Beverage Antenna. Theoretical Look on Practical Result

By: Igor Grigorov, VA3ZNW

My Beverage Antenna (**Figure 1**, that was described at: http://www.antentop.org/019/va3znw_019.htm) is successfully working at my station. The antenna was successfully tested at CQ WW 160- Meter Contest (CW), CQ WPX (2016, CW) and ARRL International CW Contest (2016). I worked there with my IC- 718 using only 50… 90- Wt.

However it stands interesting for me what is the theoretical data for my Beverage Antenna. Parameters of the antenna were simulated with NEC for MMANA. **Table 1** shows the data for my antenna. Maxima gain is given to the radiation angle at where it is.

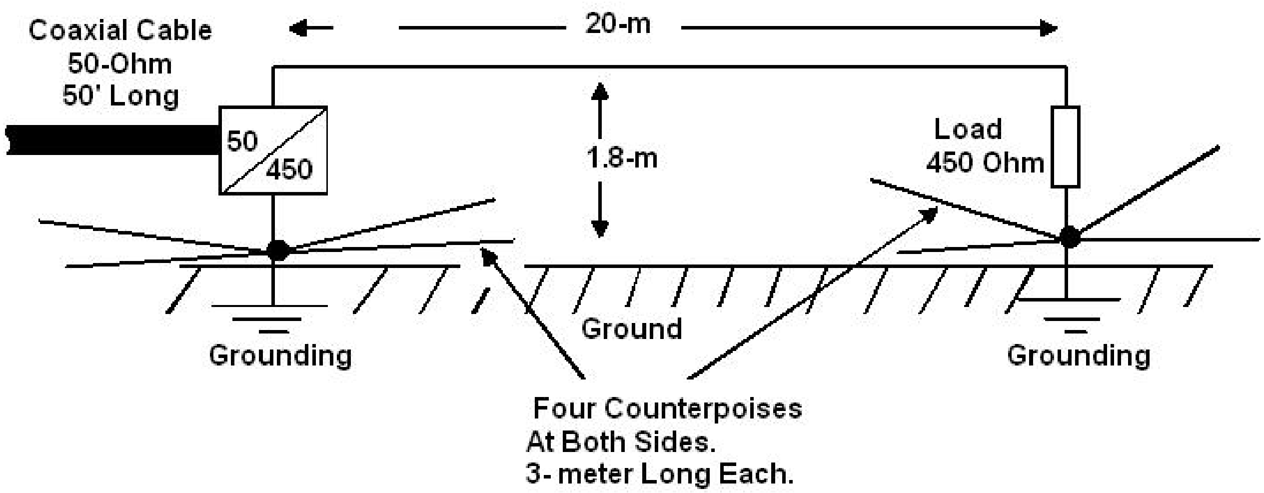

Figure 1
Beverage Antenna at VA3ZNW Amateur Station

Table 1
Data for Beverage Antenna placed at 1.8 meter above the Ground, simulated with NEC for MMANA and measured practically by SWR- Meter of IC- 718

Band	160	80	40	30	20	17	15	12	10
Z	163-j842	476-j96	418-j213	460-j75	489+j5	387+j119	568+j79	379+j267	569+j51
SWR	12.66	1.24	1.64	1.18	1.09	1.38	1.32	1.9	1.32
Gain	-19.1	- 13	-9.8	-7.43	-5.33	-4.5	-2.65	-2.36	-0.26
At Vertical degree	51	79	77	64	56	52	47	45	42
SWR by IC-718	1.5	1.0	1.2	1.2	1.1	1.2	1.2	1.0	1.2

The **Table 1** shows that at all amateur HF Bands my Beverage Antenna has the gain much below zero. However it is possible compensate at receiving mode by turn on the internal transceiver's preamplifier. At transmitting mode only propagation may help me. However I often received reports 559- 579 at 160- 20 Meter Bands where the antenna losses are big enough. At the 17- 10 Meter Bands the report 599 is common one there. It is very interesting that practically measured SWR is close to the theoretical one above the 160- Meter Band where the some known inaccuracy in simulation is happened. **Figure 2** shows SWR of the Beverage Antenna measured with the Rig Expert AA1000. It is very close to the reading by the IC- 718 and to the theoretical calculated by the NEC for MMANA.

Another important side of the Beverage Antenna is the Diagram Directivity. Below **Figure 3** to **Figure 11** show DD of the Beverage Antenna at the 160, 80, 40, 30, 20, 17, 15, 12 and 10- meter Bands in the vertical plane. Feedline with matching transformer is on the left side and the termination resistor is on the right side of the figures. As you can see from the **Figure 3** - **Figure 11** the DD of the Beverage Antenna is far away from a perfect one. Antenna has signification radiation into zenith. It is may be not bad for 160- 40 Meter Bands where it gives local QSOs. However at the higher bands it is just waist of the transmitter power.

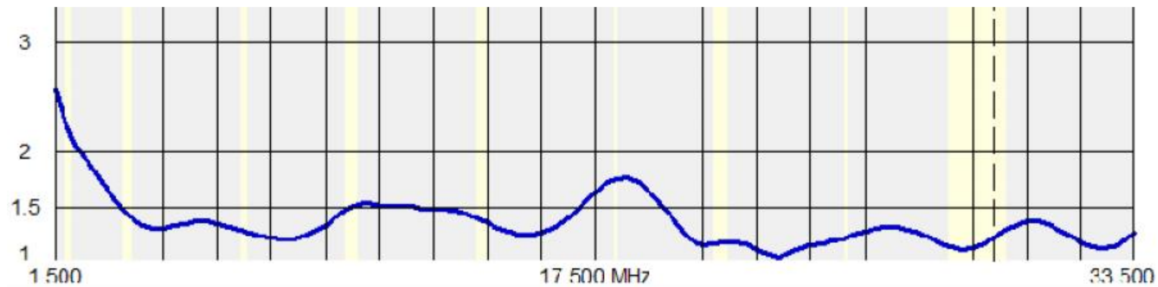

Figure 2
SWR of the Beverage Antenna shown by the Rig Expert AA1000

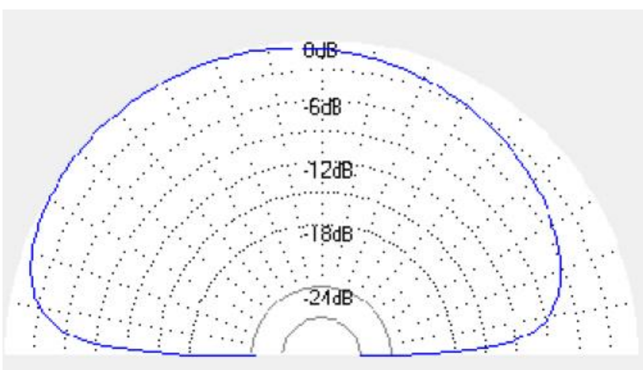

Figure 3
DD of my Beverage Antenna at 160- Meter Band

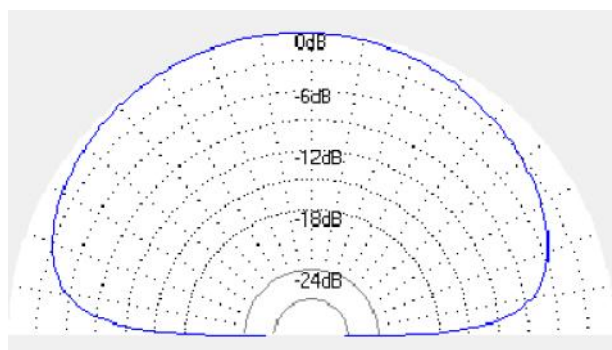

Figure 4
DD of my Beverage Antenna at 80- Meter Band

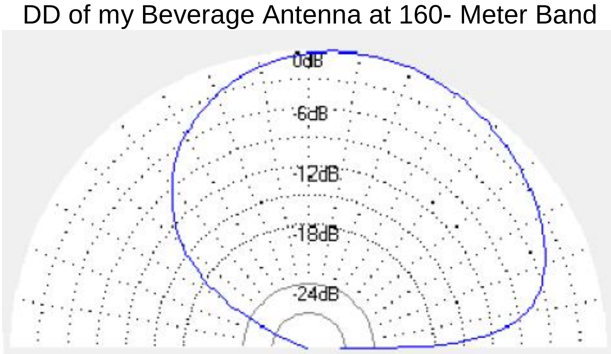

Figure 5
DD of my Beverage Antenna at 40- Meter Band

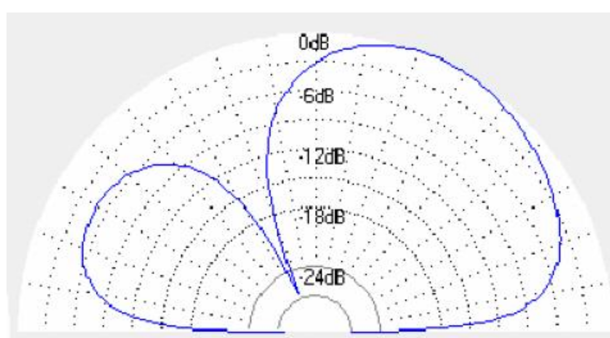

Figure 6
DD of my Beverage Antenna at 30- Meter Band

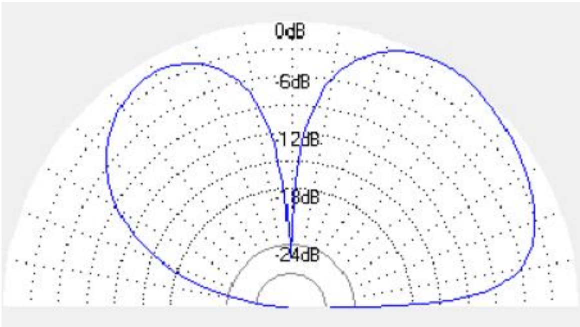

Figure 7
DD of my Beverage Antenna at 20- Meter Band

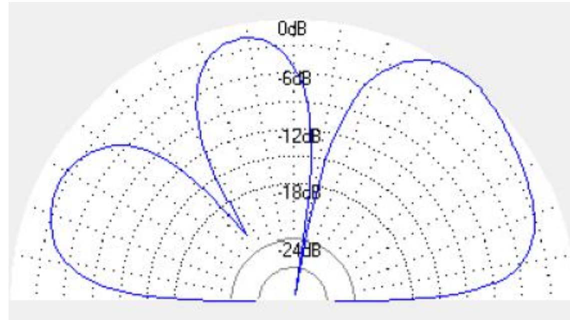

Figure 8
DD of my Beverage Antenna at 17- Meter Band

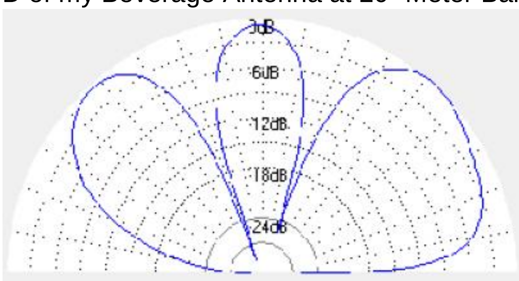

Figure 9
DD of my Beverage Antenna at 15- Meter Band

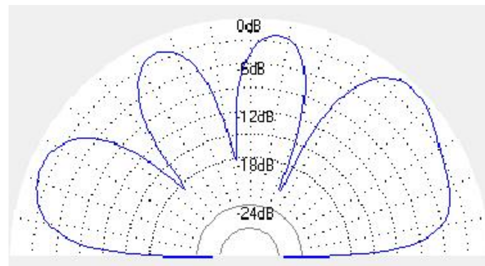

Figure 10
DD of my Beverage Antenna at 12- Meter Band

Of course after I have found the theoretical data for my Beverage Antenna I would like to improve the antenna efficiency. Most simple way to improve the efficiency of a broadband Beverage Antenna is to connect to the termination hot end an additional wire with length that is not resonant for the used bands. To find the needed length and possible practical configuration is a not simple task. But I decided to do it. Additional wire in 7 meter length was connected to the antenna load. **Figure 12** shows the antenna. Parameters of the antenna were simulated with NEC for MMANA. **Table 2** shows the data for my antenna. Maxima gain is given to the radiation angle at where it is.

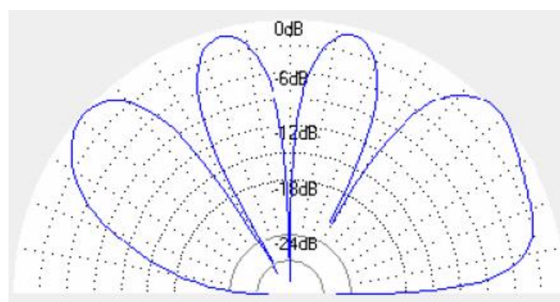

Figure 11
DD of my Beverage Antenna at 10- Meter Band

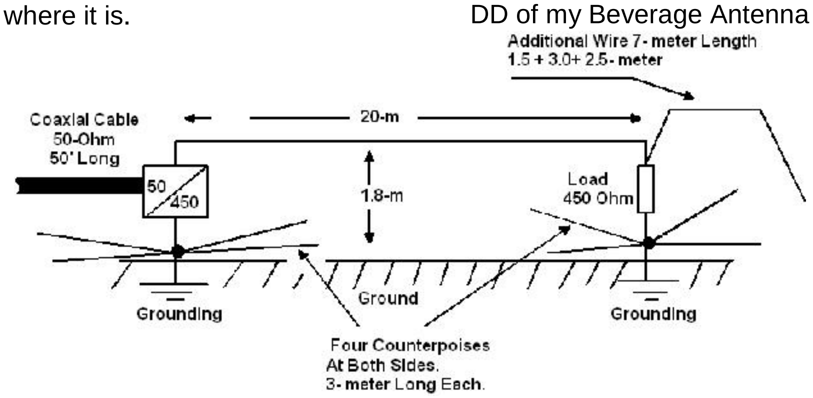

Figure 12
Beverage Antenna with additional wire at the termination end

Table 2

Data for Beverage Antenna placed at 1.8 meter above the Ground with additional wire at termination side (**Figure 12**), simulated with NEC for MMANA and measured practically by SWR- Meter of IC- 718

Band	160	80	40	30	20	17	15	12	10
Z	133+J736	601+J239	100-J172	1233-1518	401+326	353_51	417+104	622-204	277+711
SWR	12.56	1.71	5.16	7.12	2.14	1.32	1.29	1.65	6.14
Gain	-17	-10	-9.7	-1.21	-3.77	-2	-0.6	2.43	2.28
At Vertical degree	53	84	29	61	55	53	49	78	23
SWR by IC-718	1.3	1.0	3.0	3.5	3.0	1.1	1.0	1.0	1.2

As you can see from the **Table 2** additional wire affected my Beverage Antenna. Antenna gain was increased (theoretically) near to 3 dB at all working Bands. However due high SWR I lost middle of HF Bands- 40, 30 and 20- Meter Bands. I cannot say that I have noticed significant difference in reception and transmission mode at the rest Bands. Below **Figure 13** to **Figure 11** show DD of the Beverage Antenna at the 160, 80, 40, 30, 20, 17, 15, 12 and 10- meter Bands in the vertical plane. Feedline with matching transformer is on the left side and the termination resistor is on the right side of the figures. DD the Beverage Antenna at 160 and 80 Meter Bands are practically identical so those ones shown at one figure- **Figure 13**.

As you can see from the **Figure 13** - **Figure 20** the DD of the Beverage Antenna with additional wire at termination load changed compare to classical Beverage Antenna. In theory the antenna should work better compare to my old one. However the antenna as well has signification radiation into zenith.

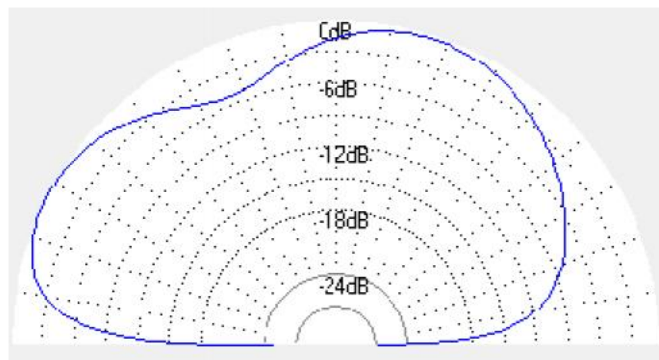

Figure 14
DD of modified Beverage Antenna with additional wire at termination load at 40- Meter Band

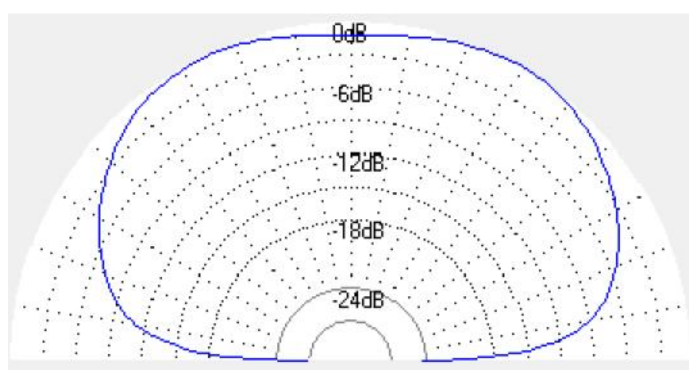

Figure 15
DD of modified Beverage Antenna with additional wire at termination load at 30- Meter Band

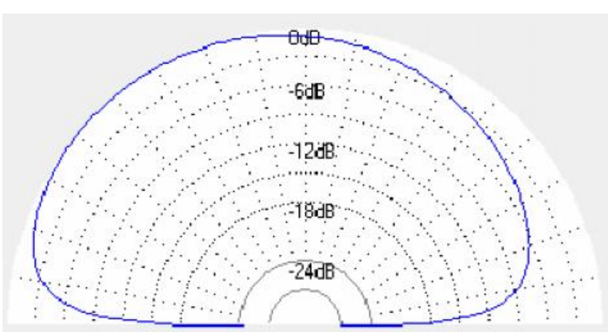

Figure 13
DD of modified Beverage Antenna with additional wire at termination load at 160 and 80- Meter Band

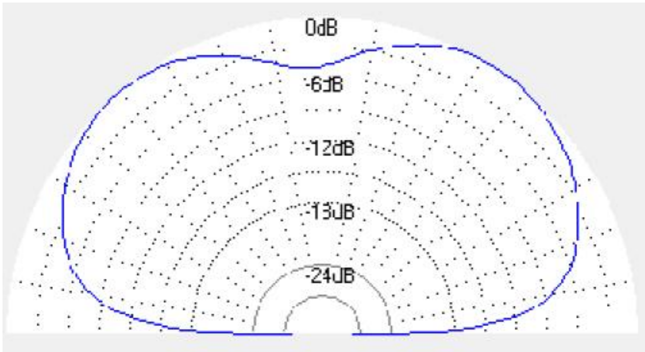

Figure 16
DD of modified Beverage Antenna with additional wire at termination load at 20- Meter Band

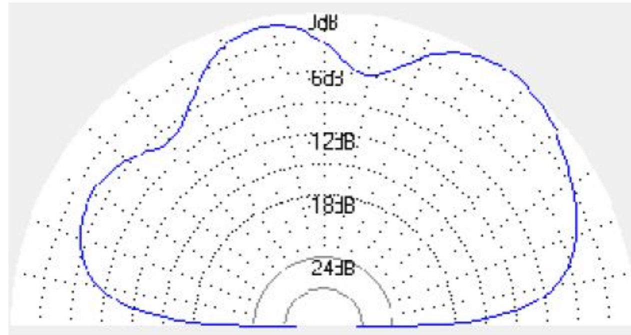

Figure 17
DD of modified Beverage Antenna with additional wire at termination load at 17- Meter Band

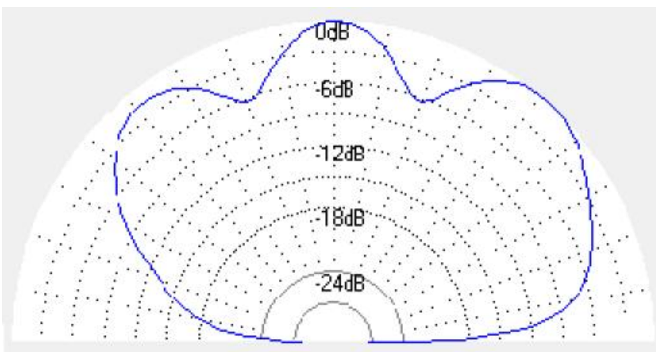

Figure 18
DD of modified Beverage Antenna with additional wire at termination load at 15- Meter Band

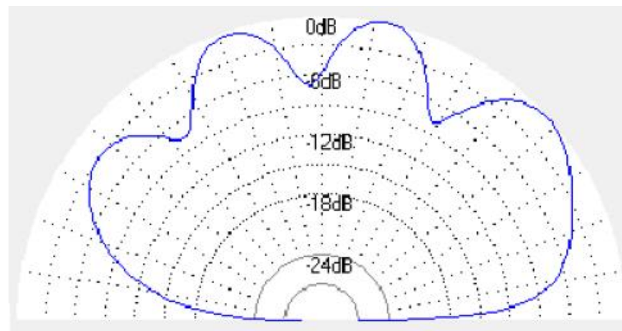

Figure 19
DD of modified Beverage Antenna with additional wire at termination load at 12- Meter Band

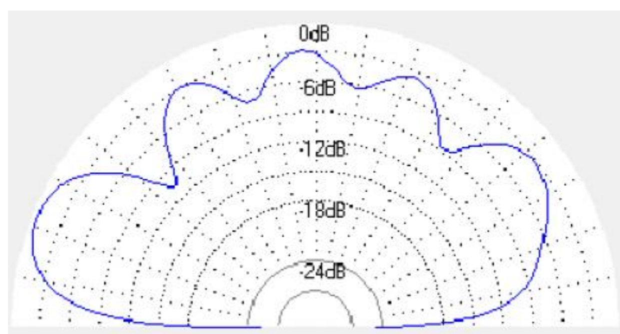

Figure 20

DD of modified Beverage Antenna with additional wire at termination load at 10- Meter Band

Anyway to have an objective appraisal the old and new antenna it needs to do A- B test. I did not do it. Unexpectedly I found that the antenna at some days have received lots industrial electrical interferences. Because of it and because of I need the 40, 30 and 20 meter Band the antenna was de- configured to the classical design. Though sometimes it seems to me that the antenna (with additional wire) worked very well at 17, 15, 12 and 10 Meter Bands. May be at some days I return back to experimenters with Beverage Antenna with additional wire at termination load.

Next my experiment with my Beverage Antenna was simple. Under the antenna I installed a copper wire that connected together ground at feeding transformer and ground at termination load. **Figure 21** shows design of the Beverage Antenna. At early times when I experimented with Beverage Antenna I noticed that such additional wire very often improved efficiency of the Beverage Antenna. Parameters of the antenna were simulated with NEC for MMANA. **Table 3** shows the data for the antenna. Maxima gain is given to the radiation angle at where it is.

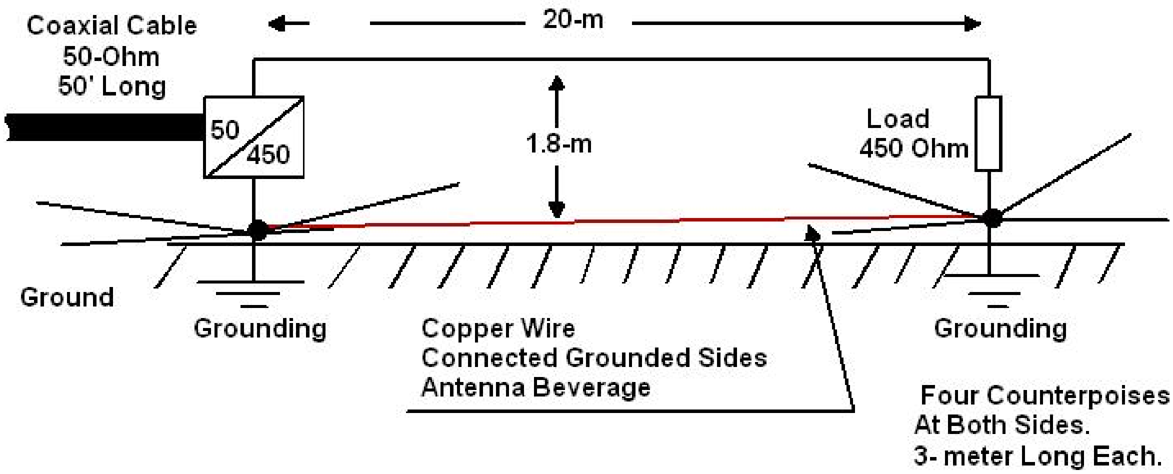

Figure 21

Beverage Antenna with additional wire between feeding transformer and termination load

Table 3

Data for Beverage Antenna placed at 1.8 meter above the Ground with additional wire between feeding transformer and termination load (**Figure 21**), simulated with NEC for MMANA and measured practically by SWR- Meter of IC- 718

Band	160	80	40	30	20	17	15	12	10
Z	2459-j160	374-257	618-283	466-64	534-13	395+108	586+46	379+259	411+82
SWR	5.49	1.9	1.85	1.16	1.19	1.33	1.32	1.89	1.23
Gain	-26	-12	-9	-7.7	-5.2	-4	-2.53	-2.3	0.2
At Vertical degree	36	65	72	64	54	51	48	45	42
SWR by IC-718	1.2	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0

Theoretical data show that the antenna gain a little improved (above 160- meter Band where some known inaccuracy at simulation is happened) at the configuration. Below **Figure 22** to **Figure 30** show DD of the Beverage Antenna at the 160, 80, 40, 30, 20, 17, 15, 12 and 10-meter Bands in the vertical plane.

Feedline with matching transformer is on the left side and the termination resistor is on the right side of the figures. As you can see from the **Figure 24** - **Figure 30** the DD of the Beverage Antenna with additional wire between feeding transformer and termination load looks better compare to my classical Beverage Antenna shown at **Figure 1**.

Theoretical DD at 160 and 80 has more radiation to zenith compare to Beverage Antenna shown at **Figure 1**. My opinion was that the antenna began work better the classical variant (**Figure 1**).

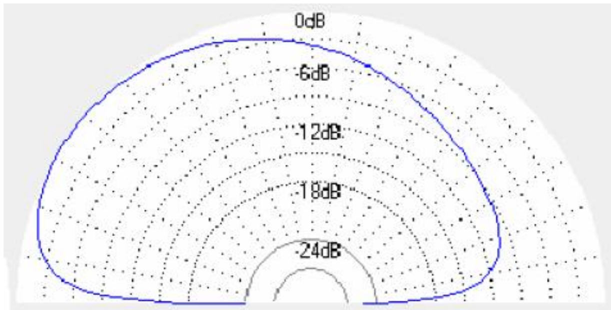

Figure 22
DD of Beverage Antenna with additional wire between feeding transformer and termination load at 160- Meter Band

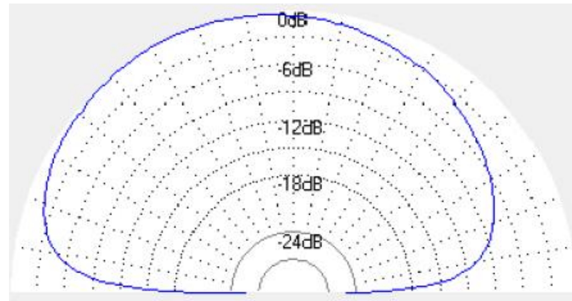

Figure 23
DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 80- Meter Band

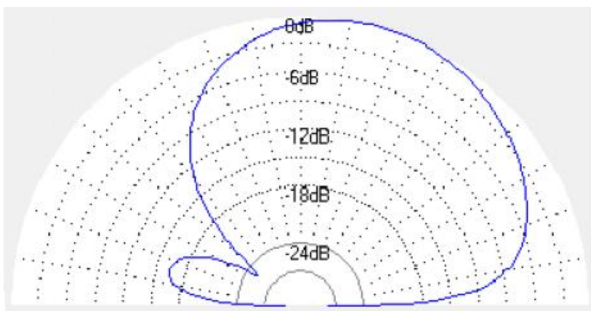

Figure 24
DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 40- Meter Band

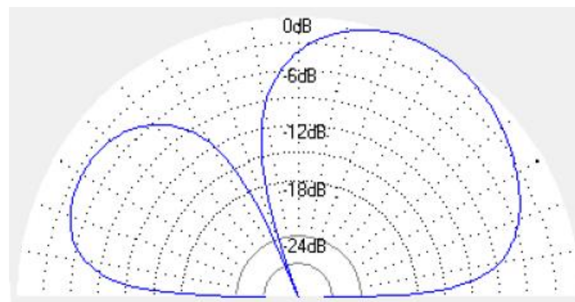

Figure 25
DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 30- Meter Band

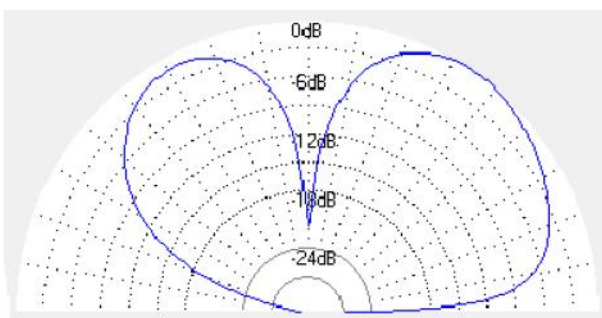

Figure 26
DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 20- Meter Band

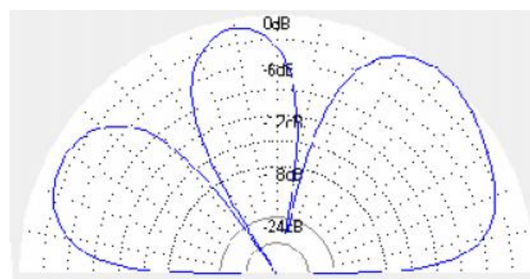

Figure 27
DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 17- Meter Band

However the configuration gave me unexpected effect. Beverage Antenna began received industrial electrical interferences. Antenna practically was not affected at day time but at evening time the interferences were such very strong that I cannot use 160 and 80- meter Bands. Sometimes the interferences closed the 40- meter Band.

Interferences not disappeared when I disconnected off the wire from any one side of the antenna- from termination load or feeding transformer. Moreover the interferences did not disappeared when the wire was disconnected from the both sides of antenna. I suspected that the ground wire for some reason received interferences from the street light. So, I should return to the old configuration of my Beverage Antenna…

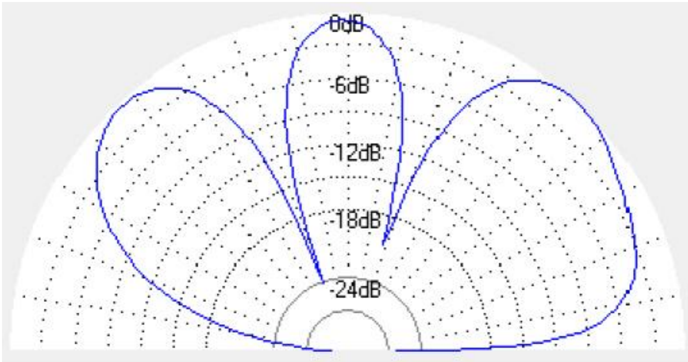

Figure 28

DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 15- Meter Band

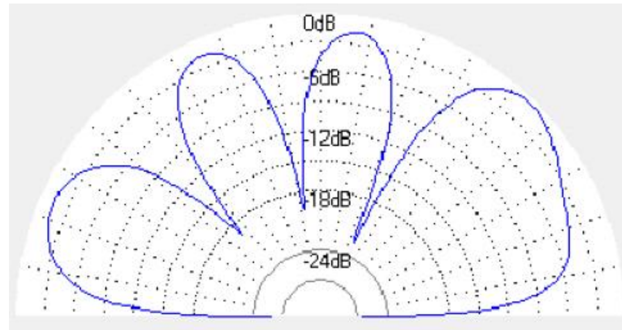

Figure 29

DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 12- Meter Band

Last possibility to improve the efficiency of the Beverage Antenna could be increasing the height of the horizontal wire to 4- meters above the ground. In theory this way should bring to multi beam DD at the high frequencies bands (because the vertical wires of the antenna take part at creation DD) and to some difference of the antenna impedance from the impedance of the termination load. **Figure 31** shows design of the Beverage Antenna with horizontal wire placed at height 4 meter above the ground. . Parameters of the antenna were simulated with NEC for MMANA. **Table 4** shows the data for the antenna. Maxima gain is given to the radiation angle at where it is.

Theoretical data show that the antenna gain improved at all Bands. However because the antenna impedance not to be close to the impedance of the termination load there would difficulties with matching of the antenna at 12 and 10- meter Bands.

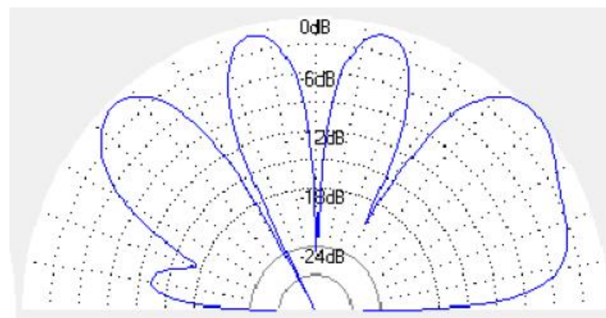

Figure 30

DD of my Beverage Antenna with additional wire between feeding transformer and termination load at 10- Meter Band

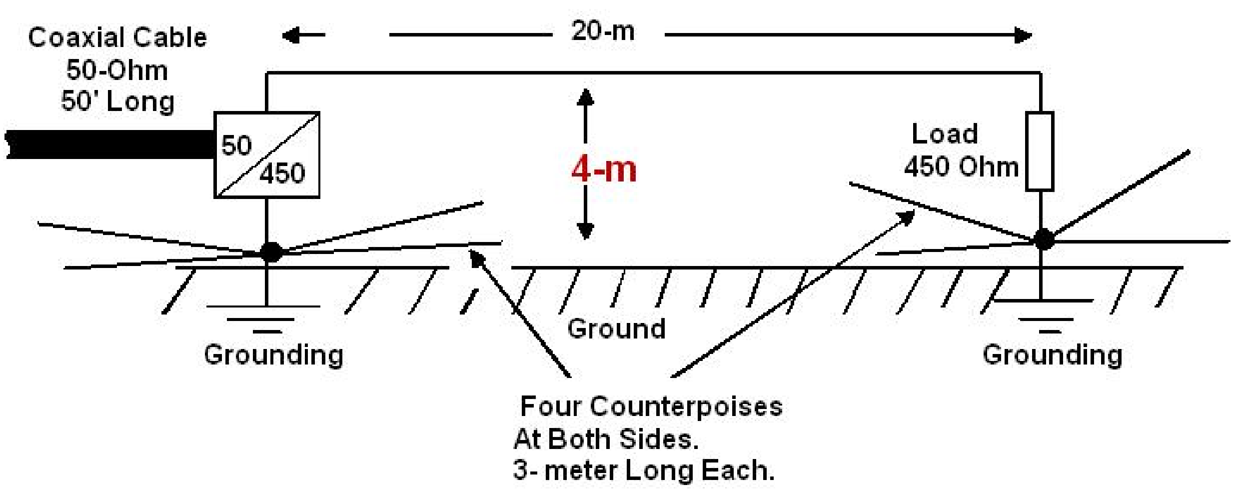

Figure 31

Beverage Antenna with horizontal wire placed at height 4 meter above the ground

Table 4

Data for Beverage Antenna placed at 4 meter above the Ground (**Figure 31**), simulated with NEC for MMANA

Band	160	80	40	30	20	17	15	12	10
Z	166-713	641-J145	462-J91	439+J4	554+J14	643+532	386_284	1399_J288	912+1580
SWR	9.77	1.56	1.22	1.03	1.23	2.75	1.99	3.26	8.49
Gain	-15.89	-10.44	-6.73	-4.3	-1.42	-0.2	1.69	3.65	0.42
At Vertical degree	49	71	86	74	62	33	51	34	47

Below **Figure 32** to **Figure 40** show DD of the Beverage Antenna at the 160, 80, 40, 30, 20, 17, 15, 12 and 10-meter Bands in the vertical plane. Feedline with matching transformer is on the left side and the termination resistor is on the right side of the figures.

As you can see from the **Figure 32** - **Figure 40** the DD of the Beverage Antenna with horizontal wire placed at height 4 meter above the ground looks better compare to my classical Beverage Antenna shown at **Figure 1**. However lost 12 and 10- meter bands and complexity with installation of the horizontal wire did not compensate the new antenna advantages.

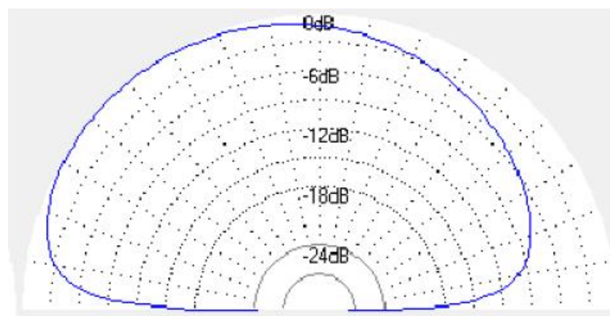

Figure 32
DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 160- Meter Band

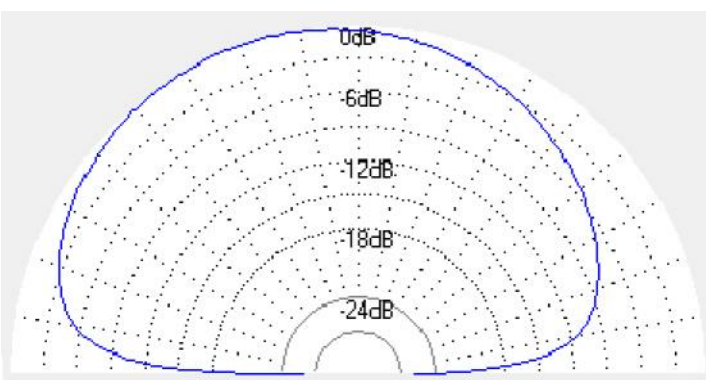

Figure 33
DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 80- Meter Band

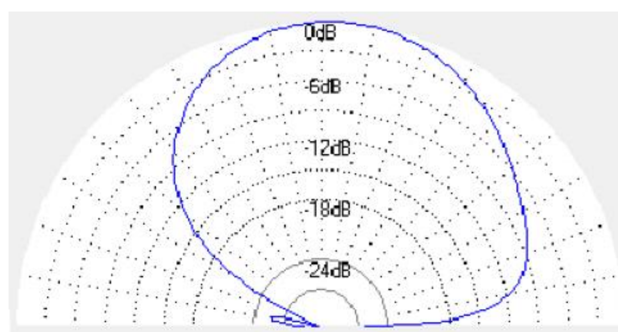

Figure 34

DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 40- Meter Band

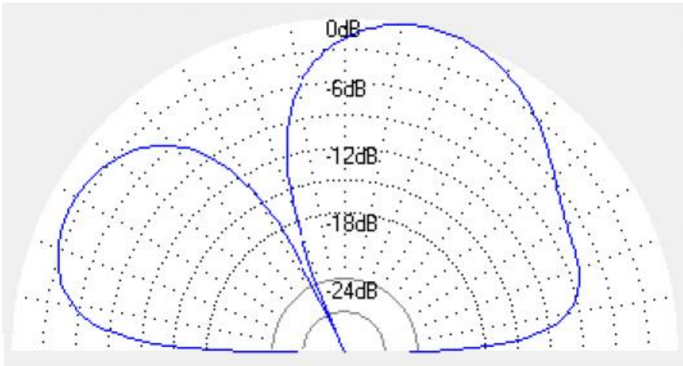

Figure 35

DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 30- Meter Band

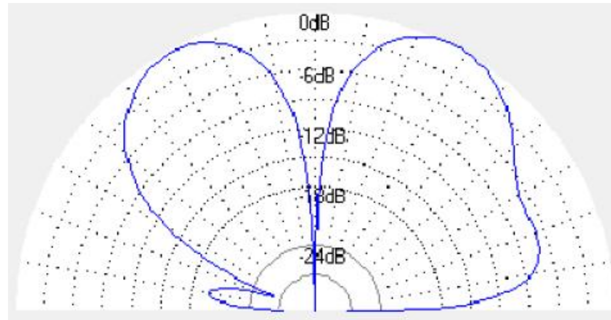

Figure 36

DD of Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 20- Meter Band

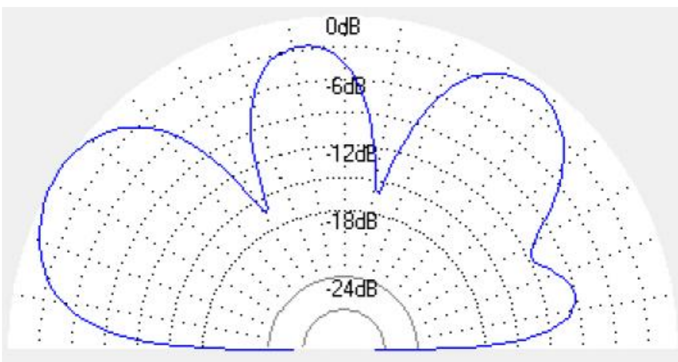

Figure 37

DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 17- Meter Band

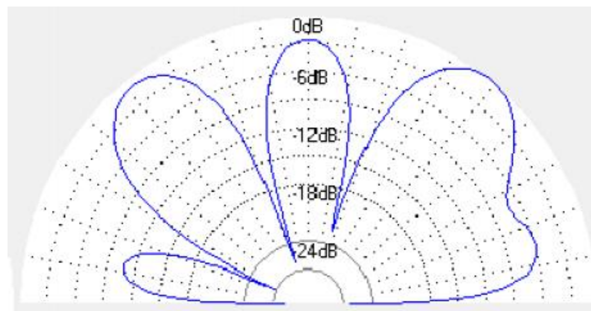

Figure 38

DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 15- Meter Band

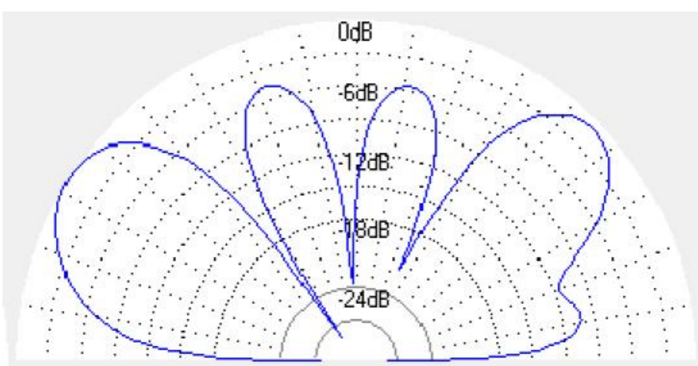

Figure 39

DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 12- Meter Band

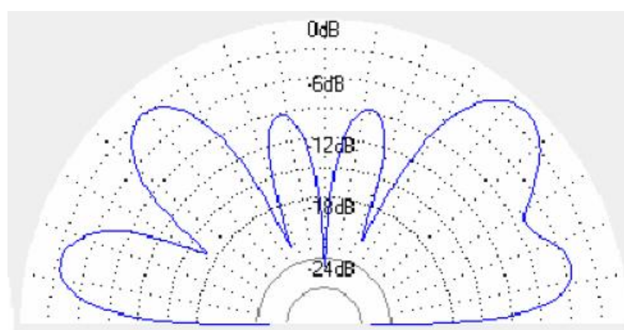

Figure 40

DD of theoretical Beverage Antenna with horizontal wire placed at height 4 meter above the ground at 10- Meter Band

In conclusion I decided to simulate Beverage Antenna that I used at my amateur station UA3ZNW- UZ3ZK- RK3ZK from 1990- to 2002 year in Belgorod, Russia. **Figure 41** shows the antenna. The antenna was installed on the parapet of the 9- storey building. Antenna length was 80 meters. The horizontal wire was located at height about 1- meter above the parapet. Antenna wire was stretched on several wooden masts placed near 5 meter from each other. I used the dry trunk from small trees. Transformer of the antenna was made according to **Figure 42**.

Transformer had 7 turns wound by tripled wire on ferrite ring from yoke from Color TV. I have no picture of the original transformer. However it looked like transformer shown on **Figure 43**. Transformer was placed inside a plastic bag for protection from the weather influences. Termination load of the antenna was made from 18- kOm /2- Wtt Russian resistors MLT- 2 (the resistors are still in sell on ebay) that were connected to bridge. The load had resistance 600- Ohm.

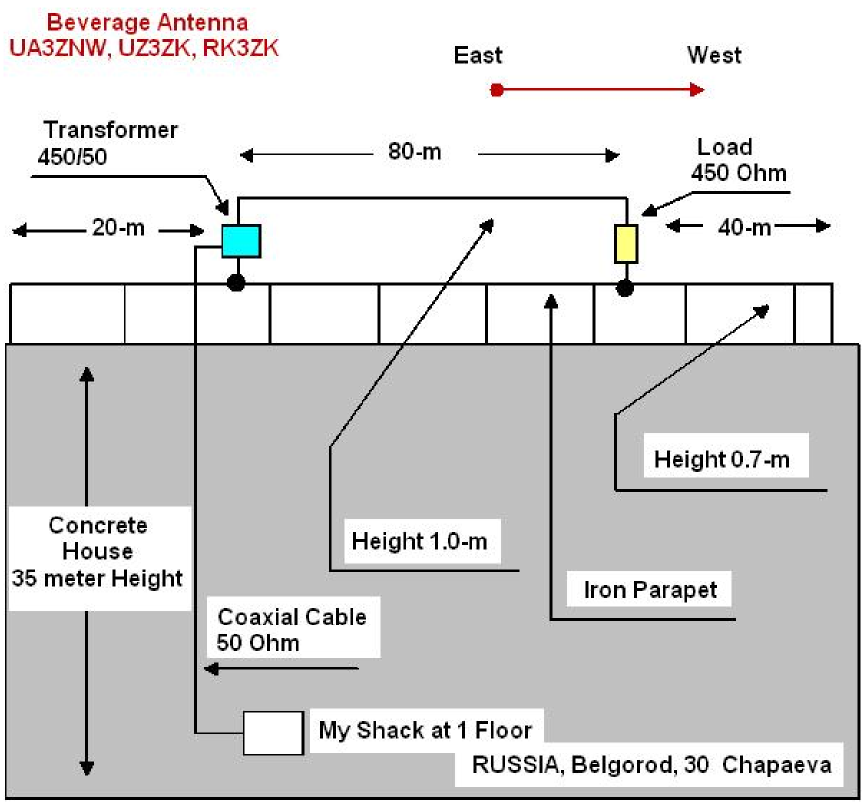

Figure 41

Beverage Antenna used at my amateur station UA3ZNW- UZ3ZK- RK3ZK from 1990- to 2002 year

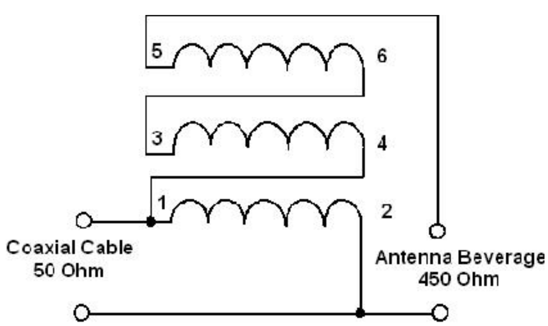

Figure 42

Transformer of the Beverage Antenna used at my amateur station UA3ZNW- UZ3ZK- RK3ZK from 1990- to 2002 year

Figure 43

Transformer 50/450 (75/600) wound by tripled wire on ferrite ring from TV yoke

Antenna for first several years was feed through 75- Ohm coaxial cable that was going along the building wall. Then I have removed this cable and have installed a new one (50- Ohm good coaxial cable) inside building in ventilation shaft. Termination load was reworked to 450- Ohm. SWR of the antenna was not more the 1.5: 1 at all bands with 75 and 50- Ohm coaxial cable. You may find on the **Figure 41** address of the building. It seems to me still it is possible to find remains of my antennas on the roof using Google Map…

Antenna worked great on all HF- Bands from 160 till 10- meter band. 160 and 80 meter bands at the antenna were good to communicate with Ham stations from Europe and Asia.

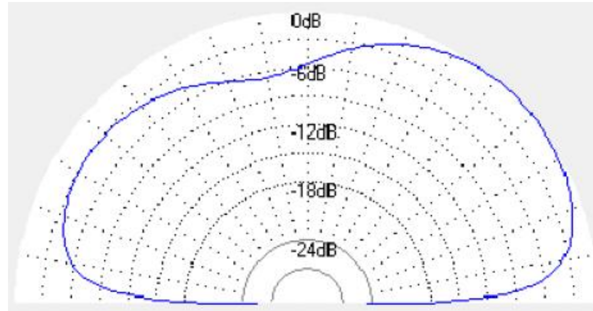

Figure 44
DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 160- Meter Band

Table 5

Data for Beverage Antenna (**Figure 41**) used at my amateur station UA3ZNW- UZ3ZK- RK3ZK from 1990- to 2002 year

Band	160	80	40	30	20	17	15	12	10
Z	589+15	502+275	645-308	703-152	437-j11	524-J202	507-99	361+21	435+67
SWR	1.3	1.79	1.95	1.68	1.04	1.55	1.27	1.25	1.17
Gain	-20.9	-10	-8.7	-4.3	-5.64	-2.5	-1.47	-0.9	0.6
At Vertical degree	43	25	24	25	18	17	14	13	12

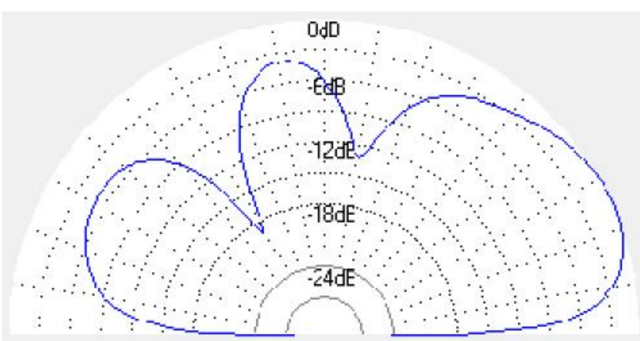

Figure 45
DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 80- Meter Band

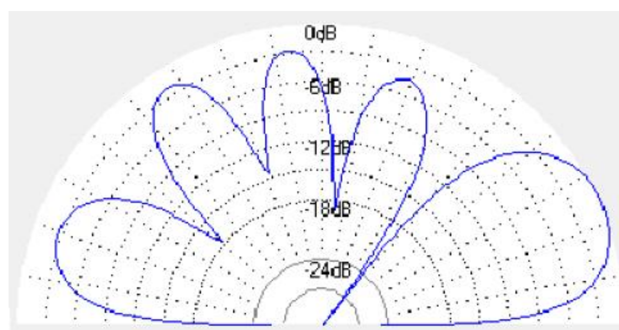

Figure 46
DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 40- Meter Band

North America and Japan propagated good above 40- meter Band. **Table 5** shows the data for the antenna. Maxima gain is given to the radiation angle at where it is. **Figure 44** to **Figure 52** show DD of the Beverage Antenna at the 160, 80, 40, 30, 20, 17, 15, 12 and 10- meter Bands in the vertical plane. Feedline with matching transformer is on the left side and the termination load is on the right side of the figures.

As you can see from **Figure 44** to **Figure 52** the Beverage Antenna has not so bad DD.

If you have possibility to install such antenna- do not hesitate. It is easy to install, easy to match, invisible and low noise antenna.

73! de VA3ZNW

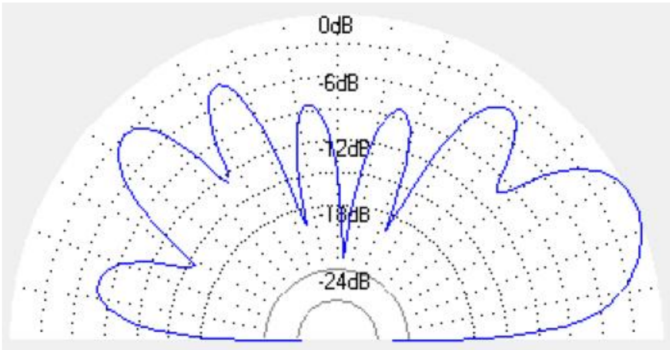

Figure 47

DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 30- Meter Band

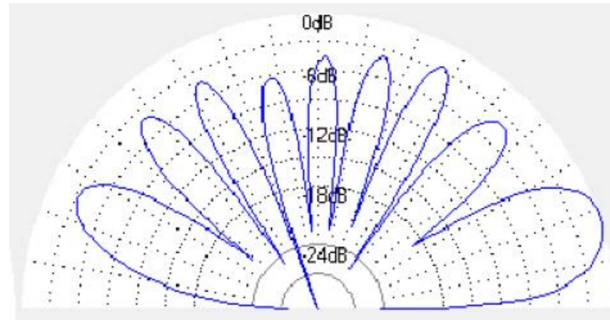

Figure 48

DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 20- Meter Band

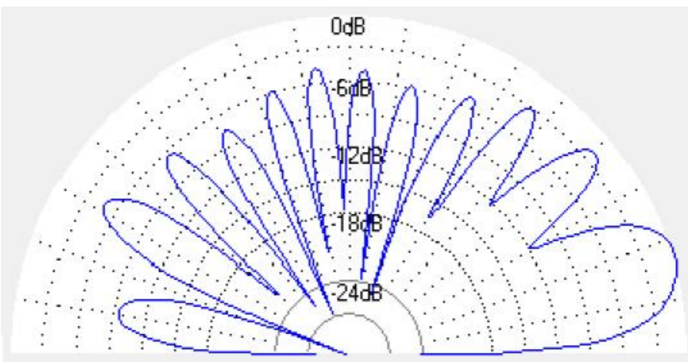

Figure 49

DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 17- Meter Band

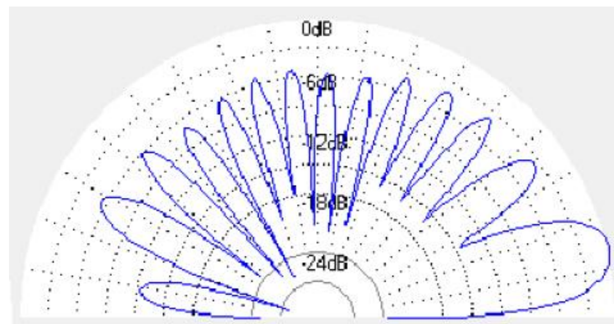

Figure 50

DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 15- Meter Band

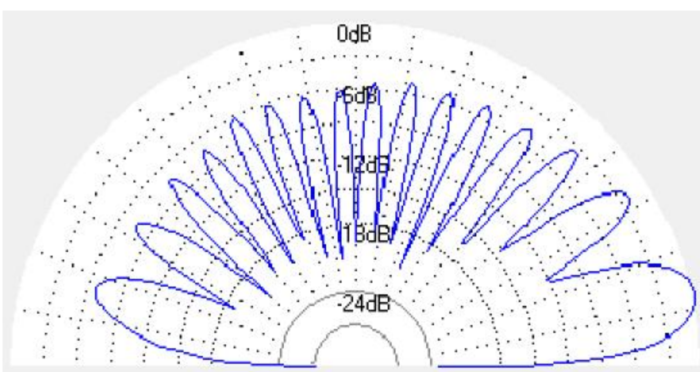

Figure 51

DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 12- Meter Band

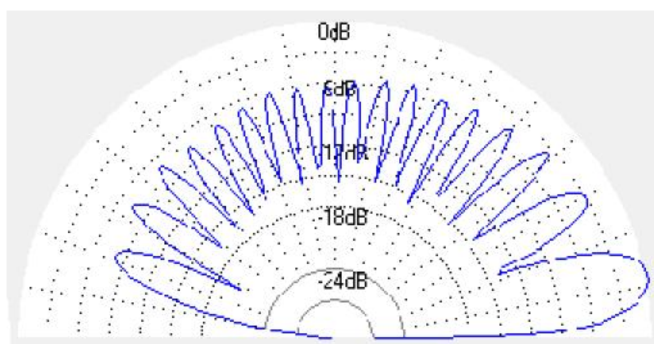

Figure 52

DD of Beverage Antenna of amateur station UA3ZNW- UZ3ZK- RK3ZK at 10- Meter Band