A SHORT TWO-WAY BEVERAGE ANTENNA PROJECT

By Phil Anderson, WØXI

I live in a suburban neighborhood and about two blocks from a shopping center. The city population is nearly 100,000. As such, you can imagine the reference noise level for AM and shortwave reception for each band of interest is not as quiet as a typical rural setting would be. My back yard is only 70 feet wide and 50 feet deep, thus reducing the selection of useable antennas. Furthermore, the city height limit for antennas in my neighborhood is 33 feet! My solutions so far to improve reception have been to install a 33 foot SteppIR vertical for 40 through 10 meters and a 40-meter dipole up 22 feet. One traditional way to reduce the noise level (floor) is to install a directional antenna. These reduce the signals received from the back side, including noise, while enabling desired signals in the forward direction with some gain. Yet, towers, rotors and a Yagi antenna are costly and perhaps disturbing for the neighbors. Hence I decided to try the age old Beverage antenna, invented in 1921 by Harold Beverage. The Beverage, like the modern Yagi, reduces signals from its back side while enhancing listening in the direction it's pointed. Results so far have been gratifying. I've made two-way CW contacts with radio amateurs in Europe and listened to US AM stations in the 8 to 10 MHz range.

Figure 1 depicts my first Beverage and supporting equipment. The antenna consists of the following: 70 feet of antenna wire strung out 8 feet above the ground from northeast to southwest (for contact with Europe from Kansas) supported by three 10 foot PVC Poles. On the northeast end, a 450 ohm terminating resistor is attached to a ground rod as noted. At the southwest end a 3-to-1 ferrite toroid UNUN step-down transformer is attached to the antenna at the top of the pole; its job is to match the 450 ohms of the traveling wave antenna to a length of 50 ohm coax going to my station. I've used this setup with my K3 Elecraft transceiver for amateur radio use, both two-way CW and AM listening. Next month I plan to try a step-up transformer into a crystal set for HF shortwave listening.

Figure 1: The Beverage and Supporting Transformer and Coax.

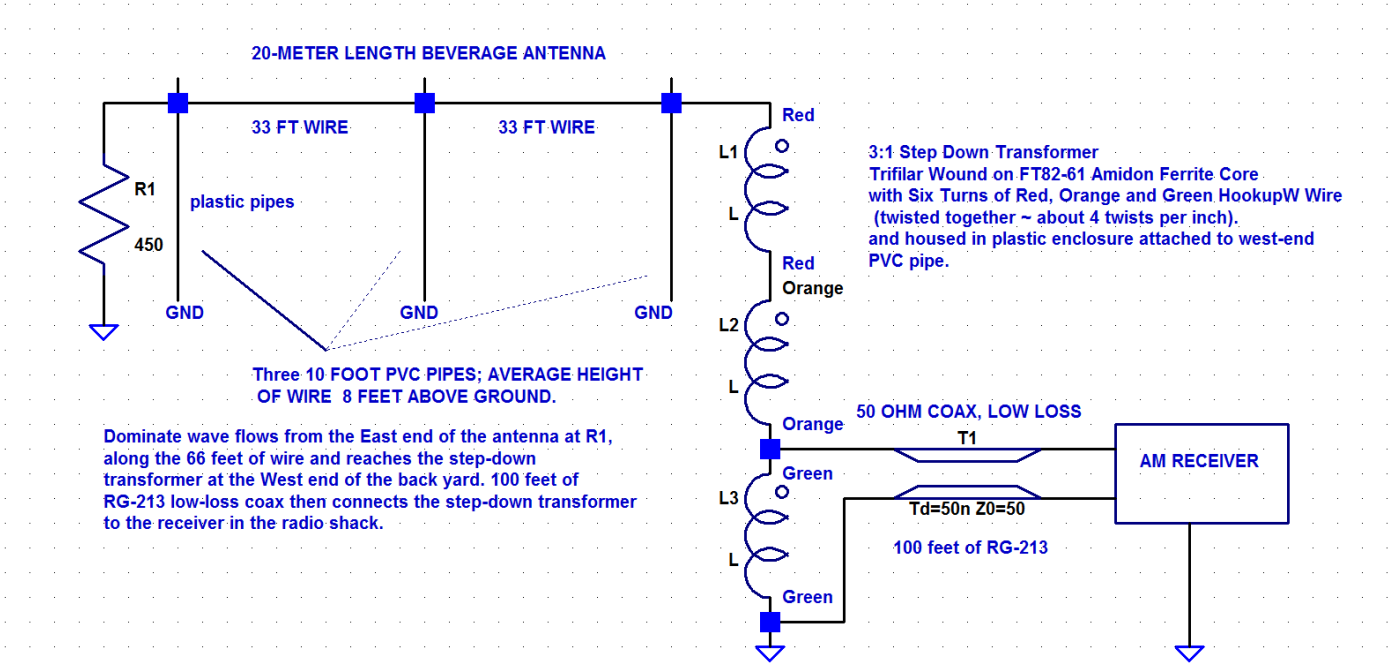


Figure 2 displays two of the Beverage antenna poles as situated just outside the screened in back porch.

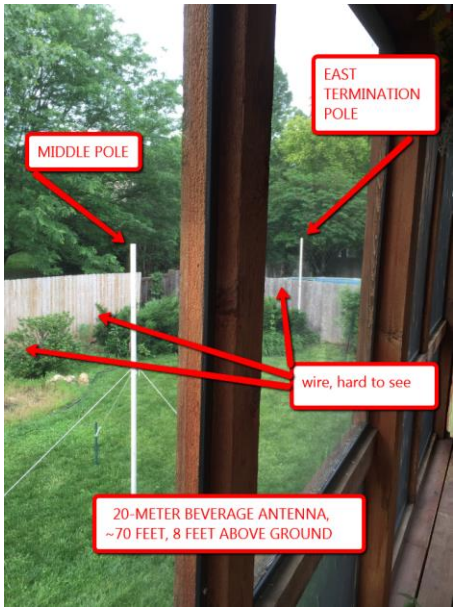


Figure 3 displays a frequency plot of an AM station received by my K3 Elecraft transmitter-receiver and P3 Panadapter at 9980 kHz via the Beverage antenna. Panadapters convert a portion of the radio spectrum received into a frequency display using an internal digital signal processor (DSP). Note that the bandwidth of the AM station shown in the figure is 10 kHz wide, as expected, in the frequency display at the top. The bottom half of the figure displays the waterfall, showing the 10 kHz signal amplitude over a short period of time.

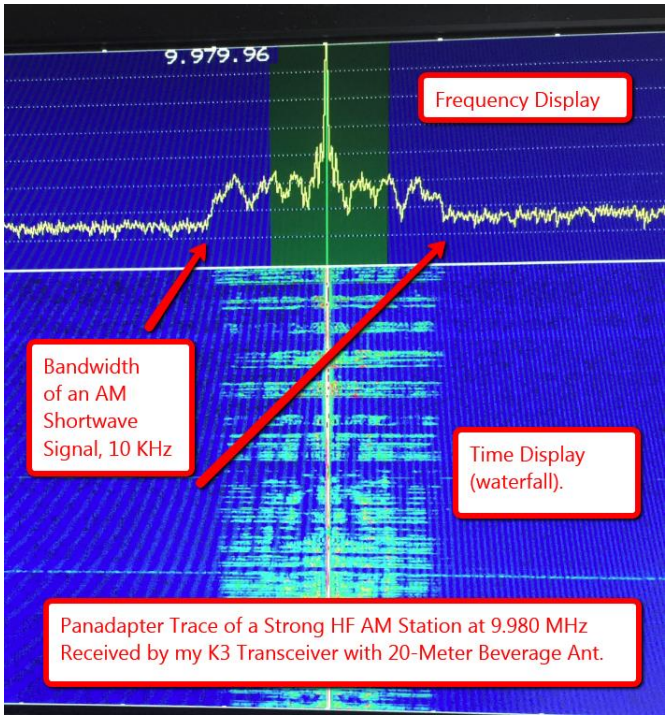
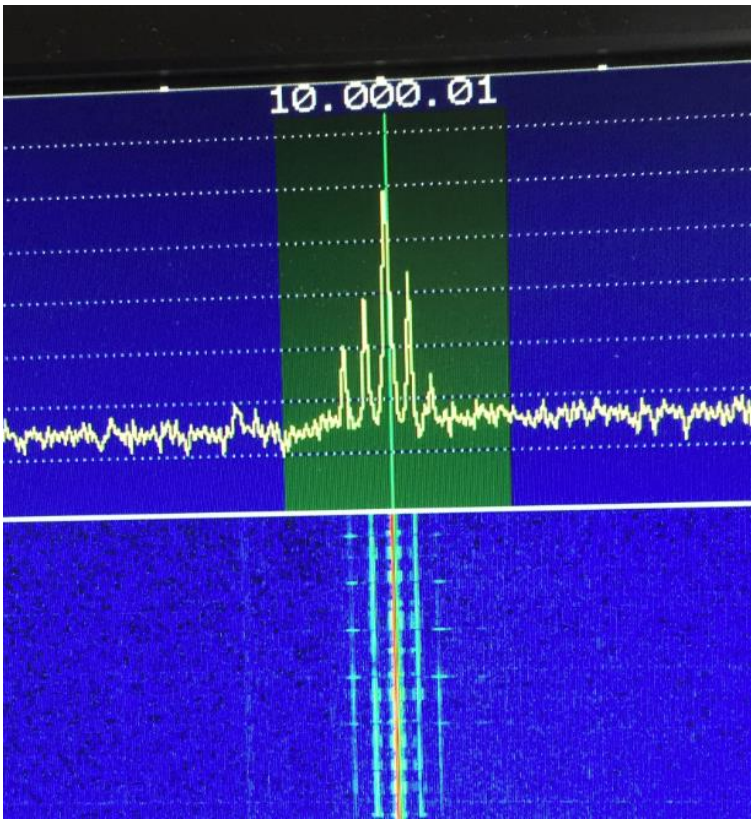


Figure 4 displays the Panadapter processed signal of WWV at 10 MHz. The carrier and sidebands represent the tones sent before the usual period of clicking that follows.



Results of my noise reduction efforts so far using the Beverage versus the Vertical antenna are noted in Table 1. While the results vary a bit given the time of day and from day to day, the results listed have been consistent. The only band that does not see at least an S unit and a half of background noise reduction is 15 meters. This is due, in part, to the natural reduction in cosmic and storm noise with increase in the frequency of reception. There is just less noise as one tunes the higher HF bands. The one anomaly is the fall off in improvement on 40 meters (7020 kHz). This is due in part to the length of the Beverage, only 70 feet, compared to the wavelength of the frequency in use. In addition, I designed the step-down ferrite toroid transformer for 20 meters, indicating that a few more turns or a different ferrite material for 40 meters might be helpful.

Table 1

FREQ in (kHz)	BAND	Noise Level via P3 for Beverage (dBM)	Noise Level via P3 for Vertical (dBm)	P3 Difference Beverage minus Vertical (dBm)	Equivalent Reduction in S Units	Wavelength % of Beverage Length
21020	15	-132	-125	-7	-1.16	133
18077	17	-132	-123	-9	-1.50	117
14040	20	-119	-109	-10	-1.66	100
10120	30	-127	-111	-16	-2.66	67
7020	40	-117	-103	-14	-2.33	50

Recall that S9 is at -73 dBm, S1 is at -121 dBm and S units are spaced 6 dBm apart up to S9.

Finally, I checked the standing wave ratio (SWR) of the Beverage for the bands and specific signals listed in Table 2. Note that the SWR is below 2 to 1 for all bands except 80 and 160. This confirms that the UNUN transformer and 450 ohm resistive load match the 8 foot up/ 70 foot long Beverage well.

Table 2

Frequency {MHz}	Band {Meters}	SWR, Measured (with Autek VA1) antenna analyzer
1.800	160	4.40
3.500	80	2.56
5.000	WWV	1.82
7.000	40	1.54
7.050	40	1.49
10.000	WWV	1.54
10.100	30	1.44
14.000	20	1.20
14.050	20	1.18
15.000	WWV	1.20
18.068	17	1.18
21.000	15	1.45

My first two-way HF Beverage contact was on 20 meter CW, 6/2/2015, with Gary, VE2GDI, in Quebec, Canada. He sent me a 57N signal report and I returned with a 55N. The noise level reported in my P3 Panadapter attached to the K3 (Elecraft) was 8 to 9 dBm below that obtain with my SteppIR vertical, as expected, given the directionality of the Beverage. The P3 reported noise level for the vertical was -105 dBm and for the Beverage varied between -112 and -115 dBm, nearly two S units down! My second Beverage two-way contact was with YN5SU on 17 meter CW, at 5 PM, 6/4/2015. He gave me a 55N. My output power was 10 watts into the Beverage.

What's next? My plans at this time are to rework the 450 ohm terminating resistor for 100 watt operation, and also rework the 3-to-1 ferrite transformer for 100 watts if necessary. I've been limiting CW transmission to 10 watts until I can complete that rework. I also plan to do further testing on using the Beverage as a second receive antenna in diversity reception mode. Initial attempts have been successful, transmitting on the SteppIR vertical at 100 watts and listening in my left headphone to the transmit antenna for side tone and receiving and in my right headphone to the Beverage fed via the second receiver in the Elecraft K3.

References:

Receiving Wave Antennas, Page 13-16, Chapter 13, The ARRL Antenna Book, 20th Edition, 2003-2005.

http://www.qsl.net/aa3px/beverage.htm. Google the web for the many articles about Harold Beverage and current work on Beverages by radio amateurs.

Electro-Magnetics, John Kraus, McGraw Hill, page 477. 1953. An Engineering text.

Antennas, John Kraus, McGraw Hill, pages 149, 412, 1950. An Engineering text.

Notes:

The Beverage antenna is often referred to as a traveling wave antenna. It was popular in the early days, circa 1920, and more recently on 160 meters by licensed radio amateurs.