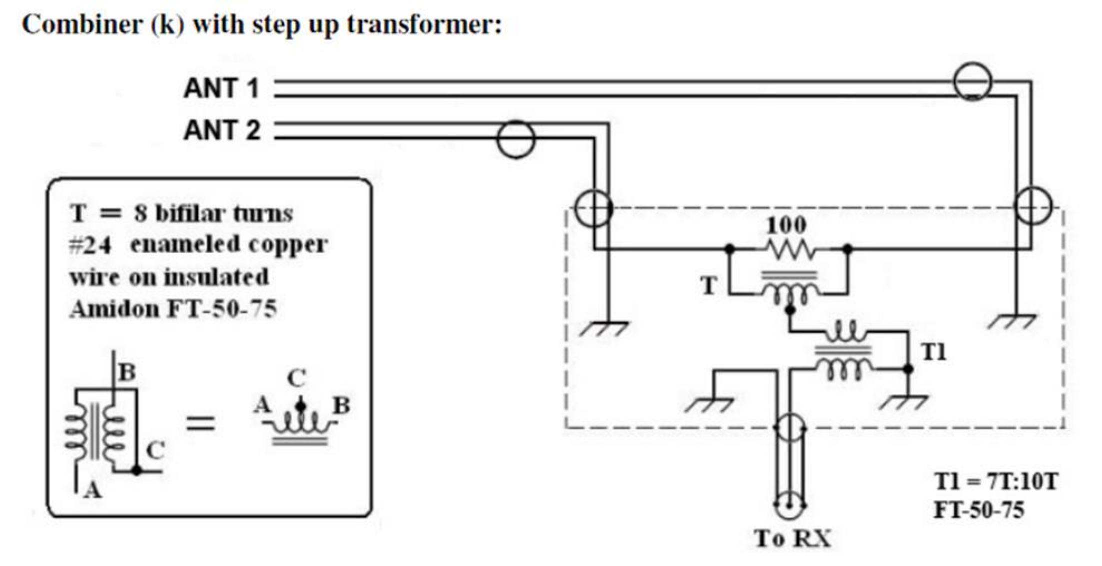
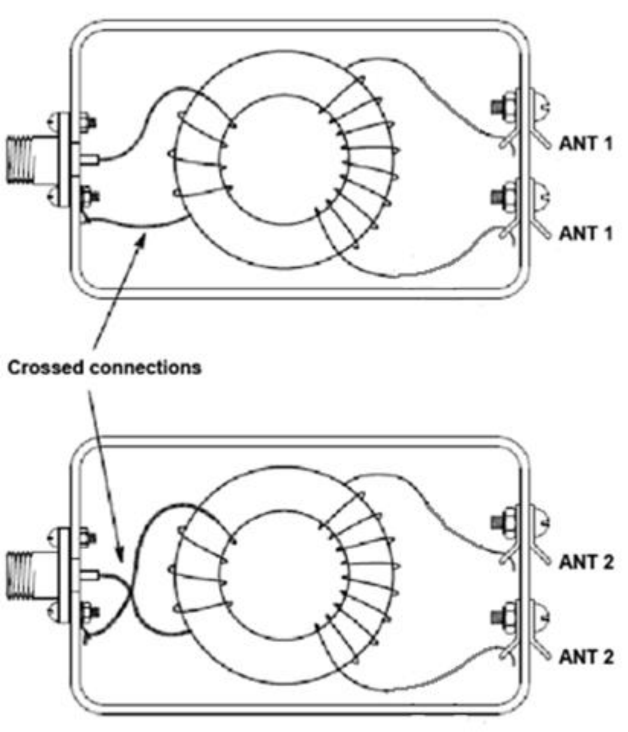



Fig 7-108—Azimuth pattern on 1.83 MHz for a single 320-meter Beverage (solid line); azimuth pattern for end-fire pair of 160-meter long Beverages, half the length (dashed line).

# End-Fire Phasing – stagger length calculation




**RG-58U with antennas staggered 30 m:**
For s = 30, d = 30 COS(30°) = 25,98 m. (Cos(30°) = 0,866)

The speed of electromagnetic radiation is approximately 2.99 x 10^8 m/s in air, so the time delay per meter in air is 1/(2.99 x10^8) = 3.34 nS/m.

Thus the required time delay is: T = 3.34 x 25,98 = 86,77 nS.

RG-58U is rated at VF = 0.66 nominally.
Thus the time delay per meter of RG-58U with VF = 0,66, which gives 3,34/0,66 = 5,06 nS/m.
From this follows that the length L of RG-58U required for a 86,77 nS delay is L = 86,77/5,06 = 17,15 m.

# How High?

- Not as critical as many think
- General rule:
  - Higher Beverages produce higher output
  - Higher Beverages have larger side-lobes
  - Higher Beverages have a higher elevation angle
  - Higher Beverages have a wider 3-dB forward lobe
- Laying on ground to 6 meters high is acceptable
- 1.5 x Antler Height is good idea!
- 2.5 meters is a good compromise

# Ground Quality

- The better the ground, the lower the output
- Ground quality has little impact on radiation angle
- The poorer the ground, the less pronounced the nulls between the different lobes
- Directivity remains almost constant
- Beverage does not work well over salt water

# Different Beverage Antennas from One Hub

" Never run different Beverage antennas from a single spot, using a single ground rod (or ground system). In such a case you will, via the common ground rod resistance, cross-couple part of the signals from one Beverage into another Beverage. If you want to run different Beverages from one point, run the master feed line to a switching box (head end of the master feed line), and fan out to various feed points, each of which is fed via a separate feed line, in such a way that the ground rods of these feed points are separated at least 5 meters from one another. "

**Torolf Johnsson**: The above is a quote from ON4UN's "Bible". Separate ground planes, then. I myself have made this mistake in the late 90s when I had not yet taken part in the "Bible". I had three Beverages attached to the same ground plane - this was no "hit".
Despite different antenna orientations, I basically heard the same stations on all three antennas. There was some kind of "crosstalk" that was the result, and this came probably via ground AND that the antennas came too close to each other at the feed point. At least 5 meters according to ON4UN, I would probably not take any risk but instead separate antennas and ground plane as far as possible (for example at least 30-50m).

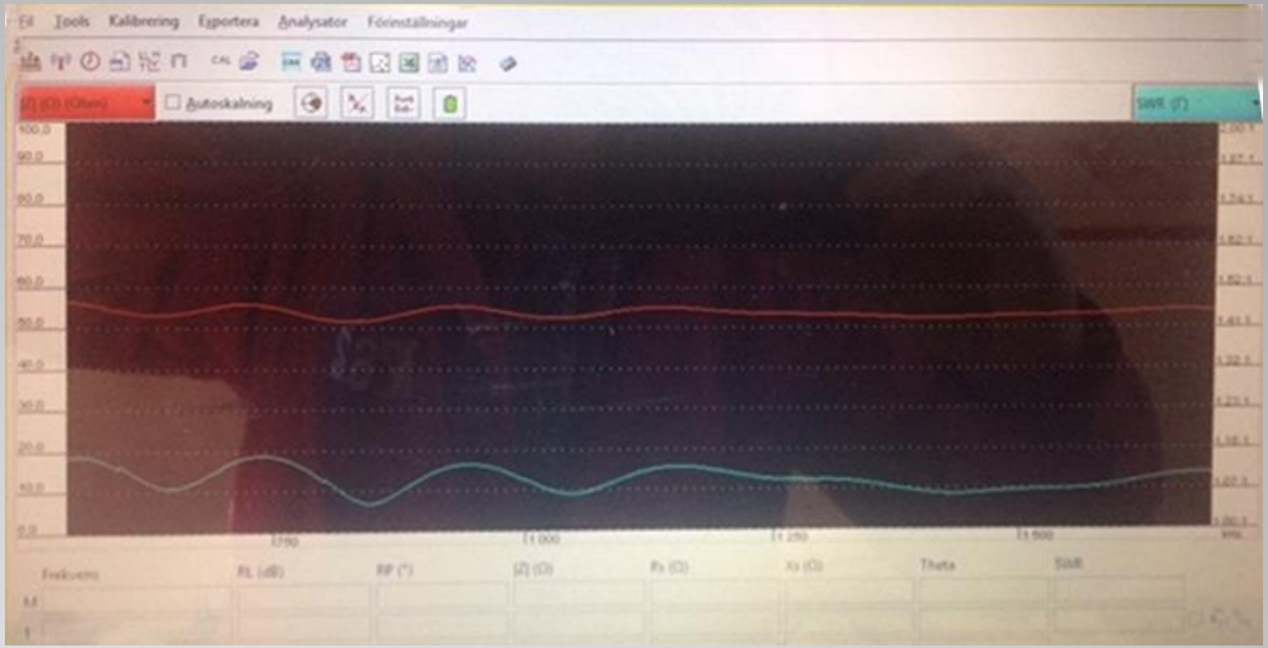
**Tore B Vik**: When we establish ourselves on Andøya, we have two ground points for each antenna - the balun and coax screen are each grounded to their own ground rod with as great a distance as possible. With 3 antennas towards the same area, it is a bit problematic with 6 grounding points.

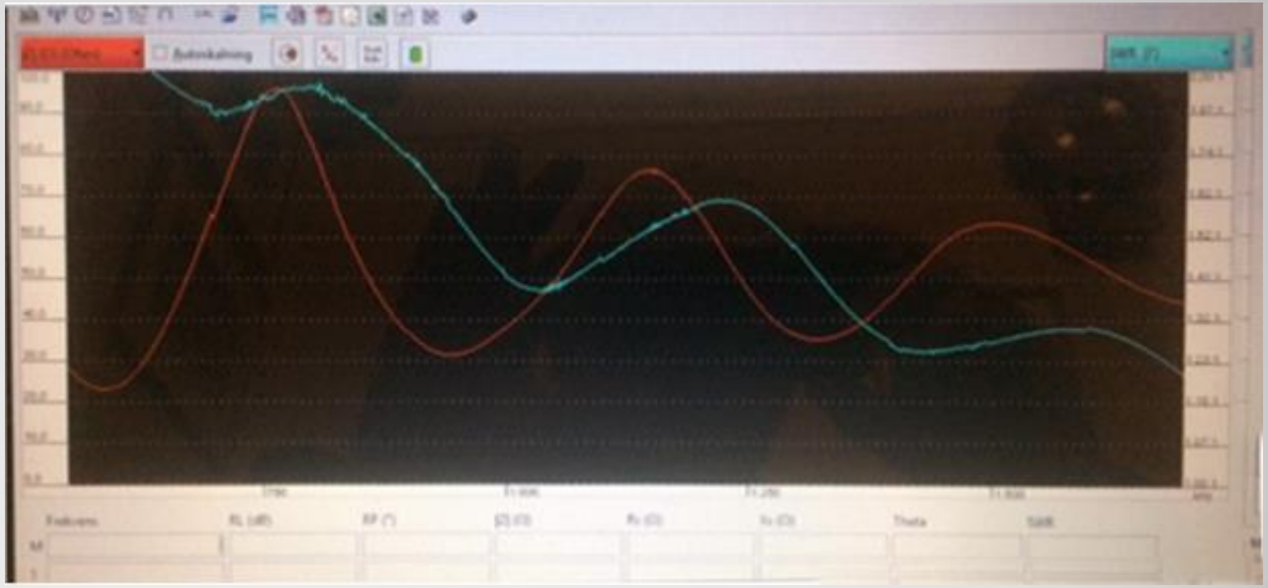
**Stefan Wikander**: Here are two pictures of a good grounded Beverage (mine) and one of the antennas located in Parka. As you can see, the difference is huge.

In terms of listening, the difference is not as great, but splatter, side attenuation and especially the back attenuation is clearly better on a good grounded antenna.

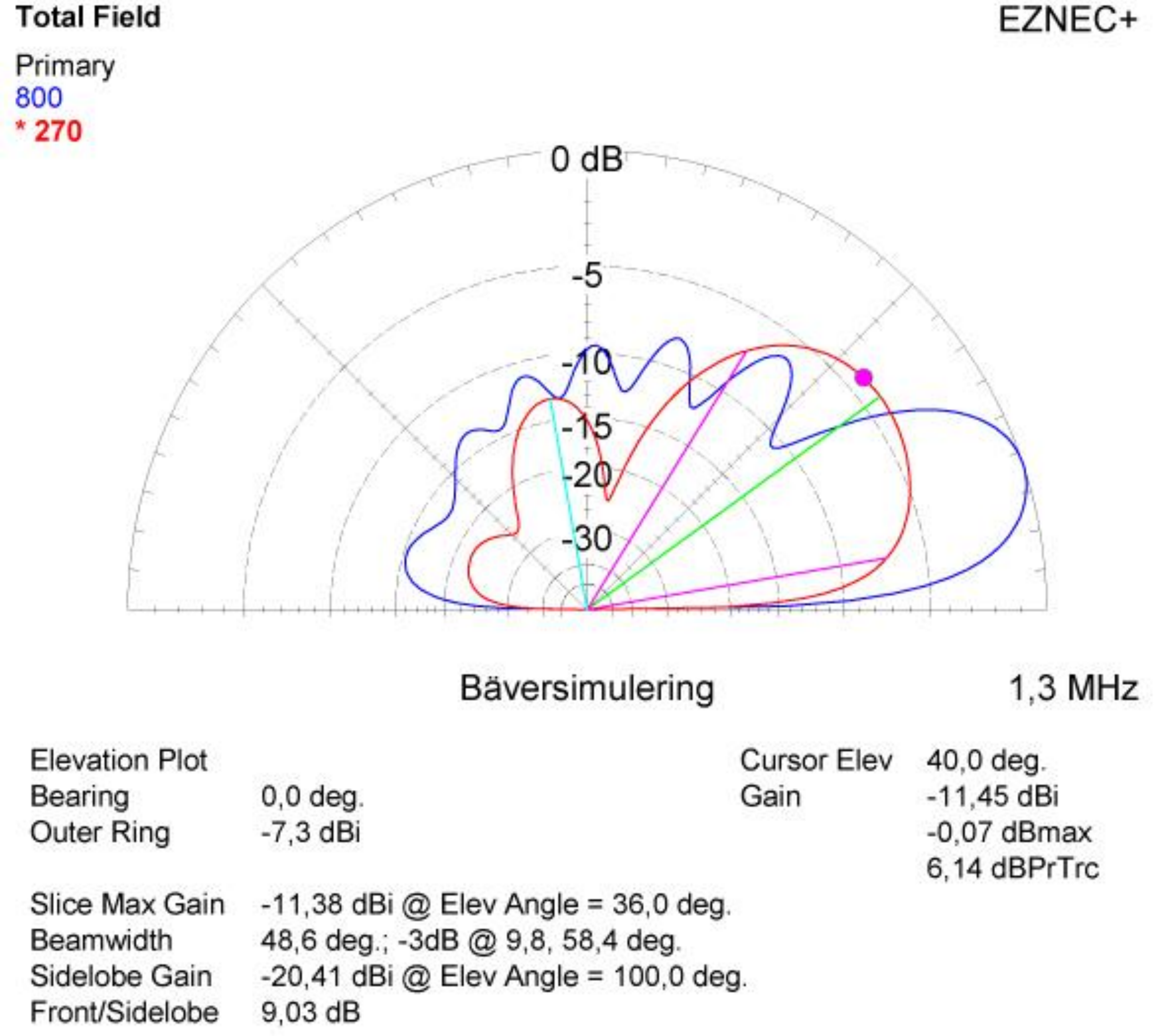
The adjustment to 50 ohms is impossible to obtain when there is so much fluctuation.

I have between 5-15 ground rods at the ends depending on soil conditions. Also salt and Bentonite is used.



# Comparison between Beverages 270 m/800 m




**Torolf Johnsson**: Simulation where I compare a 270 m Beverage with an 800 m Beverage. The pattern diagram shows the characteristics of the antennas seen straight from the side. You can read a lot from this, including that at an elevation angle of 40 degrees (from the front), the 270 m has about 6 dB more gain. At an elevation angle of 20 degrees, the 800 m has about 5 dB more gain.

Another interesting and important feature is the attenuation in the rear direction, where the 270 m Beverage wins with 6-10 dB better attenuation!! So at a 40 degree elevation angle, the shorter antenna has at least 12 dB better S/N ratio (6 db forward and 6 db better attenuation backwards) - that's a lot!
Now, most signal paths do not enter at 40 degrees, but there are perhaps situations in connection with sunrise where this is quite common.

# BOG (Beverage on Ground) a shorter alternative to the classic beverage…..

- Insulated wire lying on the ground surface or slightly buried
- Surge impedance / termination resistance around 200-300 ohms
- Lower gain than elevated beverage, usually requires a preamp
- Lower velocity factor than elevated beverage

  ➔53-63 % length of comparable elevated beverage, but varies widely depending on ground characteristics

  ➔300 m: length can vary from 120 m – 270 m
  ➔630 m: length can vary from 165 m – 600 m
  ➔2200 m: length can vary from 570 m – 1150 m

- Optimal performance (RDF, F/B) more single-banded unlike elevated beverage
- BOG can be un-terminated and still maintain it's directivity and F/B if "right" length
- Performance can be adversely affected if buried too deeply as noted by actual experiments and NEC4 modeling by N6LF after a wet winter season and sod absorption of wire
- Experimentation required!! - Start long and cut back for best F/B
- Use a good ground at antenna start – will improve signal strength

# BOG (Beverage On Ground)

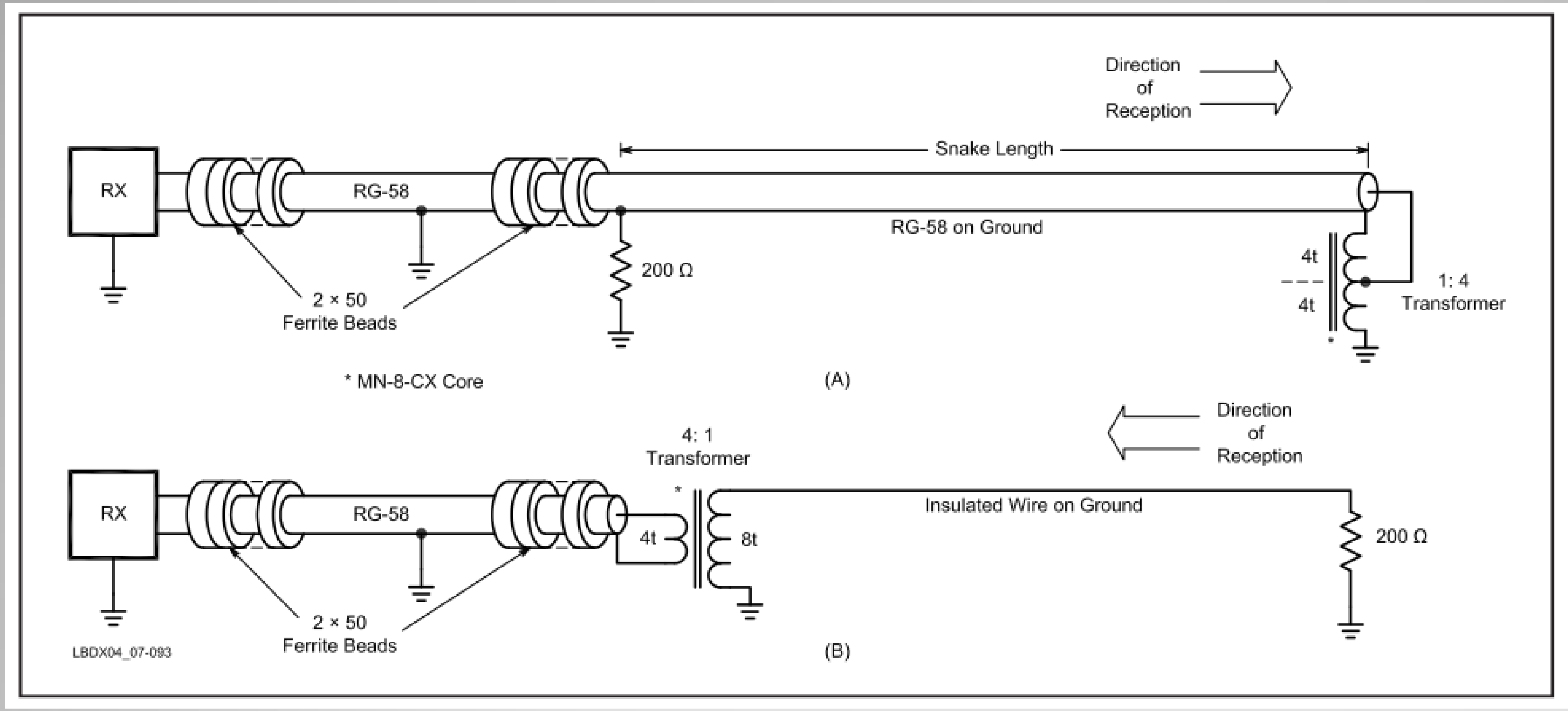
A BOG can do a good job unterminated. If too long they self terminate. Depends upon the soil as to length.

The biggest mistake is making the BOG antenna too long. Try not to go over 60 m for 160 meters. Longer will work in some locations soil like desert, sand, other non/ partial conducting types.

The BOG can be a very useful receiving antenna, but your results may vary. If your BOG is slowly covered by what grows around it, or what falls from the sky, you might see significant degradation over time. The cure is simple. Inspect the antenna regularly and pull it out of the weeds as needed.

**Jerry, K4SAV**: During my testing I did notice that very wet ground significantly dropped the gain of the antenna, maybe 6 to 10 dB immediately after a heavy rain. It still seemed to function OK but the gain was low. I did have the opportunity to see what 2 inches of snow on top of the BOG did to its response. That reduced the gain by about 6 dB.

# BOG (Beverage On Ground)

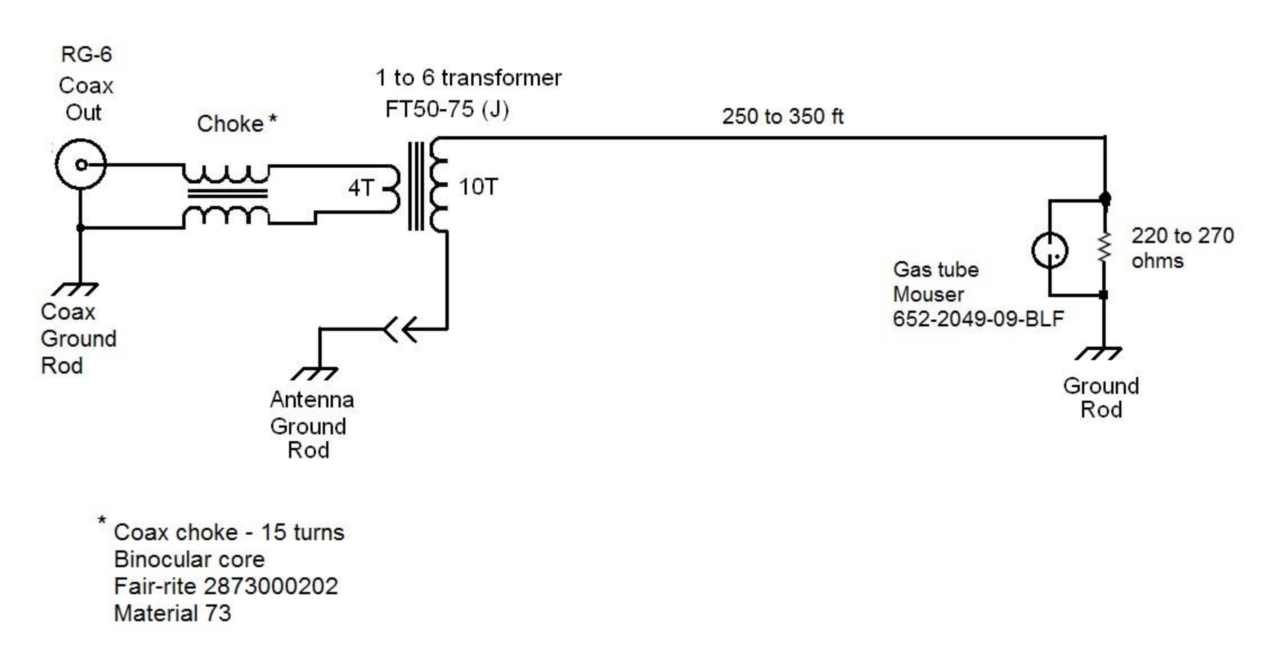



- Termination ~ 200 to 300 Ohms
- Need a 4:1 matching transformer
- Use ferrite beads to decouple feedline
- *May* require a preamp
- 70º to 100º 3 dB beamwidth
- Good ground at antenna start – improves signal strength

How long should a BOG be for 1000 kHz?

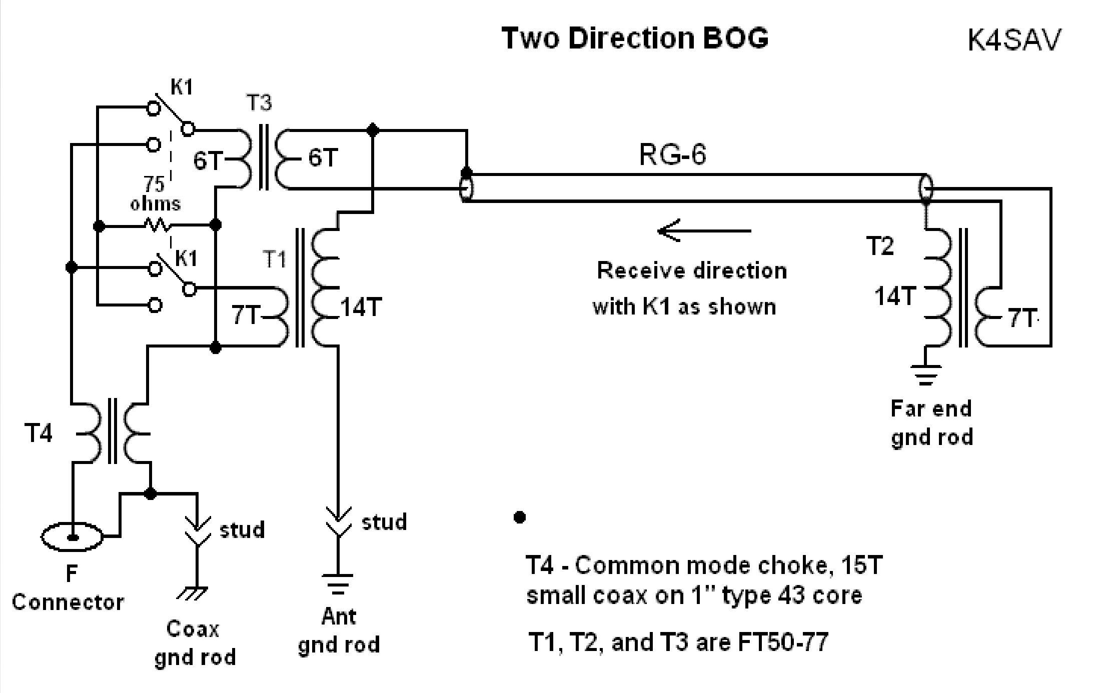
Generally, 1 wavelength is said to be the minimum “ideal” length for an above-ground Beverage. But BOGs can be shorter than this, because while the velocity factor for a Beverage in air is on the order of 95-98%, the velocity factor for a BOG is on the order of 50-60%. So, BOGs can be (in terms of their physical length, ignoring the velocity factor) 0.5 to 0.6 wavelength long and have an electrical length of one wavelength. Thus, in the MW band a BOG would ideally be 150-180 m.

## One direction BOG schematic



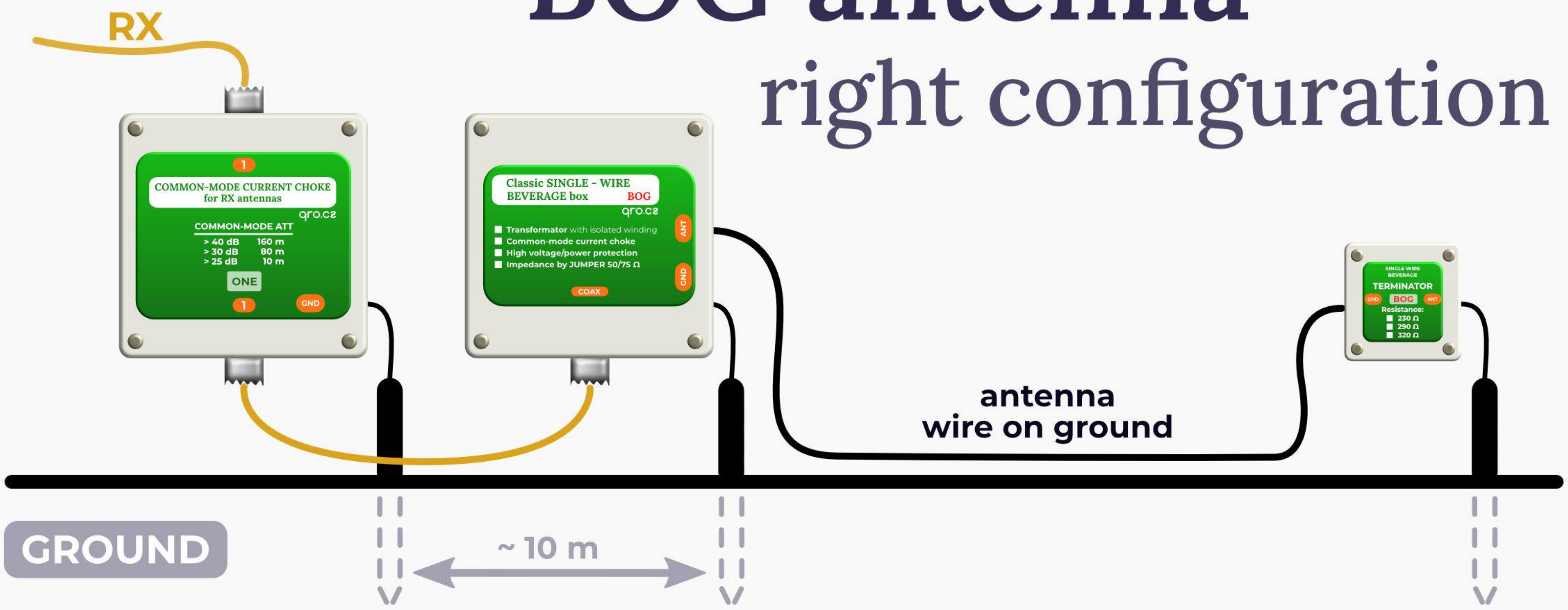

FT50-75: AL-value = 2750

## Two direction BOG schematic



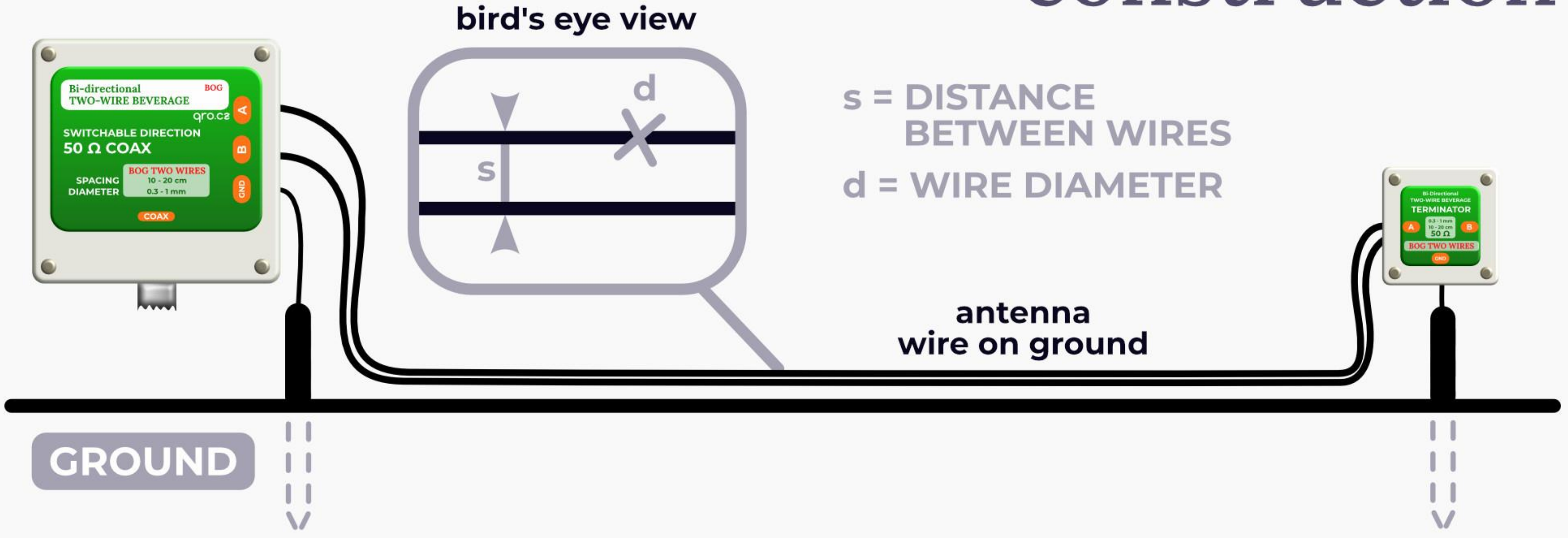

FT50-77: AL-value = 1100
FT114-43: AL-value = 603

# BOG antenna
## right configuration




QRO.cz | hamparts.shop

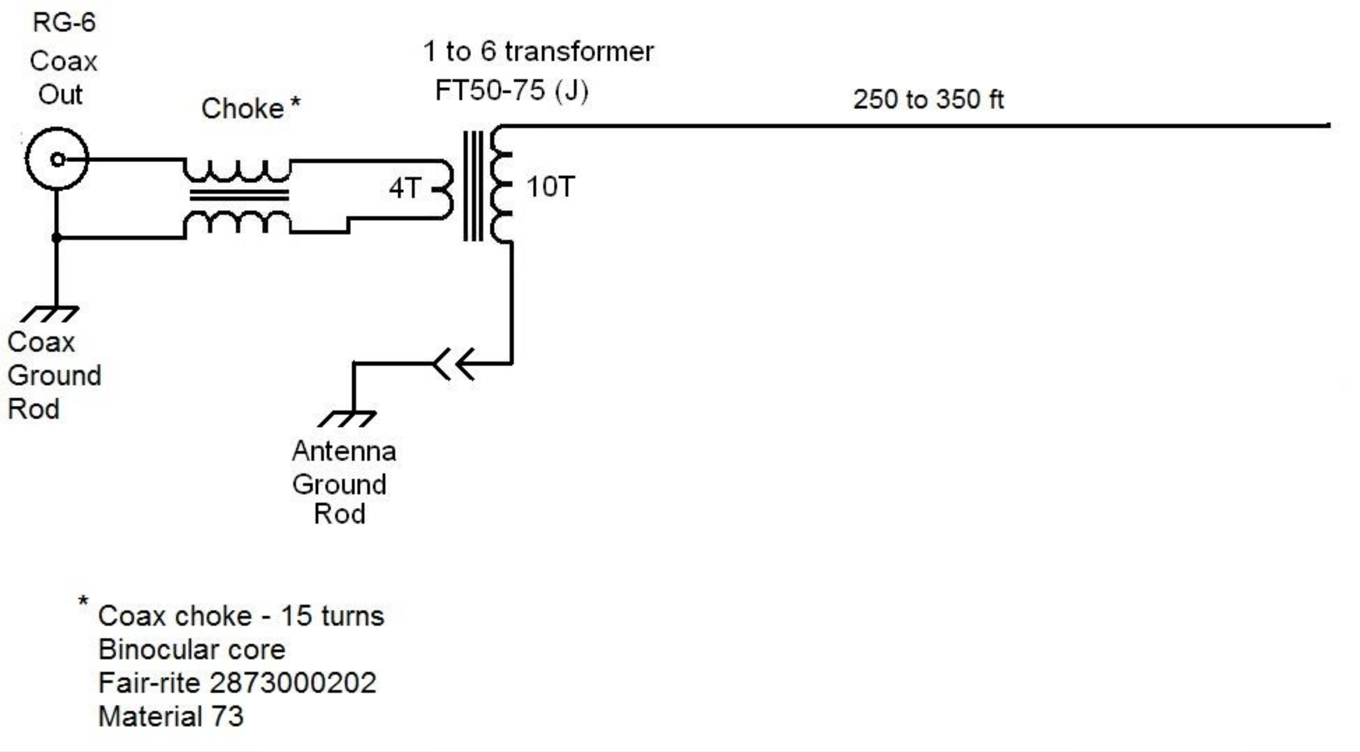
# BOG BI-DIR ANTENNA construction




| construction | height [m] | wire diameter [mm] | distance between wires [cm] |
|---|---|---|---|
| 2 parallel wires (also 450Ω) | BOG | 0.3 - 1.5 | 10.0 - 20.0 (also 450Ω) |
| 150Ω field wire (WD-1) | BOG | 150Ω field wire (WD-1) | 150Ω field wire (WD-1) |
| coax 75Ω | BOG | coax 75Ω | coax 75Ω |

# BOG – two directions without endtermination

**Torolf Johnsson**: The only grounding you need is at the balun, where ground is required to get the most "cream" out of the antenna. The difference in gain is marginal between front and back lobe so it should actually work quite well to listen also to the back lobe. The side lobes aren't annoying either.



# More about BOG

**Torolf Johnsson**: Speaking of BOG, I pulled out a bog myself yesterday. 230 m at 260 degrees, hermetically grounded at both ends and with a resistance of 400 ohms. I measured variations between 200 and 400 ohms and for my conditions 350-370 ohms would be optimal. It was exciting to start listening to the recordings from the night. I was actually very pleasantly surprised, there was a lot of La Plata that was hidden. Somewhat more muted signals than I'm used to, but there was still a lot to dig out. The nice thing about this is that there were signals on both low and high ends. I am pleasantly surprised by BOG.

It is the same principle as for a Beverage and you can probably test with a normal 9:1 balun. I made an 8:1 after measuring it up, but the small loss you get with a 9:1 is probably nothing you can hear with your bare ear.

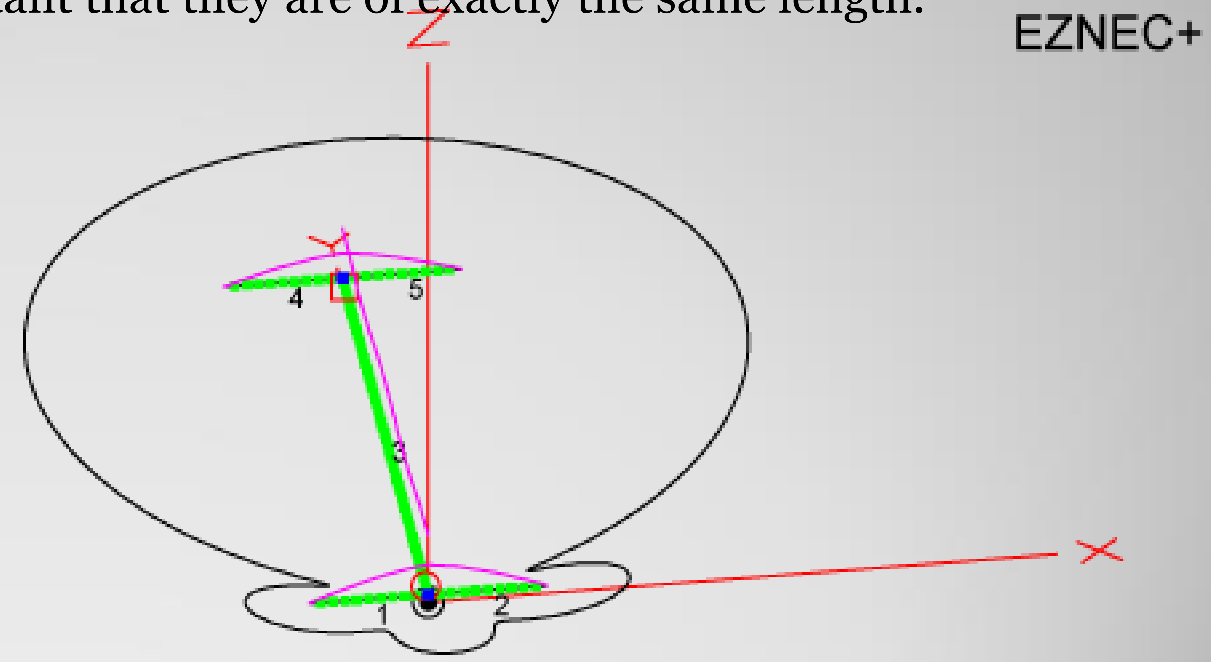
As Lisette Åkesson says, the directivity is really good. 560 ohms is probably too high, according to my simulations you get a larger backlobe when using too high resistance. But without measurement it is impossible to know, I would guess that 300-400 ohms are good starting values.

# 1/4 wave-length termination

**Torolf Johnsson**: A tip for those of you who are working with temporary Beverages and BOGs - instead of pounding down ground rods, you can use 1/4 wave-length termination. It's simply 2 wires perpendicular (90 degrees) to the antenna wire, theory says 1/4 wave-length but that's the electrical length. In practice, it would work well with about 40 m in each direction. I haven't tested this in practice but have done simulations that show that it works just fine. The wires can lie on the ground so it is a convenient way to have a temporary solution for a temporary antenna. Wires 1 and 2 and 4 and 5 respectively are the termination wires. It is important that they are of exactly the same length.

The value of the end resistance must be the same as when using ground rods, so approx. 200 ohms for a BOG applies also here.

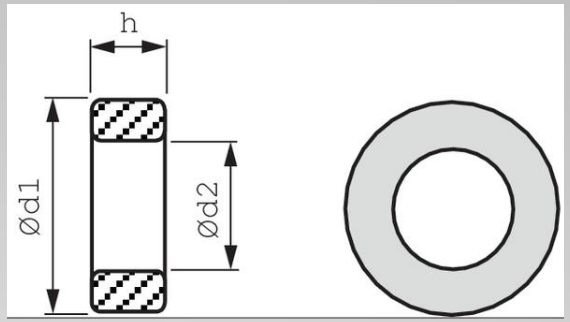
It should also work just fine to set up a staggered BOG.

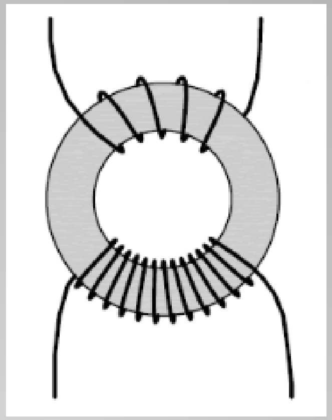


# Suitable balun for a BOG

**Epcos N30, Elfa art. No. 58-614-14**

| | |
|---|---|
| Inductance AL | 5.75 uH |
| Core class | N30 |
| Core size | R36/23/15 |
| Relative magnetic permeability | 4300 |
| Inner dia | 21.7 mm |
| Outer dia | 37.5 mm |
| Length | 16.2 mm |



4 turns

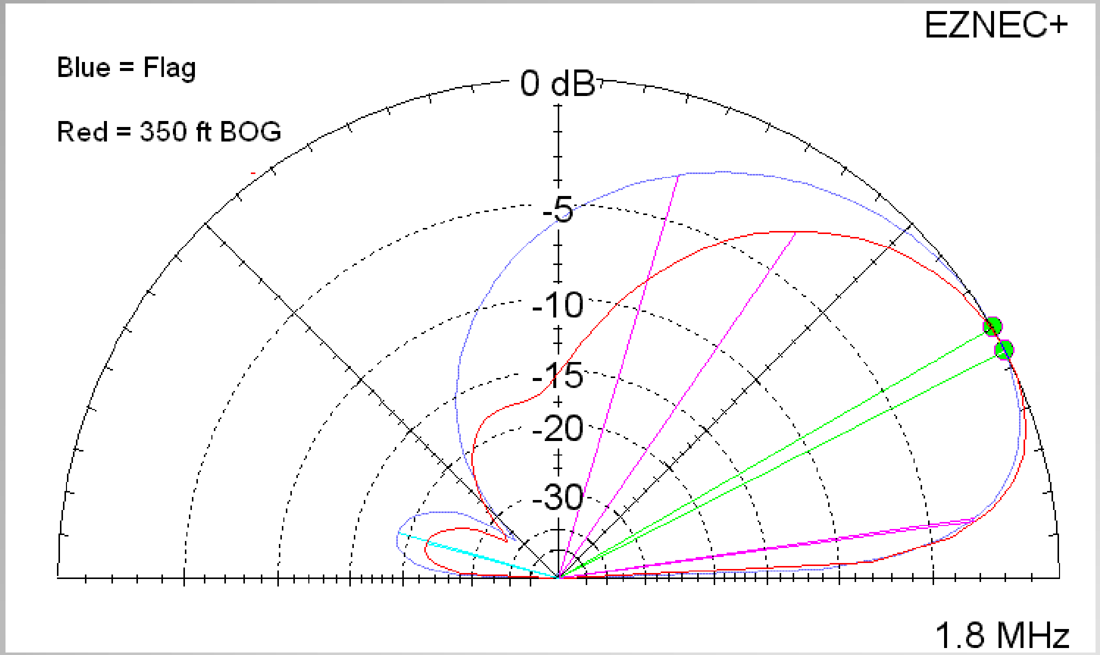
9 turns

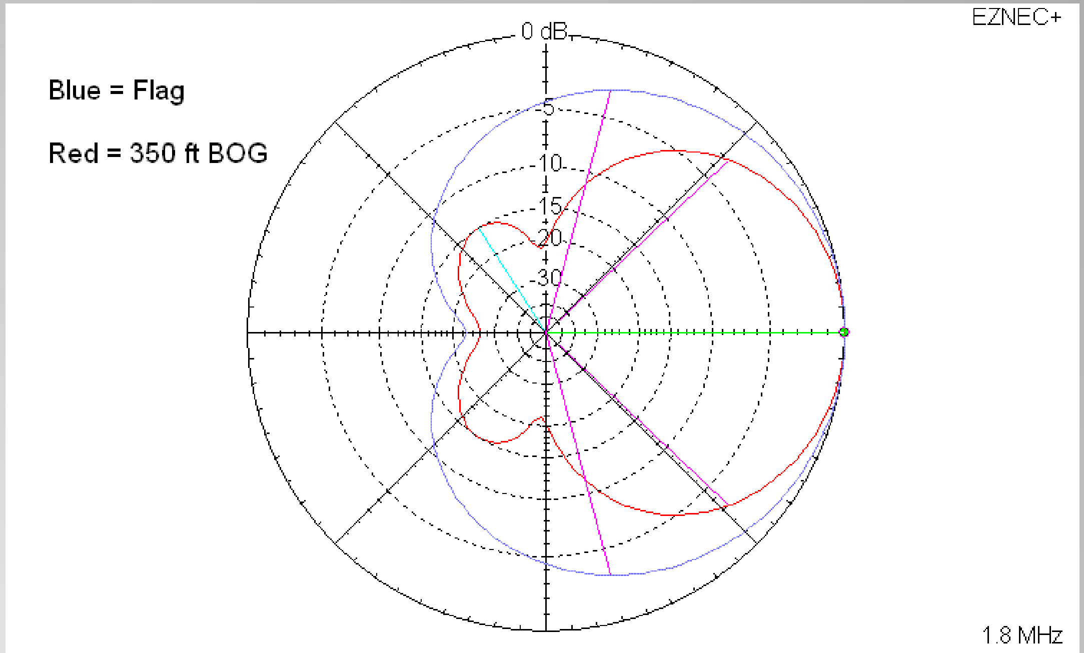
Winding direction must be the same for both windings.

**Calculation of windings**

| Min. Freq, kHz | High-Z winding (ohms) | 4 * ohms | winding L, uH | Core | AL | # of turns | Z ratio 50 ohms | # low-Z turns |
|---|---|---|---|---|---|---|---|---|
| 400 | 250 | 1000 | 398 | Epcos N30 | 5600 | 8,43 | 5 | 3,77 |

# Comparison of a Flag versus a 105 m BOG




| | | |
|---|---|---|
| RDF at 20 degrees elevation: | Flag = 7.4 | BOG = 10.5 |
| Beamwidth 3 dB: | 146° | 70° to 100° |

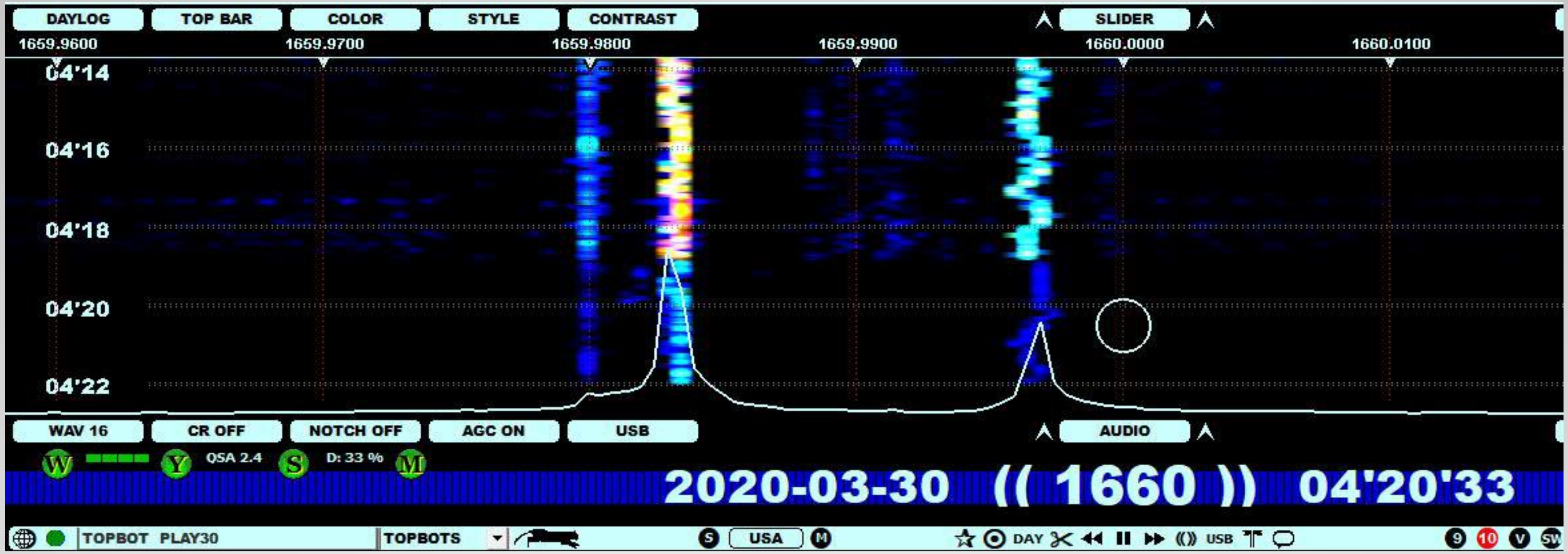
You won't find any significant differences in the patterns between a single element Flag, K9AY, EWE, Delta, Diamond, or Pennant. The most significant difference is their sensitivity to common mode noise and feedline signal pickup. Some are easier to construct than others.

The difference in performance between a single element version of the antennas listed above and a two element version is very large.

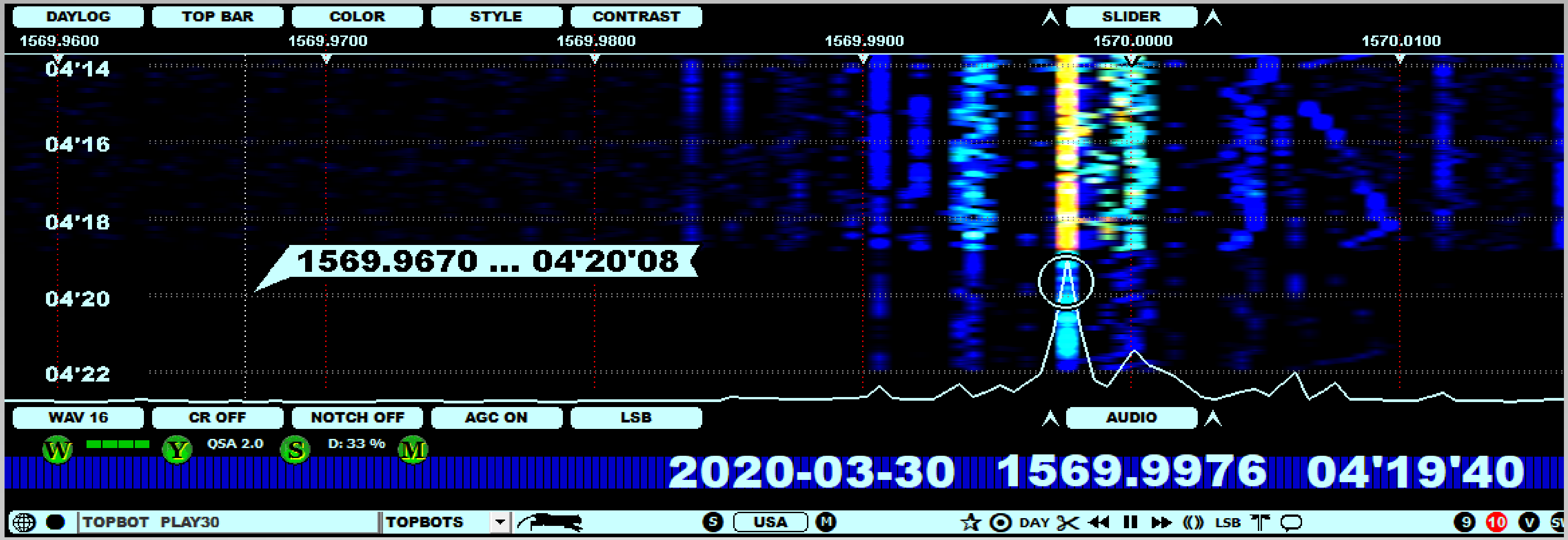
# Switching between Flag in 300° and 120 m BOG in 300°

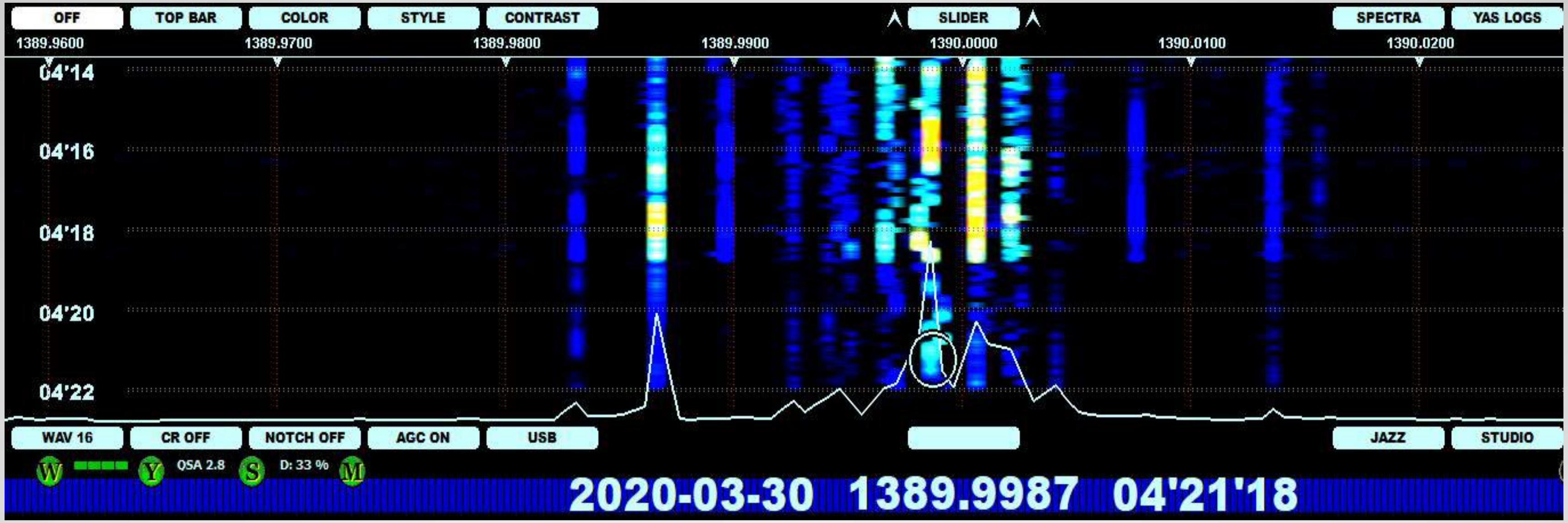
**Switching to BOG at 04:19**

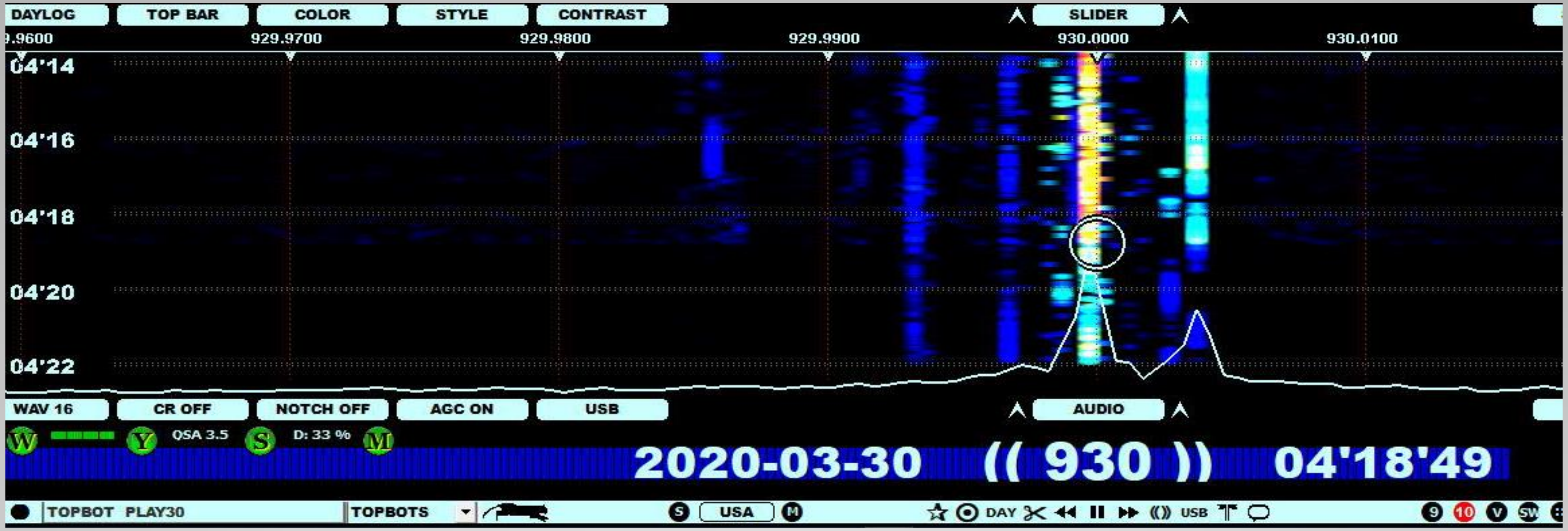
**It is clearly visible that BOG cuts out southern signals and takes in the northern ones, e.g Canada på 1310, 1470, 930 och 590**

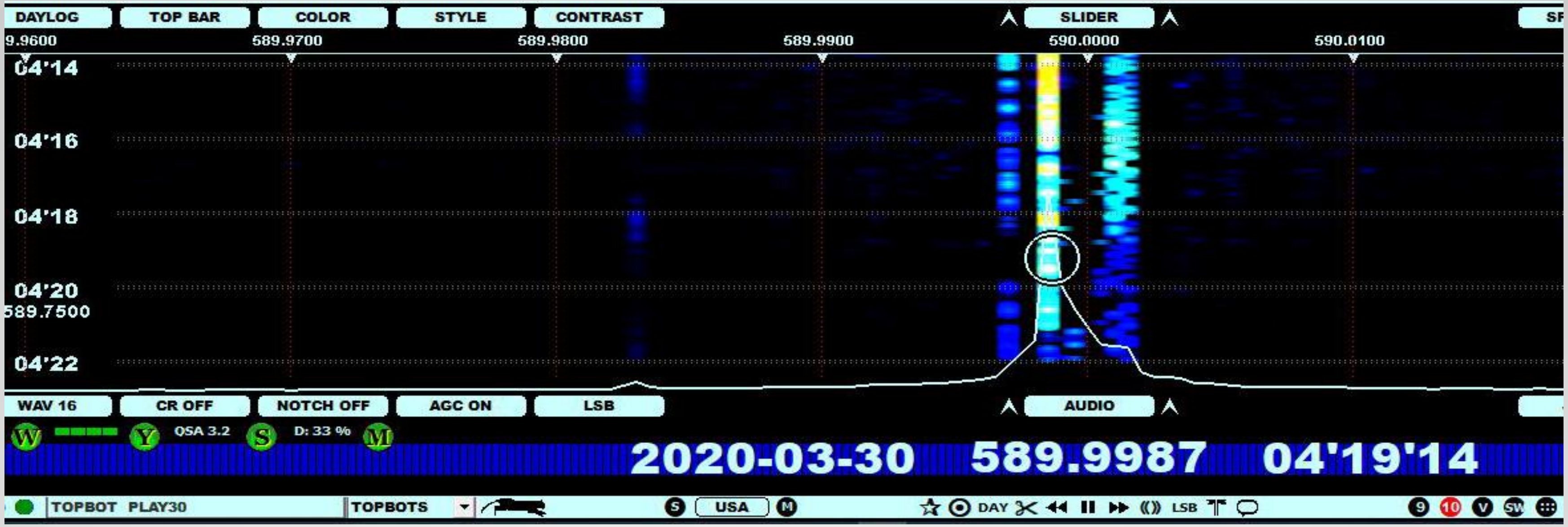



**Flag has a 10 dB preamplifier, BOG none**


DAYLOG
TOP BAR
COLOR
STYLE
CONTRAST
SLIDER
1569.9600
1569.9700
1569.9800
1569.9900
1570.0000
1570.0100
04'14
04'16
04'18
04'20
04'22
1569.9670 ... 04'20'08
WAV 16
CR OFF
NOTCH OFF
AGC ON
LSB
AUDIO
QSA 2.0
D: 33 %
2020-03-30 1569.9976 04'19'40
TOPBOT PLAY30
TOPBOTS
USA
DAY
LSB

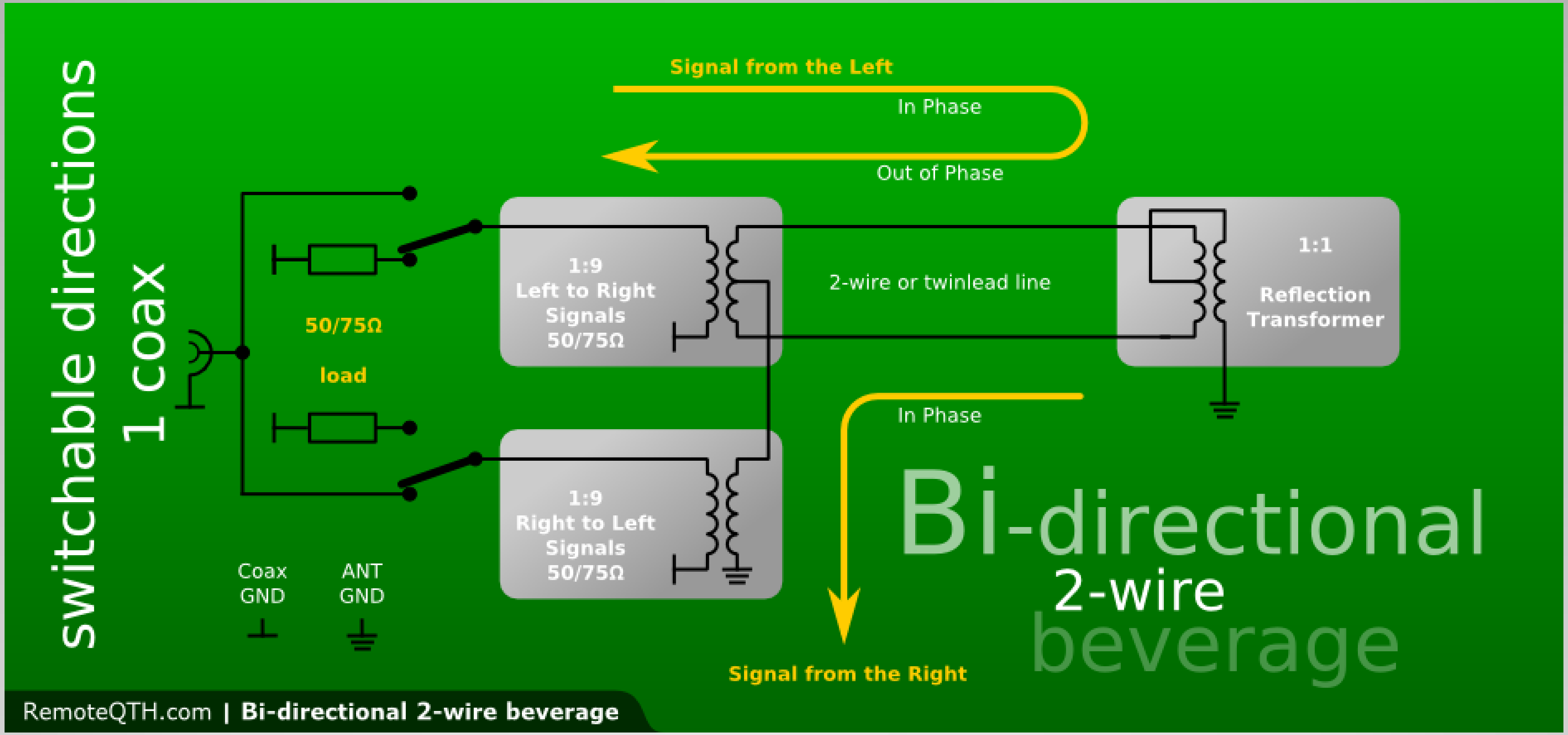

OFF
TOP BAR
COLOR
STYLE
CONTRAST
SLIDER
SPECTRA
YAS LOGS
1389.9600
1389.9700
1389.9800
1389.9900
1390.0000
1390.0100
1390.0200
04'14
04'16
04'18
04'20
04'22
WAV 16
CR OFF
NOTCH OFF
AGC ON
USB
JAZZ
STUDIO
QSA 2.8
D: 33 %
2020-03-30 1389.9987 04'21'18


DAYLOG
TOP BAR
COLOR
STYLE
CONTRAST
SLIDER
929.9700
929.9800
929.9900
930.0000
930.0100
04'14
04'16
04'18
04'20
04'22
WAV 16
CR OFF
NOTCH OFF
AGC ON
USB
AUDIO
QSA 3.5
D: 33 %
2020-03-30
(( 930 ))
04'18'49
TOPBOT PLAY30
TOPBOTS
USA
DAY
USB

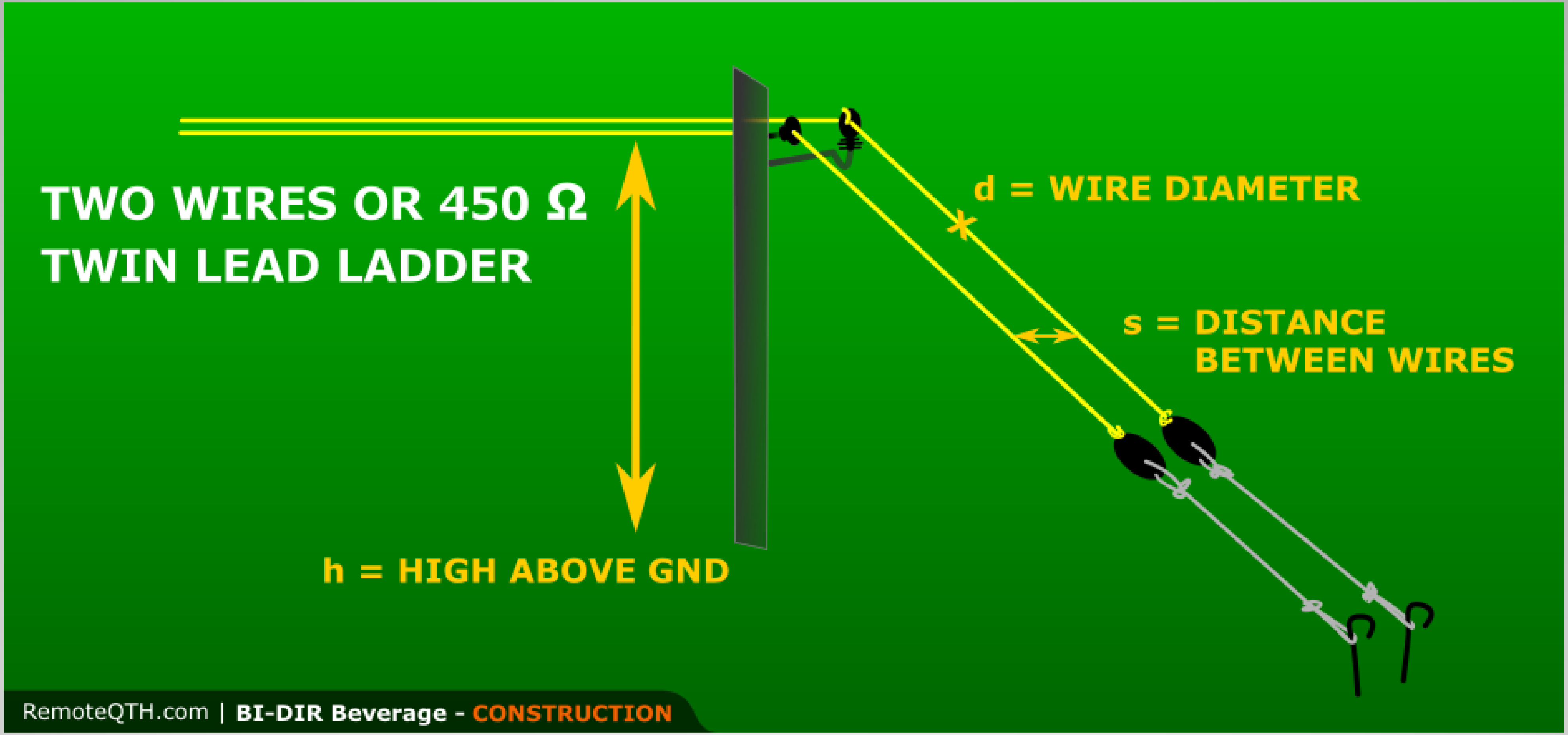

DAYLOG
TOP BAR
COLOR
STYLE
CONTRAST
SLIDER
589.9700
589.9800
589.9900
590.0000
590.0100
04'14
04'16
04'18
04'20
589.7500
04'22
WAV 16
CR OFF
NOTCH OFF
AGC ON
LSB
AUDIO
QSA 3.2
D: 33 %
2020-03-30
589.9987
04'19'14
TOPBOT PLAY30
TOPBOTS
USA
DAY
LSB

# Bi-directional Two Wire Beverage

RemoteQTH.com



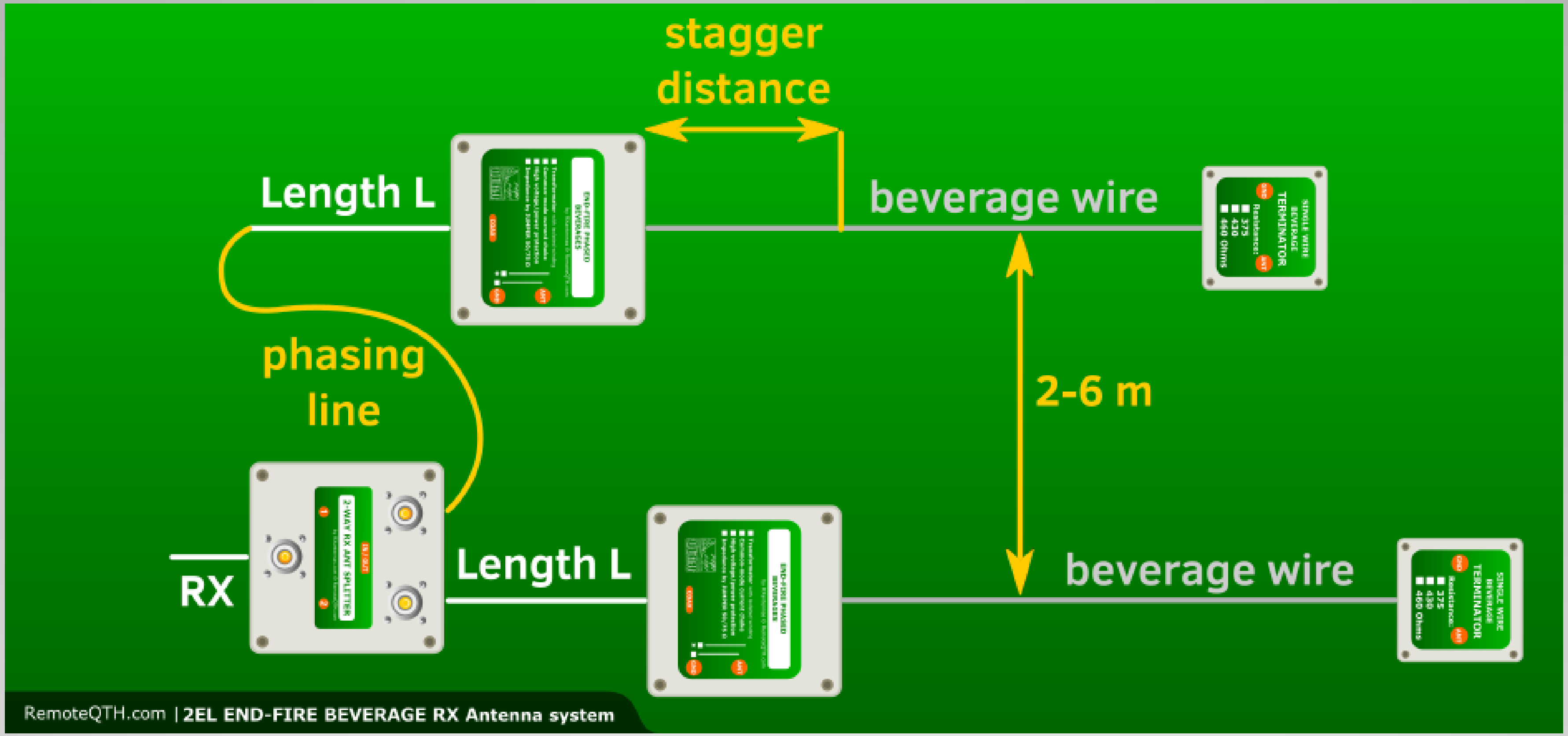

A single beverage antenna can be made to cover two directions with excellent performance over a very wide frequency range. These are two beverage antennas receiving in opposing directions to share the same space. The transformer at the end of the beverage is designed to match impedance of the antenna.


TWO WIRES OR 450 Ω
TWIN LEAD LADDER
d = WIRE DIAMETER
s = DISTANCE BETWEEN WIRES
h = HIGH ABOVE GND
RemoteQTH.com | BI-DIR Beverage - CONSTRUCTION

RemoteQTH.com


RemoteQTH.com | **Bi-Directional TWO-WIRE Beverage - switchable direction**

# 2-element End-Fire beverage antenna array

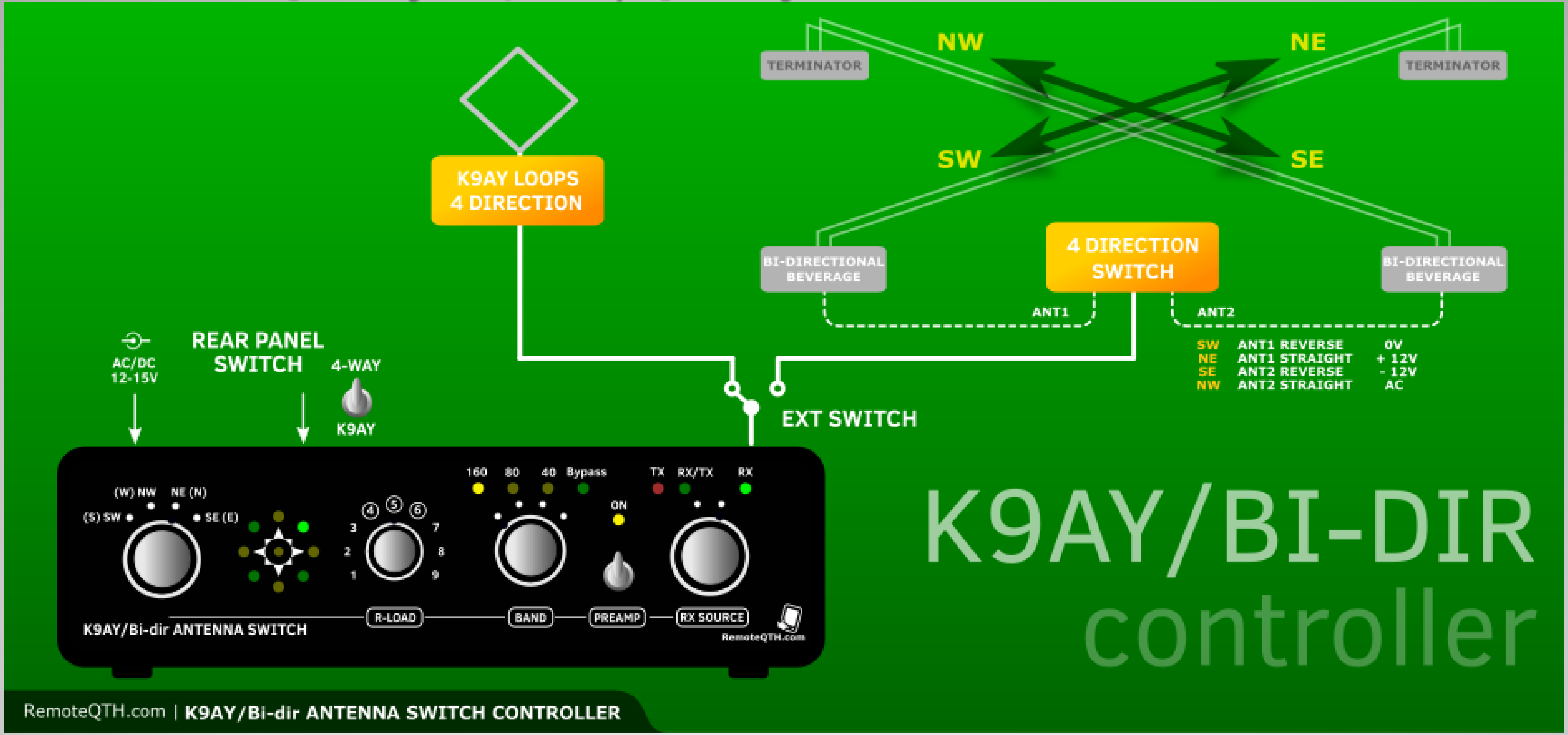



In an end-fire Beverage array it is important that the two elements have a similar F/B, as you are going to subtract the signals from both elements. In this End-Fire array the beverage antennas are very close to each other, usually 2 to 6 meters. One beverage is shifted to front by the stagger distance. This array needs smaller room compared to broadside one. Big advantage is in higher F/B.

Calculation of phasing line and Length L, see page: **Theoretic calculation of delay-length**


RemoteQTH.com | **2EL END-FIRE Phased Beverages - ALL PARTS**

# 4-way K9AY/4-way Bi-dir controller

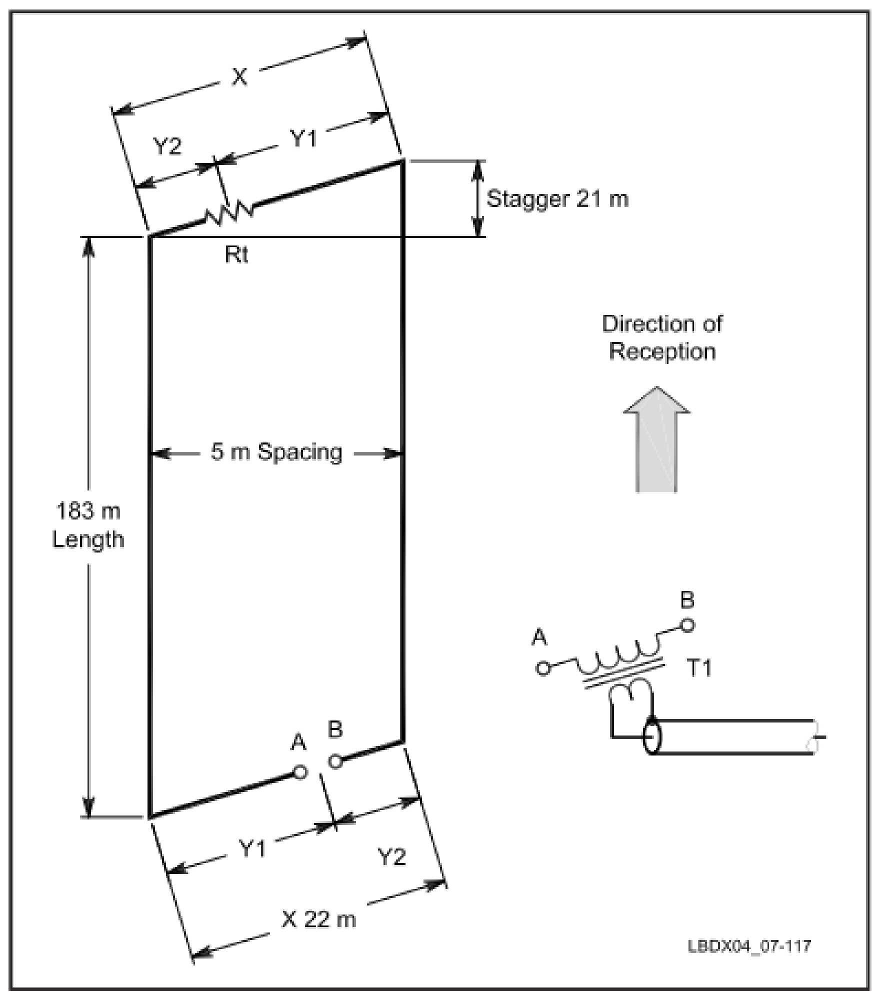



This antenna consists of 2 x Bi-dir beverage sets, 4-way antenna switch and controller. That all allows you to have 4 directions beverage antenna system + 4-way K9AY with only one coax line from field to the controller.

RemoteQTH.com


RemoteQTH.com | 4-way beverage antenna system

# The W8JI Parallelogram antenna




I finally settled for length 450 m, stagger 33 m and spacing 5 m.

This antenna actually is an array of two ground-connection-independent end-fire staggered Beverages. The short end wires form two single-wire feed lines at each end. One end-wire is series terminated with exactly twice the resistance of a normal Beverage, while the short wire at the opposite end is the feed-point.

Stagger and spacing determines feed and termination location, the offset at the two ends being mirror images.

**Arne Nilsson**: This antenna has a rather interesting radiation pattern and the dimensions are not too sensitive, it's actually quite short for a Beverage variant.

I made an Eznec calculation on it and varied the wire lengths and the distance between them, nothing seems critical!

Tested lengths between 150-300 m, and distance between the wires of 2-10 m. No dramatic difference!!

I think the secret is the phasing. In addition, you don't need to switch or phase anything at all! And F/B is not bad at all.

You also avoid ground rods and ground planes!

# How to measure earth resistance

Steve Whitt, Medium Wave Circle

Apply your multimeter, set to to read voltage on a 0-2V scale; this is measuring the potential of the "battery". Record this figure and lets refer to it as "V".
Now switch your meter to read current on a 0-2mA scale and record this short-circuit current figure "I".

Ohm's law: R=V/I gives us the total resistance of the antenna system "R".
However "R" is the sum of the terminating resistor, the two earth resistance and the resistance of the wire (negligible).
Since we know the terminating resistance, subtracting this figure from "R" leaves us with the total earth resistance; the lower this is the better.

Regular measurement of the earth resistance will indicate if a problem develops with the antenna.

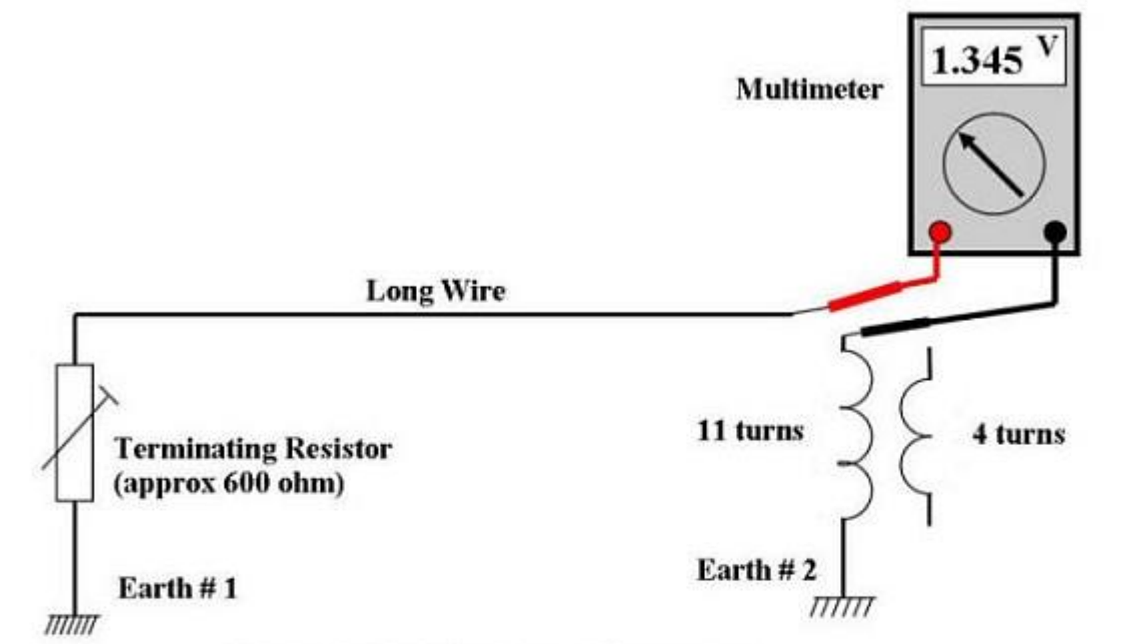


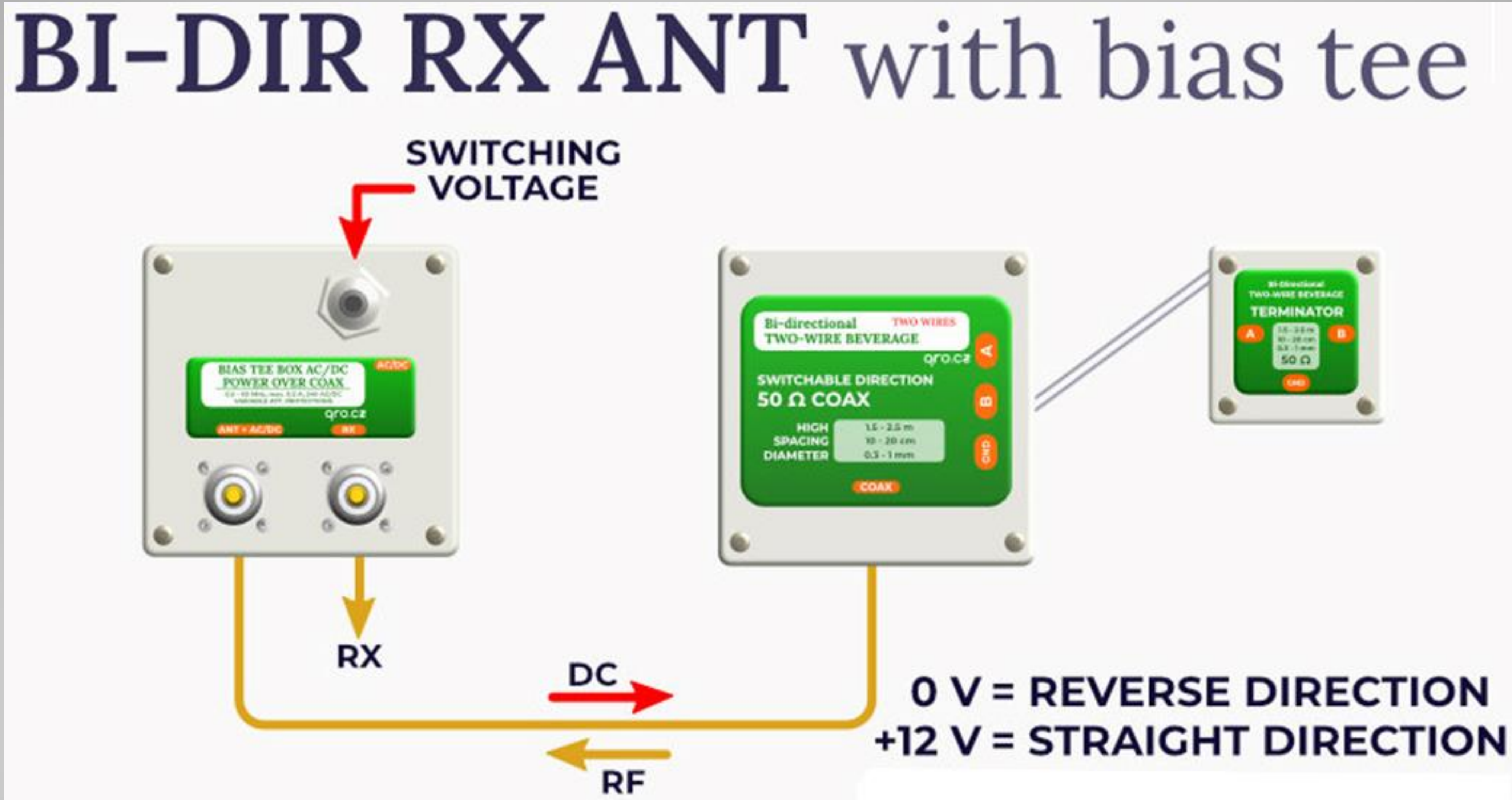
**Figure 4:** *Earth Resistance Measurement*

From my Beverage; I recorded "V" as 0.56V and "I" as 0.85mA. Thus V/I =659 Ohms and since I knew that my terminating resistor was exactly 500 Ohms and the wire resistance was about 30 Ohms, this gives a total resistance of 129 Ohms for two earths (ie about 65 Ohms per earth), which is not a bad figure for my simple arrangement of copper pipes.

# Building a Bi-directional Two Wire Beverage

**“The professional way” by Christoph Ratzer**

RemoteQTH.com



# Parts needed

RemoteQTH.com

VOSS.farming

**Christoph Ratzer**: To be able to use an Beverage antenna all year round, I laid 200 meters of coaxial cable underground in a plastic tube, thanks to the help of a long Fibreglass spring. I used 75 Ohm SAT cable made of pure copper, 5-fold shielded, a perfect alternative for expensive 50 Ohm cable. I use a RX coax match from RemoteQTH  - It works excellently.

VOSS 2,4 m metal post type T

Voss Lockable insulators

Fibreglass spring 200 m


RX Coax Match & limiter with CMCC box

# Fitting the wire clamps

Lockable insulators

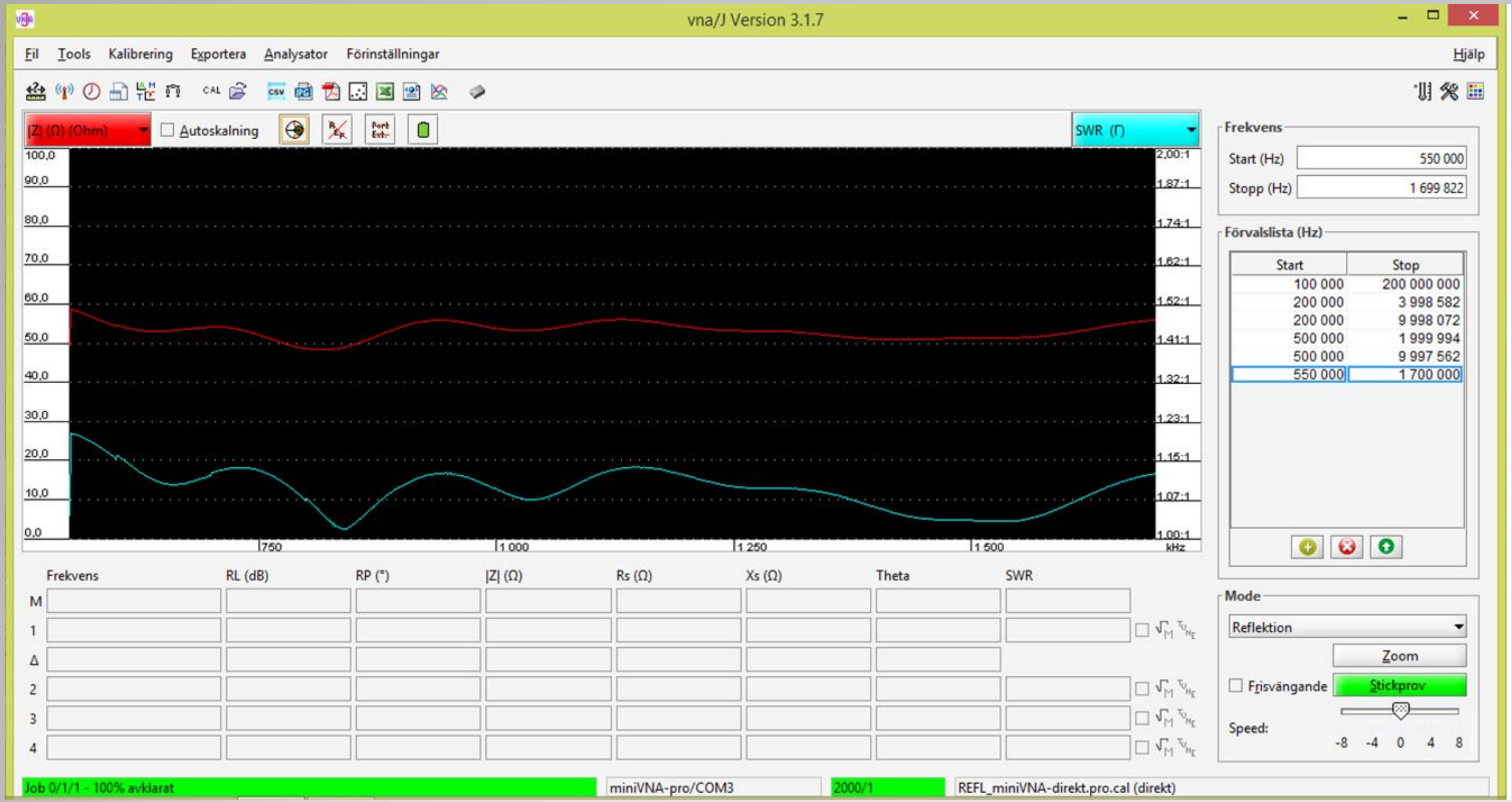
Retainging clamps

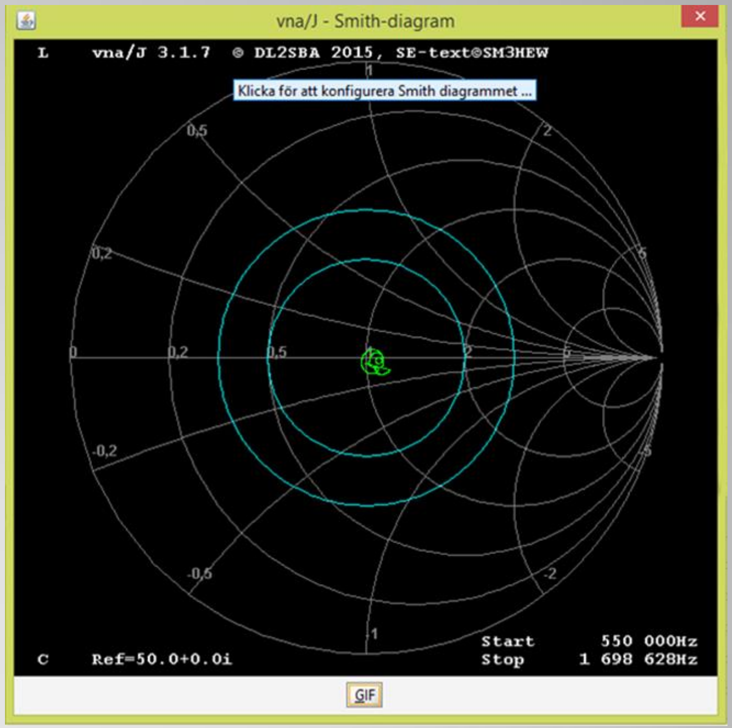
Round clamps

The retaining clamps only go in one direction and the round clamps can be twisted, but they cost twice as much, hence this construction of both variants. The lockable insulators are important and the distance of 40 cm should keep the wires well apart even in a storm.

# Final result of the 200 m two wire bi- directional beverage

# Stefan Wikander's staggered beverage – some measurements




**Stefan Wikander:** Measurements from my staggered beverage with Z and SWR and also a Smith diagram. Lots of ground rods and "trimmed" trafos. A Phased Flag Array can be built and measure just as good.