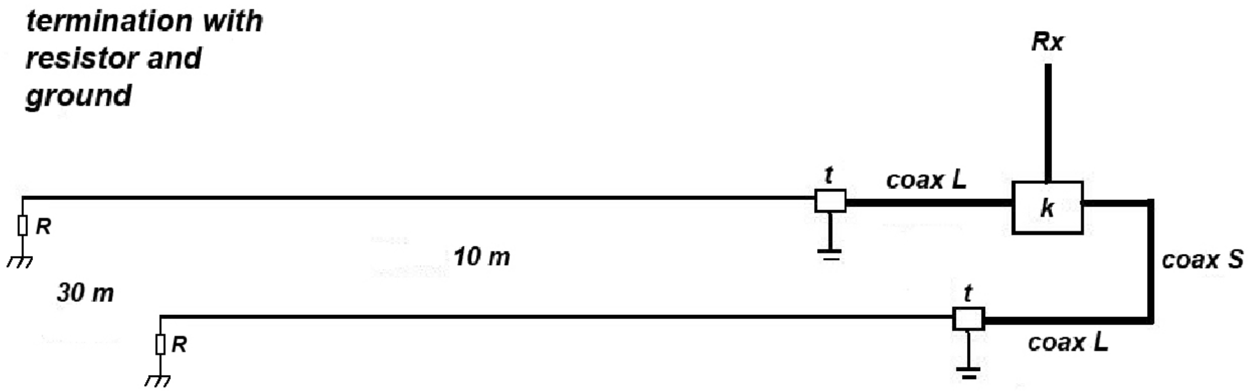
Pushing the limits of the beverage

by Torolf Johnsson

The classic "beaver" or beverage antenna, is probably the most common antenna among the MW DXers in the Nordic countries. Typically the length is of 400-1200 meters and is terminated at the far end with a resistor of 400-600 ohms. Nothing strange, the beverage in this simple design is a "forgiving" antenna that works well in most situations. I myself have used the simple beverage with good results, however, I have often been annoyed at the splatter from the Europeans at many frequencies. To some extent, one can improve the ratio of front/rear, by adjusting the value of the terminating resistor or by lowering the height of the wire, but in general, this provides little effect of the unwanted signals from back lobe.

A variation of the classic beverage, is a so-called staggered beverage array. In short, this means that two parallel beverages are erected and one beverage is displaced 10-30 feet in the length direction. Then 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.
A sketch of the principles follows:



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.

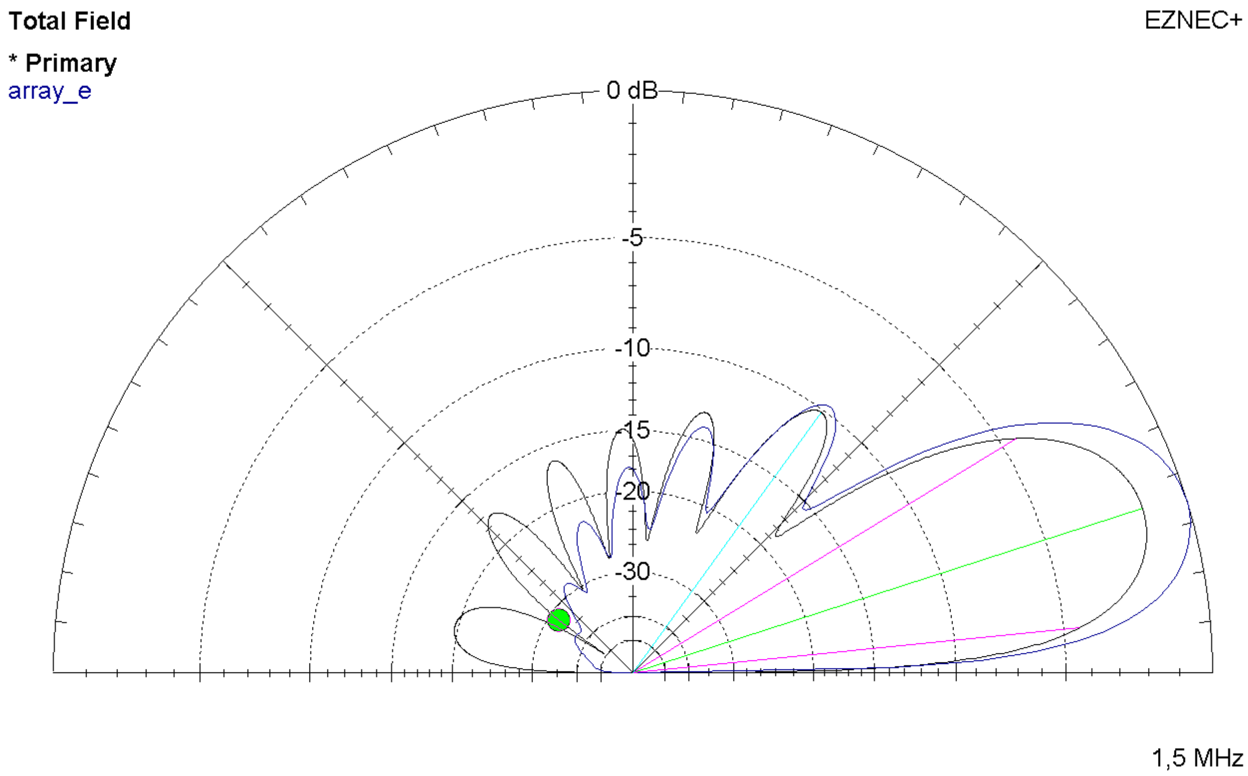
coax L	exactly the same length of coax to both beverages, length optional
Coax S	phasing coax to the rear beverage, the length depending on how long the stagger distance (S) is, S * coax velocity - for RG58 equal to 30 * 0.66 = 19.8 meters
k	combiner / splitter
t	balun, NB! do not forget to reverse the polarity of one of baluns

Without going too deeply into the details, it works as follows: the signals from the backside reaches the rear beverage first, where the signal is phased -180 degrees and then delayed exactly as long as it takes for the signals to reach the front beverage. When the two signals reach the combiner, thus the phasing is -180 and +180 degrees. When the signals are combined, the result is that the signals from the back direction cancel each other out.

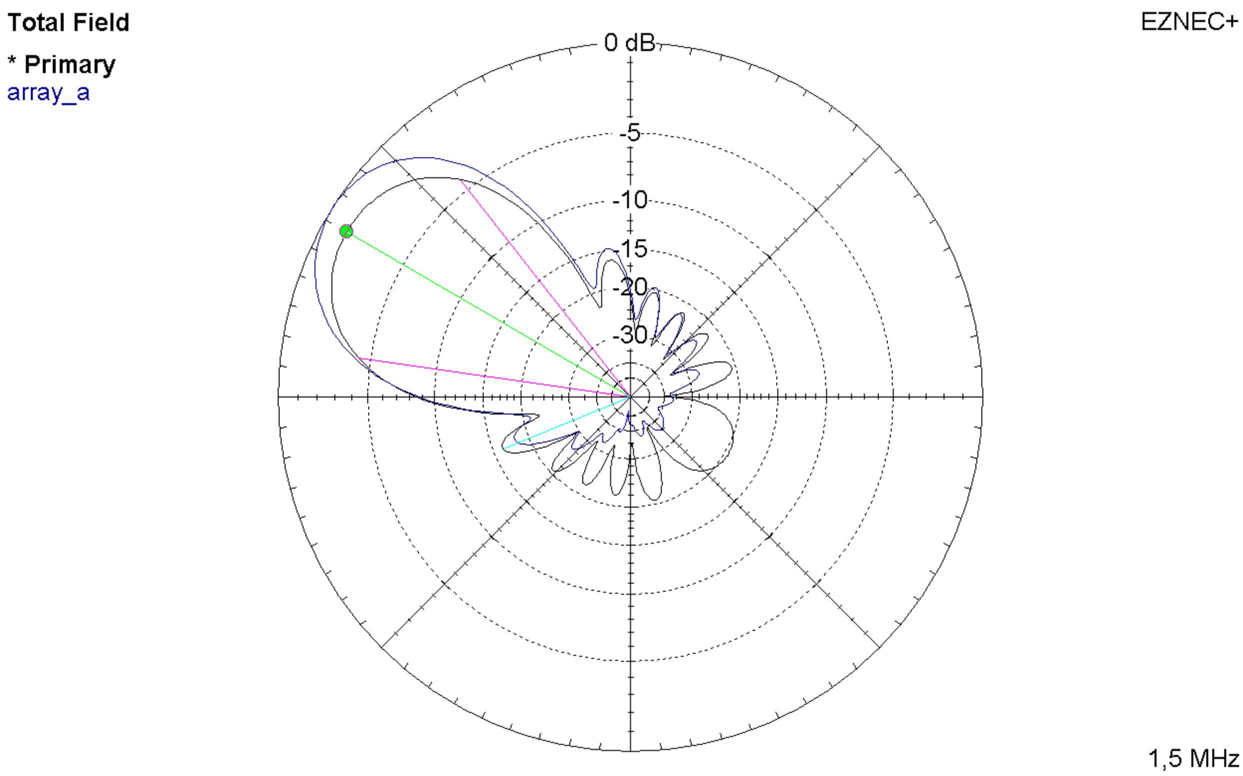
For this to work optimally, it is important that the antennas are as identical as possible. It is desirable to have access to an antenna analyzer and measure both impedance and SWR - it is recommended that SWR measure < 1: 1.2 for both of the beverages.

The following two figures compare the characteristics of a single beverage and beverage array. The simple beverage is 650 m long at 3 meters height and the beverage array is 2 * 650 m at the same height. All beverages are terminated with a 500 ohm resistor.

The figure below is the "radiation pattern" seen from the side where the **primary** is the simple beverage and **array_e** is the offset beverage array. Note especially the large difference in back lobes between the two antennas. The differences are in the order of 15-20 dB better attenuation in the reverse direction.



Below is a comparison of the radiation pattern seen from above. The graph shows the same antennas in the direction of 300 degrees with north straight up. The attenuation towards Central and Eastern Europe is of the order of 15-20 dB.



The comparisons between the antennas have been made using the simulation software EZNEC+ Ver. 5. A simulation is not an exact representation of reality, but I have done extensive A-B tests that confirms the results of the simulations.

A beverage of 650 meters has been used for the simulation. The effect is even more pronounced for longer beverages. A longer beverage gives a narrower front lobe and lower vertical elevation angle but at the same time the side- and back lobes will increase.

For those who want to immerse themselves in the subject, I recommend the book "Low Band DXing" written by ON4UN, John Devoldere. Another gold mine in the subject is Tom Rauch's website www.w8ji.com.

As for the number of turns for the baluns, those are very dependent on the core type.

I have found that the core that provides the most consistent and linear result is the two-hole core type BN73-202. For 50 ohm system the turn ratio is 9/3. Which core to use is a little hocus-pocus and surrounded by mystery. I had initially BN73-202 but got the opportunity to try a Philips 3H2 which I was very pleased with. The Finnish DX-ers also use those very old Philips cores which unfortunately is not possible to get hold of today.
I think the most important thing is that you are careful with the impedance matching, especially if you are using phased antennas.

The balun following the combiner must be a 25 to 50 ohms step-up transformer.

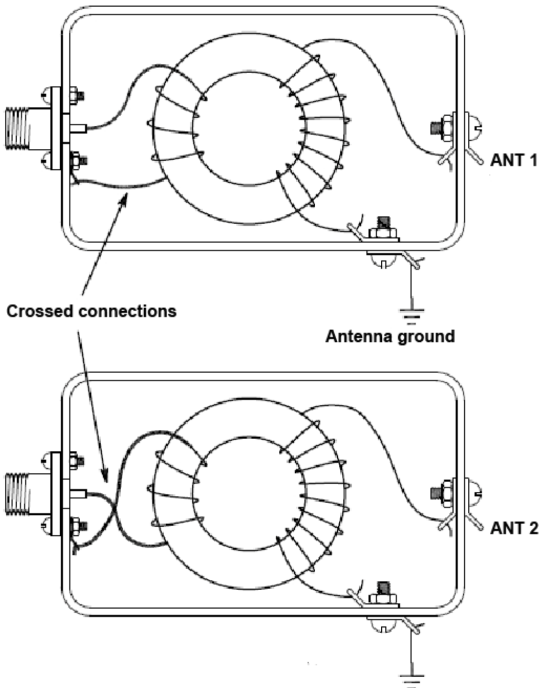
Start with 500 ohms for the terminating resistors (R).

/Torolf Johnsson

Guidelines for construction of baluns and combiner.

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

Antenna baluns:



Choosing core materials
The Amidon web page has a great deal of technical data to assist you in selecting the proper ferrite material.
However, all of that stuff is rather arcane and will take you a while to wade through. What it comes down to is this:
If you want to work from *0.5MHz 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.

Recommendations for 450 ohm to 50 ohm conversion (Beverage antennas, etc.):

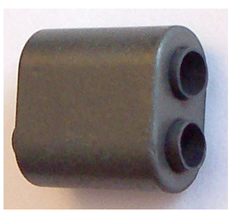
Size: Either FT-82 or FT-114
Material: Either Type 75 or Type J
Winding Pattern: Either twisted (TW) or traditional overlapped (OL) windings

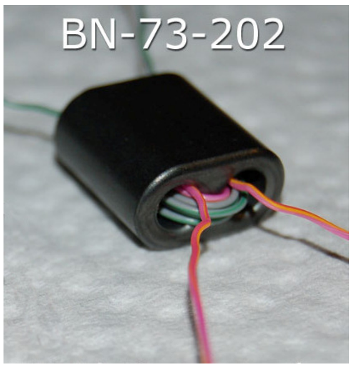
Turns count for 75 or J mtrl: 11/33 (The 11 turn coil goes to the coax, the 33 turn coil to the antenna.)

(From Fabricating Impedance Transformers for Receiving Antennas by John Bryant, May 2001 & June 2003 update)

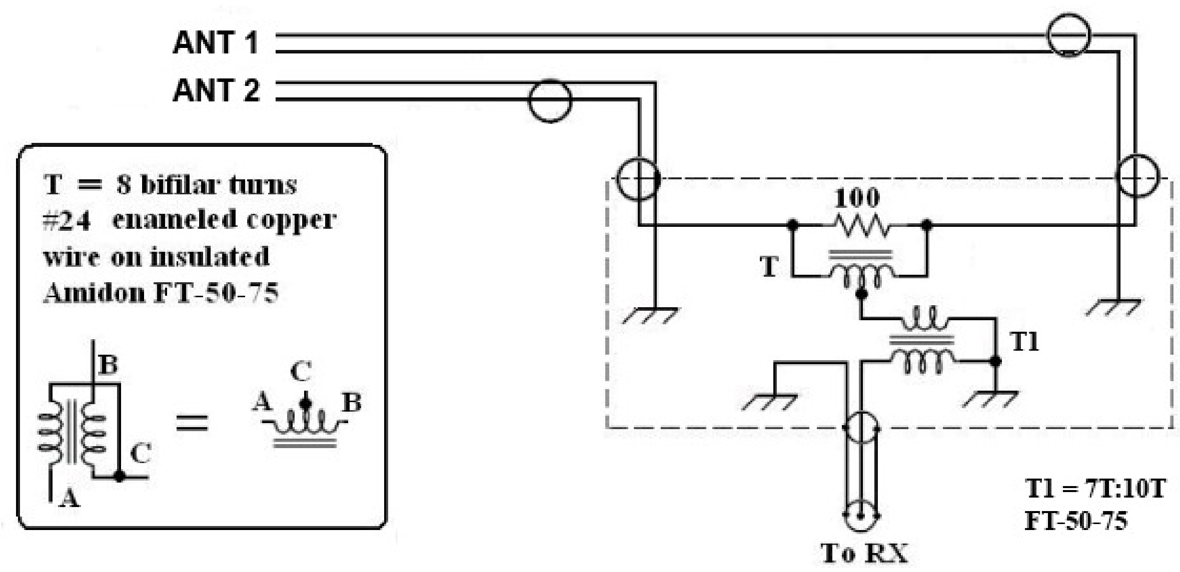
The best choice according to Torolf Johnsson is to use a binocular ferrite core like the Amidon type BN73-202.

Turns count for BN73-202: 3/8 (The 3 turn coil goes to the coax, the 8 turn coil to the antenna.)

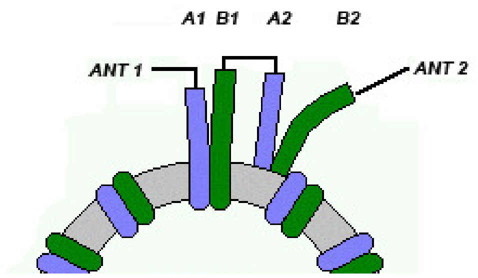




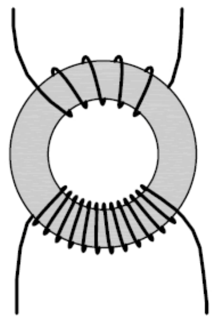
Combiner (k) with step up transformer:



This picture shows connection of the wires in the combiner transformer **T**

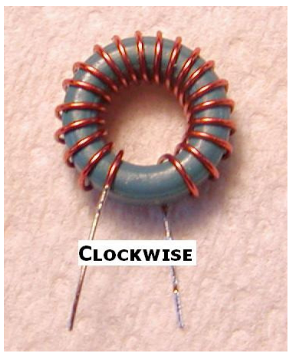


Step up balun **T1** from combiner to antenna (25/50 ohm).



The core type used determines the number of turns. The figures and turns shown are for FT50-75 cores.

The correct way to wind core baluns is:



- Each time through the center counts as 1 turn
- Spread the turns out evenly around the diameter of the core, if that means overwind the previous layer because it requires more than one layer ....that's OK
- For a second or third layer, bifilar, trifilar, hexfilar, etc or not ....spread the turns out evenly around the diameter of the core as if the first layer wasn't even there
- Wind ALL the turns in the same direction.....if you start by going through the core from the top and wind counter-clockwise, continue to do so for ALL the windings
- All windings should be tight enough to keep the turns in place.....Don't worry about rubbing through the insulation
- Straighten out all loops before they become "kinks" ....a "kink" makes the wire VERY weak at that point
- Cut the wire ends to an appropriate length, scrape the insulation off with an X-Acto knife or razor blade and measure the individual windings with an ohm meter so you know which ones are pairs (VERY IMPORTANT).

/Thomas Nilsson