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HOW TO BUILD AND TUNE YOUR EH HAM ANTENNA

Note: This document was written by Stefano and applies to the type of network he uses on the factory antennas, a double L network.

Hi everyone !!!
I'm Stefano (Steve) Galastri - IK5IIR from Florence, Italy.

Background information:

My story, as far as antennas are concerned, started four years ago when I began experimenting with the CFA (crossed field antenna).For those whom have never heard about the CFA, this antenna was designed towards the end of the eighties, and later on patented, by Dr. Kabbary and Mr. Hately. Ted wrote a series of articles on this antenna thus introducing to the world a completely new concept, basically different from Hertz's antenna. The CFA core is the generation of the E and H fields separately, then combining them in order to satisfy Poynting's theorem. Hertz's dipole also create radiation, but the E and H fields are generated in a different manner. Some time later I gained great results and, finally, I got the same efficiency (+- 2db) compared to the dipole. I carried out many tests, radio contacts and measurements which confirmed this.

Some time in 1999 TED Hart (W5QJR) asked me if I was interested in collaborating with him in the development of the Ham version of the EH antenna. I accepted with great enthusiasm and now I can say that the development is complete with fantastic results. This new concept of antenna will be a real revolution in the world of antennas. Unlike the CFA, the EH Antenna develops the E and H fields simultaneously between two elements. This allows the E and H fields to be integrated very efficiently to produce radiation in accordance with the Poynting theorem. This allows outstanding performance greater than a Hertz antenna, but only requires an antenna size that is less than 2% of a wavelength. The antenna can be even smaller, but the instantaneous bandwidth decreases as size is decreased.

This document is dedicated to all those Hams who would like to build their own EH antenna and be fully satisfied with it. It uses a double L network. The capacitors in this network have lower values than the L+T network, thus a Ham can build his own capacitors. The end result is that the performance of the antenna is the same as ones built with the other network.

Ted Hart has appointed Marco Menozzi (IZ5EEP) and I as the licensees for the production and the distribution in Europe of the EH Ham Antenna. The antenna is under a registered patent and its production and distribution for commercial use is not allowed, but we warmly suggest you build your EH Antenna for your **PERSONAL USE**. If you prefer to buy rather than build, Ted is allowing us to ship antennas any where in the world until other factories are in production in your area.

We introduced the EH Ham Antenna for the very first time worldwide on 8th and 9th September 2001 during the Ham Fair in Piacenza, Italy. We continuously take part in Ham Fairs and conferences. You can contact our office to have the schedule of the ones we shall be attending in the near future.

Practical construction:

The typical version we suggest you begin with is the 7 MHz band. It's a good compromise between the diameter of the pipe, big enough to make to allow easy construction and small enough to allow building it on a small table inside the Ham shack. If you prefer a Ham band other than 40 meters, this information applies to all Ham bands.

What you need to start with ….

1) a PVC pipe (the type you normally use to drain water with) with a 4 inch diameter and more or less 3 feet length (the commercial version of the antenna is made with fiberglass pipe for strength).

2) some 0,004 inch (or thicker) foil in copper, aluminum or brass (it's not critical). To prove the concept to your self with minimum cost, we suggest you use aluminum foil from the wife's kitchen.
3) 12AWG normal house power wiring electric isolated copper wire
4) two 50pF max air variable capacitors. 0,04 inch minimum spacing for 100 Watts. Since V=(PR)^.5, The voltage is reduced for lower power. For QRP operation the smallest trimmer capacitors can be used.

NOTE:
In order to make an antenna for frequencies from 7 Mhz down, the best length / diameter cylinder ratio is 1.5 : 1.
For frequencies from 10 Mhz up, the right ratio is 3.14:1.
I.E.: 7 Mhz EH Antenna ..... 4" X 1,5 = 6" is the length of each cylinder.

The pattern of the EH antenna changes according to the above ratios. For frequencies above 10 MHz it is necessary to only have a lower vertical radiation pattern, which is excellent for DX, thus the cylinder length is increased. Unless your primary interest on the low bands is DX, a shorter cylinder will permit non-directional local rag chewing with the antenna mounted vertical. On the other hand, if using the 1.5:1 ratio, the antenna impedance will increase and consequently cause more voltage on the capacitors. So, keep this in mind!!! A 0.04" spacing between cap plates is very precise when using 100 Watts, so, if power is increased, we suggest to increase the spacing from 0,04" to 0,02" and 0,01".
For the 7 MHz down use a 1.5 : 1 ratio with a bigger space between the caps. A 7 MHz EH with a 3.14 : 1 ratio of about 63 Pf ... will be more or less 30 Pfd with a 1.5 : 1 ratio. Consequently the two coils with a 1.5:1 ratio MUST have more turns (bigger impedance).

THE 7 MHz EH PROCEDURE

Install the two cylinders on the pipe with the following measurements:
length = diameter X 1.5 = 4" X 1.5 = 6" each
distance between cylinders = diameter = 4"

That's it .... The antenna is ready ..... Not bad at all ..... !!!

Important suggestions for the network:
The wire that feeds the top cylinder MUST travel near the center of the pipe.
The wire that feeds the bottom cylinder MUST travel close to the cylinder wall.

The wire that connects the top cylinder MUST be connected to its lower edge.
The wire that connects the bottom cylinder MUST be connected to its upper edge and positioned at 180 degrees from the connection of the other cylinder. Practically, the feeding point of the two cylinders is in the center of the antenna, just like any dipole.

When I say EDGE, I really mean the edge ..... I normally drill a hole between the PVC and the copper. Then, while soldering, you bend the wire in order to get it to stay on the edge. You can remove the excess wire with a file.

For the two wires traveling inside the pipe, I use hard drawn copper wire. It's easier to keep them in their exact position (by bending them etc).

ADD TWO SMALL COILS
We have decided to add two small coils made from two turns each in series with the cylinders. From now on we will refer to these small coils as Isolation Coils. When radiation is developed in the two cylinders, the wires that internally carry the R.F. energy from the network INTERNALLY irradiate everything (pipe, network and so on). This causes some losses. Hence, wind two turns per coil on the pipe near the edge of each cylinder. Technically, the main purpose in adding the two isolating coils is to gain some delay on the R.F. current feeding the cylinders. By doing this you will have the right phase only on the cylinders. The above two coils will turn out to be in SERIES with the wires that travel from the network to the cylinders themselves. The spacing between the two isolation coils and the cylinders is not critical (0,01 / 0,02 inches). So, the general layout of the EH Antenna will be:

top cylinder
2 turn isolation coil
space
2 turn isolating coil
bottom cylinder
L2
C2
C1
L1
Coax

The space between the cylinders MUST remain equal to the diameter. The distance between L2 and the bottom cylinder edge is about 2 inches (it's not critical). The two isolation coils can be wound inside or outside the pipe.

NETWORK Adjustment:
I warmly suggest you use air variable capacitors to start with. Then, you can use the handmade type that we have developed (refer to photo), but only AFTER.... at the beginning you need to make practice .....

THIS IS VERY IMPORTANT !!!!!
Many Hams tried making the handmade capacitors straight from the beginning and just couldn't get them working .... so, what we recommend is to start in the easiest way, gain experience and finally build your "nice" EH .... practically you'll have a prototype and a final version .....

Wind 13 close spaced turns for L2 and 12 close spaced turns for L1. Leave about 6 inches between the two ... it's not critical .... we usually wind ALL the coils in the same manner (CW or CCW). Note:It's important you maintain at least one turn difference between L1 and L2. (L2 is always the biggest).

Assemble the caps the best way you can ..... I normally use a hot glue gun, also to fix the turns. ... it' s just a prototype .... The nice one will come next .....

I must insist in you using normal power electric wire for the coils. You can use the enameled copper wire later on when you will have gained the necessary practice. So, you'll have both the coils with at least one turn more than the other ..... OKAY ???The distance between the turns must not be less than 6 inches .... OKAY ??? The distance between the coils influences the bandwidth (less distance = less BW). We have worked a great lot to make this very important procedure easy and reproducible. Many of you ask me the value of the inductance ..... YOU DON'T NEED IT!!!

Tuning:
This is what you do: Connect a portable battery operated R.F. generator (better if one with a metal chassis) to the connector of your EH antenna WITHOUT any coax... (!!!) If you do not have one of these generators, then use the Ham rig set on minimum power. First, adjust the capacitors for maximum radiation as indicated by a diode type field strength meter. Then, with higher power, adjust for minimum VSWR.

If you do not have a low power RF generator, it doesn't matter ... you can use the TX It's important that you use LOW power for the tuning and that you keep the antenna far from the TX (even better if the antenna is outside).
Please connect A SWR meter directely on the antenna's connector. (no coax in between) Then allow the line to reach the rtx.Then simply follow the hereunder instructions looking at the SWR meter readings.

... Hints and Kinks ...
In order to have a stable reading on the generator, hold it in your left hand and turn the F knob with your right hand ..... This may seem a beginner's work or a wrong way of operating, but you can be sure that there's a reason .... By operating like this you will be sure that once you connect the coax cable, the tuning will remain stable and the 1:1 VSWR will be maintained.

Another note is that to supply the R.F. generator with internal batteries as the power cables and / or lines potentially connected to the ground may influence the circuit and might shift the tuning while connecting the coax to "feed" your EH antenna. There are other generators that have a plastic chassis, but we have experienced that they are no good

... after 120 years, we thought it was time for a change …

EH antenna systems

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for the tuning of the EH antenna, because of the strong close field generated by the antenna. The plastic chassis causes differences between the tuning obtained and the effective tuning of the antenna.

Tune the generator on about 7 MHz (during this phase, the exact operative frequency tuning is not important) and look for the dip of the SWR. Now adjust C1 and C2 with very small variations so to obtain a 1:1 VSWR. (IT'S NOT IMPORTANT what the value of the caps is or the working frequency at this stage, the important thing is to obtain a 1:1 VSWR). At this point you can carefully adjust C1 and C2 to tune the antenna to the desired operating frequency.

NOTE:
In order to compensate the shifting of the frequency, due to the capacitive coupling of the antenna towards the ground (just like all antennas normally do), we suggest you to tune the antenna higher in frequency.

These operations may seem long and difficult at the beginning, but experience will make them easier to do as you get on.

During all tuning operations, you MUST keep an eye on a Field Strength Meter nearby. The FSM must be located so that its antenna is at the height of THE CENTRAL AREA OF THE TWO CYLINDERS, because that's where the maximum radiation comes out from.

Try to obtain 1:1 VSWR with the max signal on the FSM.
Check the BW at 2:1 SWR range and write it down on a piece of paper.
TAKE OFF one turn from each coil and start from the beginning. (always keep a turn of difference).
IT'S IMPORTANT to remove and reweld the turn in excess. Taps on the coils are not allowed.
Once you have found the max signal on your FSM (never move it from the initial position) you will ALSO obtain the max BW and the max efficiency. …..
Now you're sure that the network is right. (The coils will have to be 12 or 11, 10 turns).
NOW you can connect the coax line.

VERY IMPORTANT: once the line is connected, by varying the frequency, look for the point where you have a 1:1 SWR. Read the frequency: if it's too low or too high to the desired value, take note of the difference between the tuning value and the one obtained. You must reconnect the generator and retouch the tuning by correcting the tuning itself in plus or minus the "delta" value previously pointed out. However, IF YOU DON'T obtain 1:1, then YOU MUST retune the antenna. It's important that you get a 1:1 VSWR WITH the line connected by using the very low power generator. If the antenna is supplied with 1 or more Watts, it could be impossible to obtain a 1:1 SWR. In this case, it's not a mismatch of the antenna, but it's the strong close field that is influencing the measurement. You can read more about this further on.

Note …… in order to not influence the antenna, by falsifying the tuning, the FSM must be put at a minimum distance that is equal to the length of one of the cylinders.
Keep in mind that this is NOT a Hertz antenna, everything here is completely new ….

The logic of the tuning is the following:
I.E.
If the inductance of L1 is reduced, then the value of C1 will increase …….
If the capacity of C1 is increased …. then the capacity of C2 will reduce
or
If the inductance of L2 is reduced …… then the value of C2 will increase …..
If the capacity of C2 increases …. then C1 decreases.
Always keep at least one turn in difference between L1 and L2 (L2 is more than L1)

The final maximum target would be that to adjust the two coils, so that the two caps have the same value +- 3 Pf.
In this way the network can be considered well balanced and the antenna will be at its maximum performance. Any effect of the strong field on the RTX station will be minimized.

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Considerations about the Antenna coupling with the line:
This Antenna behaves in a different manner. Listen to me: since the energy produced is the same or more than that produced by a full-size dipole (both antennas have the same efficiency), you will have a concentration of the radiated field nearby the antenna itself. We are generating a 131.23 foot wave with a 15.75 inch long antenna .....
So, what happens? Waves expand through the medium at a certain distance from the antenna, so, the wave will have regained its natural dimension. Practically, it's squeezes out from the ideal sphere of the antenna, the field around the antenna is very strong, much more than the dipole which has a bigger natural surface. So, what you talk about with this new antenna, is a front wave. The external part of the coax shield is "invested" by this strong field. Such may cause a part of RF to reach the RTX and generate an increase of the SWR or RF burnings.

This reason why we suggest you a few things to always keep in mind:

a) One of the main things to do is to keep the cable parallel to the pole for its whole length and avoid the coax "to fly" around.
b) The ideal is to keep the antenna above the RTX station and not beside it, and if that is not feasible, you MUST have a good RF GROUND on the RTX station.
d) If you don't have the ground, you can insert an LC series resonant circuit plus a piece of wire connected to the ground of the RTX. This circuit must be tuned at the maximum RF current at the wanted frequency. Now you have a VIRTUAL RF GROUND that will avoid any increase of the SWR.
e) In case of field day operations, you must allow the line to run over the earth, grass or whatever for at least about 15 feet. Because of the capacity between the external coax shield and the ground, the strong RF field coupled on the line will be discharged to ground.

Once again, if you have the possibility of putting the antenna at least 3 or 4 meters above the station there will be no problem at all.

We confirm that the line does not radiate. We can guarantee you one hundred per cent that the line has nothing to do with the EH Antenna's performance. All you have to do is change the length of your coax to realize that the performance DOES NOT change. You can even insert a choke or a balun on the line and nothing will happen, just remember that if you try this you might get a phase shift in your tuning, so you may have to retune your antenna. You can even use a 1-meter coax cable (in 40 meters band) and you'll see that the antenna's performance doesn't change.

For the reasons above mentioned, we suggest you to NOT operate with the antenna too near to you.
As a matter of fact, it's so small that you'll want to keep it on your bedside table ..... the great thing is that it works well even there !!!! .... obviously with an attenuation in the performance ... after all, all antennas should be kept well free on the air and an EH Antenna, at least in this case, is not an exception to that rule.

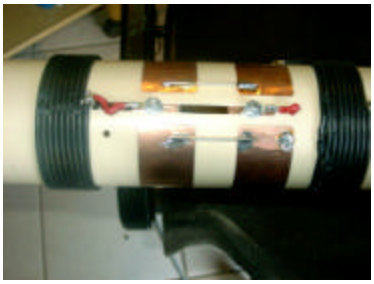
The polarization:
We want to be clear, precise and honest, so we can't leave one of the fundamental aspects out ....
The polarization is important: the EH standard antenna (with a 3.14:1 ratio) has a gain if compared to the dipole, but entirely developed on 360°. The EH standard antenna has a very SQUASHED shaped radiation lobe, this is the reason why the positioning of your EH is very important and it also helps to understand the reasons why you can see changes if compared to the dipoles, the long wires and other antennas. We suggest to mount it in a vertical position.
The EH Antenna radiation diagram is optimized to have an excellent efficiency in local and DX signals for the respective using frequencies according to the ratio to use.
These are the two features that you should experiment at the end:

1) pattern-directivity (by tipping the pole from 30 to 60 degrees) Included antennas from 10 MHz up (3.14:1 ratio).
2) very low reception noise
3) high efficiency

If that's what you get, you've built your EH Antenna perfectly!!!
Contact us for any doubt or whatsoever we'll be glad to help you.
Let us know how you're getting on with your experiments.

Sincere 73's Stefano Galastri IK5IIR stefano@eheuroantenna.com

That's me with a 40 meter – 3.14:1 ratio (old ratio not to use for the 7)
The two isolation coils are hidden . They are placed inside the pipe.



Attention!!!!
This is an idea on how to build the caps. The present configuration IS NOT LIKE the above photo. Once again we recommend you to use the air variable capacitors. OK???

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