

## Building a Reversible Beverage Array at OH2BEN

Technical notes



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## Building a Reversible Beverage Array

### 1. Introduction

I have documented some notes of my Beverage array. Just to make myself a decent documentation, but also to help others build same kind of installation. There are very little construction instructions available how to build low impedance Beverage using military telephone wire WD-1A or Finnish 'Killu' (copperweld).

Somebody may think that here is lot of stuff which is quite self-evident. But it's not. Because I am not an engineer or technically oriented person, this is also a learning process for me. I am good to solder PL-259's, but all electronic stuff is beyond my understanding. But I am learning J. And I can assure you, that it takes a lot of time to understand all technical nuances and there are still a lot of things what I cannot understand. Therefore all notes are just how I understand it and in a KISS way. And therefore you cannot expect to see some nice or new ideas :-). For example, I would love to steer my relays via coax, but at this point I cannot know how to implement it.

At this point I like to thank Rys SP5EWY and Gary KD9SV for email conversations and some technical details which really got my project going. Jukka OH4MFA for his great Topband WEB-site and Marko OH3XR for his antenna ideas and antenna wisdom. Thanks guys ! And last but not least my loving wife Anna, who is supporting me with all my 'weird' projects.

If you found this article interesting and supportive for your own projects, please give me some feedback.



Hope you will enjoy,  
Best Regards, GD DX & 73's de

Tom, OH2BEN

## 2. Concept design and drivers

Basically my drives are:

- To get decent RX antennas to main directions. As good as possible, what lot and space permits
- Easy to install and remove if needed.
- Using WD-1A military twin lead telephone wire or same kind of Finnish telephone company wire "Killu", which I have both available.
- Do it stealth and camouflaged. Put it away up to avoid humans, deer and moose. Traditional 2 wire Beverage is out of question, because of stealth and camouflage approach.
- Using remote coax switch and minimize need for several long coax runs.
- Coax impedance matching for 50 ohms.
- KISS ! Do it yourself with economic way.

Benefits and added value:

- When feeding boxes and reflection boxes are ready, you can put as long Beverages as you can or situation permits. Off course length will affect to COS (Cone of silence). Concept will work. Temporally Beverages for contests, DX-peditions etc. or permanent one.
- Twin line type wire is easy to install and balance in not so big problem as in wide spaced two wire Beverages.
- Black wire will camouflage easily in the trees.
- It's simply to install and remove.

## 3. References and pointers

I am not going to try explain how Beverage antenna works. You can find a lot of information from Internet and antenna literature.

Good starting point to my project is look at references, which influenced a lot in my project. Here are just a couple of most important ones:

### 3.1 Beverage general info

Topband reflector, W8JI.com, K3KY (<http://www.angelfire.com/md/k3ky/page20.html> ) and ON4UN book are musts.

You can learn a lot from RA6LBS site and his Power Points. To be noted, that RA6LBS has designed his first prototypes for telephone wire. So therefore these references interested me a lot ! Materials are written in Russian, which I cannot understand, but pictures can tell you more than thousand words. Especially the later link was a great inspiration for me. Good schemas and pictures how it was done. Photos and schemas about feedbox especially. There are a lot of info about different kind of low band antennas and arrays on the other power points! F.ex look at those 4 Square possibilities or multi beverage array sketches. Maybe some future projects, when we don't have anything else to do ;-)

<http://www.ra6lbs.ru/index.files/page23.htm>

[http://www.ra6lbs.ru/Papers/Bv\\_RA6LBS.ppt](http://www.ra6lbs.ru/Papers/Bv_RA6LBS.ppt) Check this out !!!

Good article, which gives a lot to concept ideas, even though it was implemented different way: Six Antennas from Tree Wires (73 magazine, October 1983) Also on K1VR's site: [http://www.qsl.net/wars/construct/ste\\_antswitch.htm](http://www.qsl.net/wars/construct/ste_antswitch.htm)

OH4MFA have also very informative Beverage site:

<http://personal.inet.fi/cool/oh4mfa/beverage.htm>

<http://www.saunalahti.fi/hohtola/ham/killu/killu.html> 'Killu impedance'

### 3.2 Transformers

Here is N1EU's link, how to calculate transformers. Look at the examples at very bottom. With these info I made a simple excel for calculations.

<http://n1eu.com/topband/BeverageXfmrs.htm>

### 3.3 Direction management

<http://members.ll.net/ford/bidirectional.htm>

Ford has a very good site, where there is a very good story of building traditional reversible Beverage. In the end, there is good a schema about how to implement relays for direction management. Other good reference is RA6LBS schema.

### 3.4 Antenna coax relay box

I liked EI7BA / John's concept of remote coax switching. All coax are grounded when not connected. Just thinking of thunderstorms and winter static. Another good link is MW1STE's instructions, because there is a complete list of components and "instructions for Dummies".

<http://www.iol.ie/~bravo/remote.htm>

[http://www.qsl.net/wars/construct/ste\\_antswitch.htm](http://www.qsl.net/wars/construct/ste_antswitch.htm)



## 4. Design



My first plan was to make array from K1VR tree wire / six coax approach. I found out, that this approach will need a lot of long coax runs, and quite complicated control to handle all those relays coaxes. Therefore I started to look for model, where is central box for controlling and selecting right antenna coax. Control box can be some commercial remote coax switch or something home made. When we add to this concept possibility to reversible Beverage, the concept design is ready.

My design is based on ON4UN's design, Fig 7-98 on page 7-70 (4<sup>th</sup> edition). Pages 7-71 - 7-83. Transformers BN-73 202 explained on page 7-58 – 7-60 also 7-91 – 7-92.

I am using a typical electrical IP54 rated plastic box ( 70mm x 70 mm x 40 mm). They are inexpensive and you can get 10 piece bulk cheaply from Bauhaus or equivalent store. Nuts and bolts with plates are 6mm. Wing nuts are very handy, when you have to do some antenna work in freezing temperatures in the middle of the night.

I made at the same time 4 setups, no primary proto. Three Beverage setups to used in the Beverage Array and one spare setup to use as a backup, in peditions or temporary installations. In this way it was a more efficient way to build.

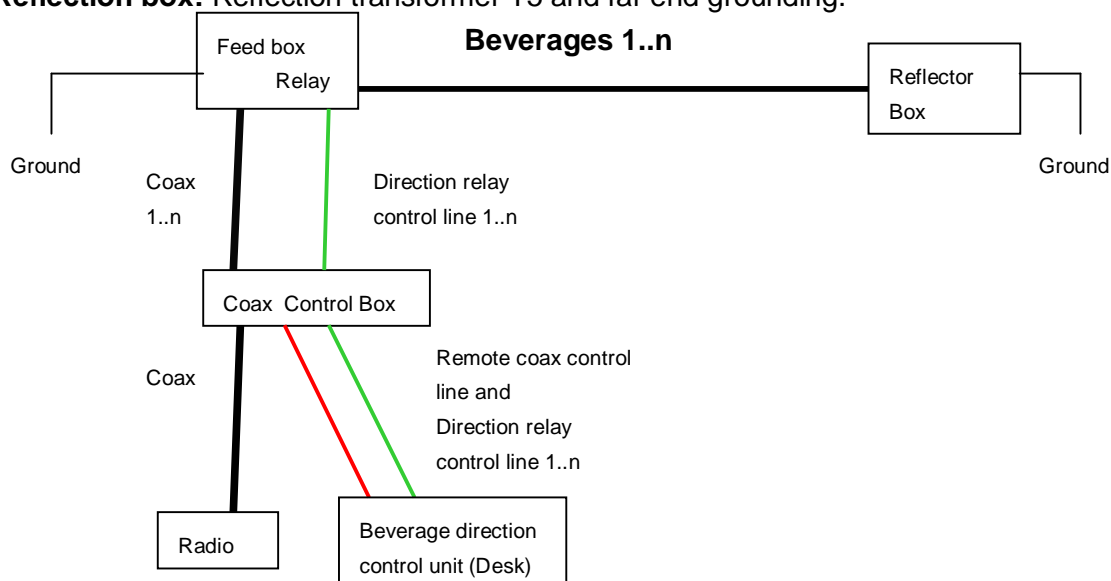
### 4.1 Components

**Remote Coax switch:** Controls right coax feed line to Beverage 1-3.

**Control unit:** On the desk to select direction. Controls remote coax switch and Beverage direction relays.

**Feedbox:** Matching transformers T1 and T4 for direct and reversible directions. Relay controls direction and which transformer is fed and which end is terminated into 50 ohm resistor. Voltage input for relay control via separate line or coax. In my setup this was done with separate line. Grounding to coax or grounding rods.

**Reflection box:** Reflection transformer T5 and far end grounding.



## 4.2 Transformers

My transformers specs, based on figure 7-98 on page 7-70. Windings done by W8JI and ON4UN book's instructions. I am using just pieces of telephone wire color coating in transform wiring. Nothing special. Hint: use same colors in same tasks / purpose. It made mass work easier, if you are doing all boxes in series.

I decide to use (try) 450 ohms as 'traditional Beverage impedance' and 150 ohms as wire feeding impedance. Coax 50 ohms.

Specs:

Antenna wire	Calculated by 200 Ohm. WD1-A wire impedance around 150-170 ohm.
Transformer	BN-73 202 or Fair-Rite 2873000202
T4 – n2	3 rounds (50 ohms)
T4 – n1	5 rounds, with center tap 2.5 rounds (150 ohms)
T1 – n2	2 rounds (50 ohms)
T1 – n1	6 rounds (450 ohms)
T5a – n1	3 rounds, with center tap (1.5 rounds) (150 ohms)
T5a – n2	5 rounds (450 ohms)

Some notes of my calculations, just to make sure of my formula. Many turn ratios are familiar from literature :

Ohms	n1:n2
50 : 150	4 : 7
75 : 150	4 : 7
50 : 200	2 : 4
<b>75 : 200</b>	<b>3 : 5</b>

50 : 300	2 : 5
75 : 300	2 : 4
75 : 450	2 : 5
<b>50 : 450</b>	<b>2 : 6</b>
<b>50 : 150</b>	<b>3 : 5</b>

#### 4.3 Reflector box



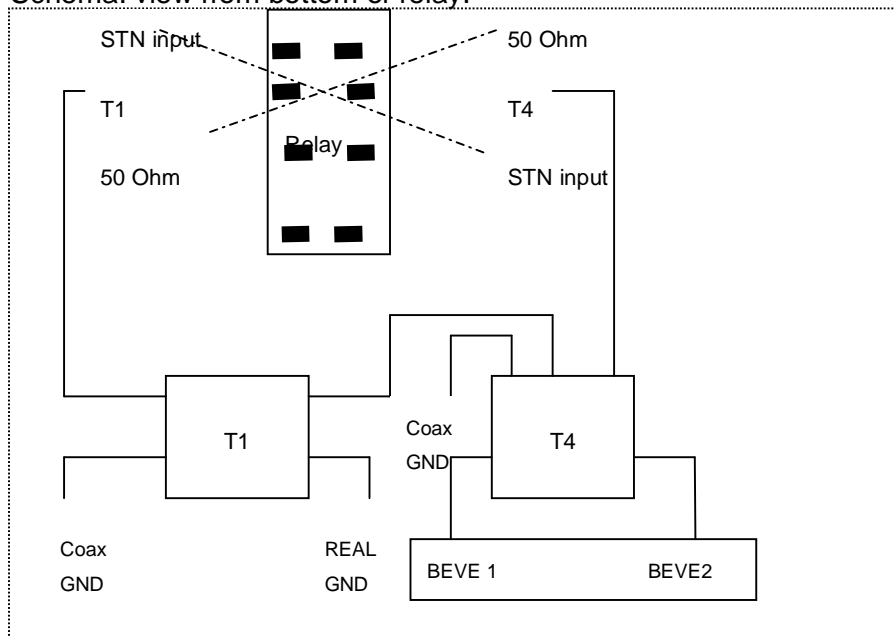
Some comments:

- Left side, beverage wires one and two
  - Right side: Grounding from central tap.
  - Transformer is glued in the bottom of the box.
- Turning ratio 3:5 rounds, with central tap.



#### 4.4 Feed box

Schema: view from bottom of relay.



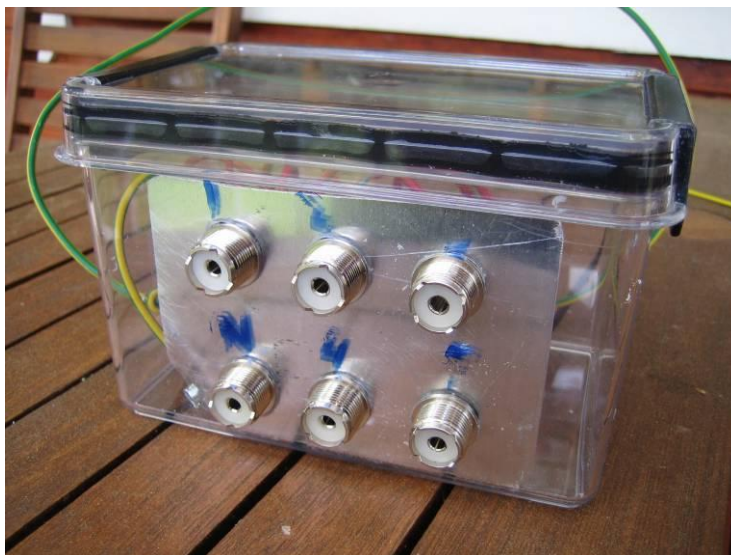
Some comments:

- Left : Coax feed
- Left down corner: 50 ohms termination resistors ( 2 x 100 ohm). Easy to change.
- Right down corner: Real grounding from T1-n1. Note: The other groundings are to coax shield.
- Right: Beverage wires one and two (from T4-n1)
- Blue connector for 12V relay control
- Relay is DPDT
- Transformers turning ratios:
  - § T4: 3:5 CT ( 50 ohm : 150 ohm)
  - § T1: 2:6 (50 ohm : 450 ohm)
  - § T5A: 3 CT: 5 (150 ohm: 450 ohm)

## 5. Direction management

### 5.1 Coax control box

You can use commercial made remote coax switches or make your own. My projects coax control box is done by EI7BA instructions. This box is only for my RX-antennas and I can switch 5 different coax lines. As you can see, there are double boxes to provide good protection against rain, freezing and snow.



Direction	Direction relay control at antenna feedbox	Coax
S	0, default	1
N	+	1
E	0, default	2
W	+	2
NE	0, default	3
E	+	4
SE	+	5
SW	+	3
W	0, default	4
NW	0, default	5

## 5.2 Beverage control (Desk)



Left knob: Pennant switch: N - E – S – W

Center knob: Beverage control: SW – W – NW – NE - E – SE

Right knob: 7 MHz 4 Square control: SW – NW – NE – SE

Little switch between left and center knob: Selection between Pennants and Beverages

Pennant and 4 Square knob controls only positive voltage to relays in antenna control box.

Beverage control is 2 x 8 rotary switch. Outer round is controlling right coax selection (1-3) and inner round reverse direction relay control in feedbox.

## 6. Beverage installation

One of my drivers is that Beverages are quite invisible. Basically this is easy, because line is black it will become camouflaged easily in the trees and the forest. All Beverages are put so high, approximately 3-5 meters, that they will cause no harm to humans, deer, Moose, skiers and Skidoos.

All lines are just hanging on tree branches, no specially made supports or poles. Also a little bit zig zagging, max 20 degrees on NE-SW Beverage when following road line. No influence to performance. No long down leading. Usually wires come straight down to termination.

Both ends have two approx. 1 meter long grounding rods. Grounding rods distance are approx. 2 meters or more.

RG-58 coax is used as feeding line. Coax shields are grounded at Coax control box, not at Beverage end. Control box is situated some 30 meters from the house.

## 7. Measurements

I made measurements with MFJ-259B Antenna analyzer 20.10.2007 from ham shack. Coax to Control box (approx. 30 meters) are 75 ohm. From control box all coax runs are 50 ohms (30 – 40 meters). Measurements are done from both direction. Results of same Beverage directions are aside. Def= Default direction direct, Rev=Reverse direction

Freq		NE Def	SW Rev	W Def	E Rev	NW Def	SE Rev
1.820	SWR	1.1	1.0	1.0	1.1	1.0	1.0
	R	56	52	50	54	47	50
	X	0	2	2	7	4	2
3.650	SWR	1.1	1.1	1.1	1.1	1.0	1.0
	R	49	46	45	51	49	52
	X	6	6	6	5	2	0
7.040	SWR	1.2	1.1	1.4	1.1	1.2	1.1
	R	44	44	36	47	44	45
	X	8	5	5	4	7	5

## 8. First comments of use

I have been using this array from 27.7.2007, when we have very light nights and no good graylines here in Finland and up in the north. By autumn, the conditions are improving all the time. Some receiving experiences so far:

- Usually Beverages max strengths is 3-4 S down from TX antenna (Top loaded vertical). But S/N ratio is very fine J
- Pennants are 2-5 S down from Beverages

- Many times I can read quite easily DX stations 519, when readability with Pennants is 319-419. So Beverages, even they are quite short (180 m), makes a big difference to Pennants
- Comment from Marko OH3XR, "I am still continuing calling DX station, where many other OH-stations stopped calling. So it tells me that receiving conditions are quite OK and maybe even a little better than average."
- Now I can hear a lot more DX than before, unfortunately now the challenge is just to get them.
- Some QSOs on 160 meters: VK9W, KL7, UA0, JA, ZL7, HL, BY, 3B7, 3B8, ZS, K etc. Many of those qsos were not possible with Pennants.
- Especially the steering capacity is nice. You can receive a DX station from several directions. But you can also select antenna, which pick less QRM or where the S/N ratio is best.
- I have done a lot of A-B tests with Pennants. Beverages usually outrun them easily.
- Directivity example from 15.10.2007 AA1BU 0511Z on 3.7 SSB. Joe was using 5 ele Yagi. Maximum signal strength with my phased verticals (West) was S9 + 35dB (Exceptional conditions!), most of the time +25dB. At same time max strength with W beverage S9, on SW and NW beverages strength dropped to S5. When listening NE, E and SE Beverages, signal was S1-3 or just audible. So the directivity and F/B is there J
- Another example 17.10.2007 0500Z, worked OA4/N6XQ. On the peak TX antenna S6 with noise and QRM, with beverage S4-S5 HIFI ! With W Pennant just readable S0-S1.

Possible next steps:

- Getting rid of Pennants and make some other RX antenna experiments.
- At this point Beverage array 6 directions are working OK, so put one more Beverage will not give any added value to receiving (?).
- Has anyone tried a staggered array of reversible Beverages ? I can put another wire some meters aside. If there are 2 x reversible Beverages with same direction control and staggering. Will it work? So far I have not found any info on this kind of setup. Just traditional one direction staggered arrays. With doubling, I could get 6 direction phased array, that would be something awesome !



## 9. Some Beverage pictures

### 9.1 Feed box



NW-SE Feed box



NE-SW Feed box

### 9.2 Termination box



East end camouflaged termination box.  
Box under the stone.

NW-End termination



### 9.3 Grounding rods



Camouflaged grounding rod at East end

Grounding rod in NW end.

### 9.4 Wires



NW-SE Wire

Three Beverage wire crossing



Wire East to West over open field.

## 10. OH2BEN Antennas



Current antennas (16.10.2007) on top of very old satellite picture.

- Tower
  - 8 ele LPDA for 14-28 MHz
  - 2 ele Moxon for 10 MHz

