A Tree as an Antenna

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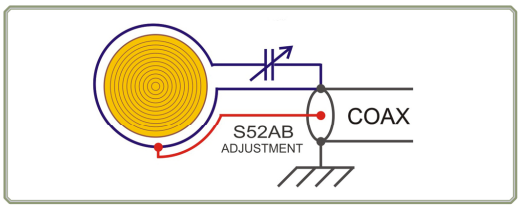
Idea of using a tree as an antenna of course is not new. It has been discussed by American officer G. O. Squier who was discussing that living creatures like plants or animals can be used as an antenna. This was proven with a successful experiment. Results of course could not be compared with usual antennae but a short range contact was possible.

More emphasis to this was given in the 1969, when extensive research was done. How to connect a tree as antenna can be found on the web by mainly two ways: gamma match and toroidal match. In the research published in the 1972 a device to transfer HF energy to a tree is named HEMAC toroid (Hybride ElectroMagnetic Antenna Coupler). That is a special coil wound around the tree which requires a special matching part, same as gamma match requires it. Gamma match requires nailing deep into the tree's core where all the juices of tree are flowing. There are many records on the web regarding experiments with this type of antenna, performed with one or another way of matching.

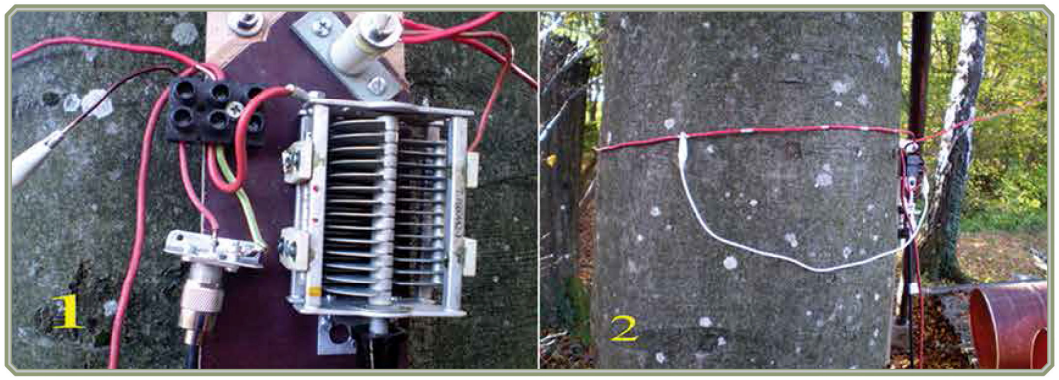
I was getting prepared quite some time to test tree as an antenna. So I had to decide between two known ways of matching: gamma or toroidal matching with a coil. Gamma match was abandoned immediately because of need for drilling/screwing into the tree. I did not want to torture a living creature although a single element one. What remained was inductive coupling to the tree. As shown on images of already made tests I have started with toroidal coupling by tuning LC at the tree to nearest frequency possible with that coil made of 10mm2 wire wound around the tree and 110 pF capacitor.



Skimmer	Vertical 12m	Tree Antenna
WZ7I	11, 12	4, 6, 7
W1NT	13	3
VE2WU	12, 35	8, 12, 9
EI9KF	13, 9,	3, 3
GI4DOH	24, 12, 12	8, 11, 6
EA5WU	24, 31, 28	19, 13, 15
SM6FMB	38, 33, 33	20, 22, 23
SE5E	31, 28, 27	19, 20, 19
SJ2W	19, 18, 31	11, 13, 13
SE0X	27, 32, 28	15, 15, 18
SK3W	36, 41, 42	33, 24, 24
3V/KF5EYY	22, 22, 21	27, 36
G0LUJ	17, 18	6, 11, 4
GW3IZR	25, 25	14, 13, 15
F5IIT	33, 32, 32	17, 13, 20
ES5PC	42, 37, 42	24, 28, 27
ES4O	18	6, 5
ES4O	18, 21	6, 4
M0ORD	16	5, 3
R6YY	16, 17, 17	11, 8, 7
SV1CDN	15, 19, 16	8, 8, 7
SV8RV	27, 27	7, 8, 5
UD4FD	25, 26, 26	18, 14, 14
DJ9IE	15, 14	12, 11
TF3Y	6, 12, 7	4, 8, 3

Table 1 RBN on 14MHz

With randomly wound coil around the tree and given capacitor I could adjust resonance to 40 m band. Resonance was determined with grid-dip meter. Actual dip with this coil wound around the tree was poorly visible. While discussing that with Albert S57UW who has been involved into antenna experiments many years ago we came to conclusion to test a coil wound around the tree i.e. the tree would be inside the strongest magnetic field and this was in latter experiments done.



Matching part construction

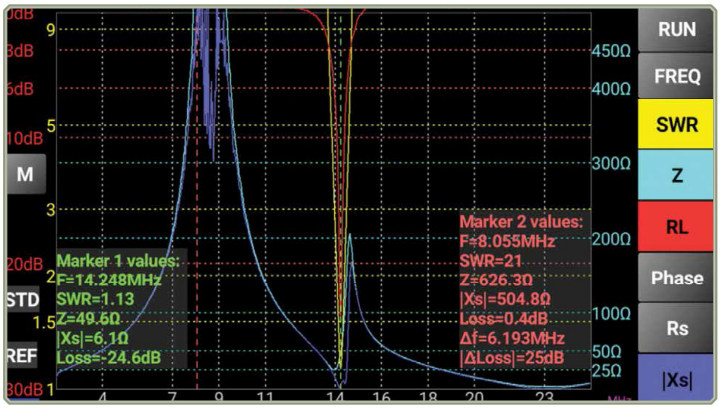
The tree itself has radius of 40 cm (beech 10m tall, on Image 4, utmost right tree in the middle of the photo). I have very shallowly drilled 2 holes for hanger screws that hold plate with: capacitor, insulator of "hot part" of the coil, plug-in terminal block, gamma match connection, coax cable and grounding that connects to the root system (Image 2). Coax cable goes to inductive coil on the tree and runs to the radio placed to the ground through entire length. In the roots around the tree I have shallowly drilled 10 holes for hanger screws M6 and M8 and connect them with a wire. Because the tree is too small for higher frequencies (3.5 in 7 MHz) I have decided to continue experiments on 14 MHz band.

Realization of gamma matching

To obtain resonance on 14 MHz band we need inductance of 2 microH and capacitance of 60 pF. Toroidal version of inductance is not possible under physical rules at given tree diameter. Only one wound around the tree is sufficient to obtain required inductance. Inductive coupling is attached to the tree at the height of 1.3 m from the ground i.e. from root system. On Image 1 you can see how elements are connected. LC circuit tuning should follow this procedure:

- *wrap a wire around the tree, begining of the wire is "cold spot", which should be wired to plug-in terminal, the other "hot spot" of the coil should be connected to insulator;*
- *to hot and cold coil terminals a capacitor is connected. Wire that connects "cold spot" of the coil to roots and coax should not be connected yet;*
- *with capacitor (which has large spacing between plates) and grid-dip meter set desired frequency. The dip in this version is very deep and visible;*

now connect the wire that goes from root system and connects coax cable with gamma match wire that is on the "cold spot" of the coil which is aprox. ¼ of the circumference and it does not change LC resonant frequency. Gamma match should be adjusted so that the most suitable 50 Ohms matching is achieved or lowest SWR is obtained. Of course it's nice to have antenna analyzer for that task. Diagram of properly tuned antenna can be seen on the Image 3 (tnx. to Jure, S52CQ). Although all is done rather quick, the tuned parameters are very good and are over all expectations. (SWR 1:1.3; Z=49.6 Ω; R1(Loss)=-24,6dB)



Performance test

First very short performance test – as mentioned earlier, was done on 7 MHz. For control I was using Reverse Beacon Network (RBN). After few short calls on 7 MHz and 50 W output power following skimmer receivers have received my call: LZ7AA-5dB/ DO4DXA-10dB/DJ2BC-10dB/ OL7M-8dB/ DJ9IE-5dB/ HA6PX-11dB/ OE6TZE-2dB/ DL3KR-6dB/ HA2KSD-16 snr dB. Main and longer experiment was however made on 14 MHz. Tests were done with different output powers starting from 1W to up to 50W. Interesting skimmers received the signal with 1 (one) Wat: HA6PX-11,19/ OH6BG-7/EA5WU-6, 14/ DJ9IE-4, 16/ SM6FMB-6, 19,10/ SE0X-7/ SK3W-20/ OH8WW-4 SNR dB. All were receiving my signal at HF propagation marked as FAIR at this frequency. I have done a couple of QSOs with power higher than 50W. With respect to conditions at the time of testing QSOs were done across Europe and Middle East with very good reports for this antenna. A comparison was done also with 12m high vertical all band antenna that is loaded through 1:4 transformer. Results are stated in the Table 1. HF propagations at that time for 14 MHz were rated as Fair.

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Final conclusions

- This kind of antenna is interesting for all that love experimenting. You should not expect too much of it. This is not an antenna for contesters and high demanding operators, for "pile-ups" etc. Personally I think that it could be usable in new digital QSOs, like FT8 and similar. By all means it's an emergency solution for all that have nearby a person that does not tolerate any kind of antenna erecting. If a suitable tree is close to your building a "bird house" can be put to that tree. In that "bird house" coupling devices could be nicely hidden and as such that bird house would not be disturbing to anyone.

- Tree as an antenna coupled to 14 MHz as described is surprisingly quiet RX antenna worth of trying only as an RX antenna. Let me state that trees have been used as RX antennae already in 1904 in the East coast of the USA when receiving signals from France, England, Germany and Italy. At that time they have used the most advanced devices.

- In a same way I have tried to couple a copper gutter and lightning protection network. This test was brief just to confirm that it works well on all metal objects that we have around us. RNB reports have confirmed my assumptions that coupled gutter or with it connected lightning protection network move 1mA field meter already at 20W of output power. This however is not desired at those of us who care about own health.

- As stated earlier feeding coax runs on the surface and hence most of the cable radiation is excluded.

- How such an antenna will perform on other locations no one can tell. This article is an experiment conducted on my location and by any means does not assure same results elsewhere. We have got to put into account also the fact the

vegetational state of the tree in this time of the year (end of October or November). Tree is in the state of sleeping and it all may be different if experiment was conducted during Spring or Summer.

Special thanks: Jure S52CQ,, Albert S57UW, Roman S52AS, Sinisa S52ST

References:

• George Squier, Tree Antennas
• Performance of Trees as Radio Antennas in Tropical
Jungle Forests (Panama Canal zone experiments) February 1972
• A Tree Antenna for the 600 Meter Band – the Ham Shack of W5JGV
• The »Tree Antenna« - W7AIA
• eHam.net (ham