W3HH - T2FD

Article published in Radio-REF of January 2003)
In January 2002, F5HUP described an antenna of the "W3HH" type which he named "Folded dipole".
In April 2002, F6AEM criticized this article and gave a very severe opinion on this type antenna.
At the first reading, I "a priori" agreed with F6AEM, to then issue some reservations about his radicalism. So I decided to investigate the problem
Obviously, the title "Folded dipole" is not appropriate. It is to confuse the whole with one of its parts. If the W3HH can be classified among the folded dipoles, its behavior differs noticeably deviates due to load resistance.
Moreover, the values given by F5HUP are not optimal, in my opinion, for this type antenna.
But, is this antenna as bad as F6AEM says? There is the question…

First of all, it is known in my professional world (design of military equipment tactics, among others), under the name of “TOS-3 antenna” (sic). It is called "broadband" and of acceptable performance for wavelengths less than twice its length.
It has the advantage of being able to operate with a transmitter without an antenna tuning box, while allowing it to output a suitable power (-3 to -4dB only for a ROS of 3).
This is why it is used with 1kW transmitters for which the antenna boxes are "monsters". For us radio amateurs, it makes it possible to be perfectly adapted with internal automatic tuning systems that do not support high VSWR.
Brief general analysis of the antenna:
- It is obvious that its yield must decrease more rapidly than that of a doublet when its length becomes small compared to the wavelength (< lambda/2).
- For shorter wavelengths, efficiency should increase with higher wavelengths. negative oscillations. Furthermore, the horizontal radiation pattern should flick above the wavelength, as with all wire antennas.

Is the performance likely to drop dramatically for certain frequencies?
A priori, I will not advance, but we can hold this reasoning:
a) This antenna has several influential parameters:
- length
- strand spacing
- resistance value
- end geometry
- possibly value of lengthening chokes
b) The amateur bands represent only small portions of the HF spectrum
c) Consequently, there must be a way to optimize all these parameters for obtain the best compromise for our bands.
On the strength of these considerations, I took out of a closet a beautiful antenna of the W3HH type, the “YA-30” manufactured by YAESU. I had stocked it for a completely different use than “ham radio”, and it has in fact never been used.

I measured its dimensions, the value of its resistance and determined the ratio of the transformer. His features are depicted in Figure 1.

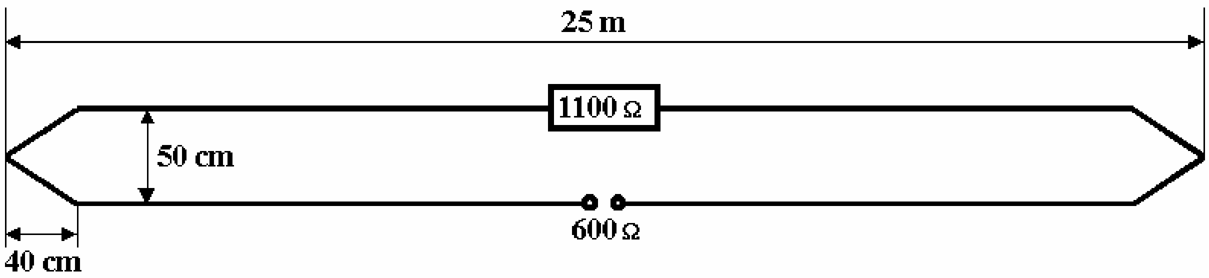

figure 1

Then I "mounted" the antenna in my favorite simulator (NEC-2 core), for the first time horizontally at 15m above average ground, then obliquely above the same ground, with an angle of 30°. See figure 2.

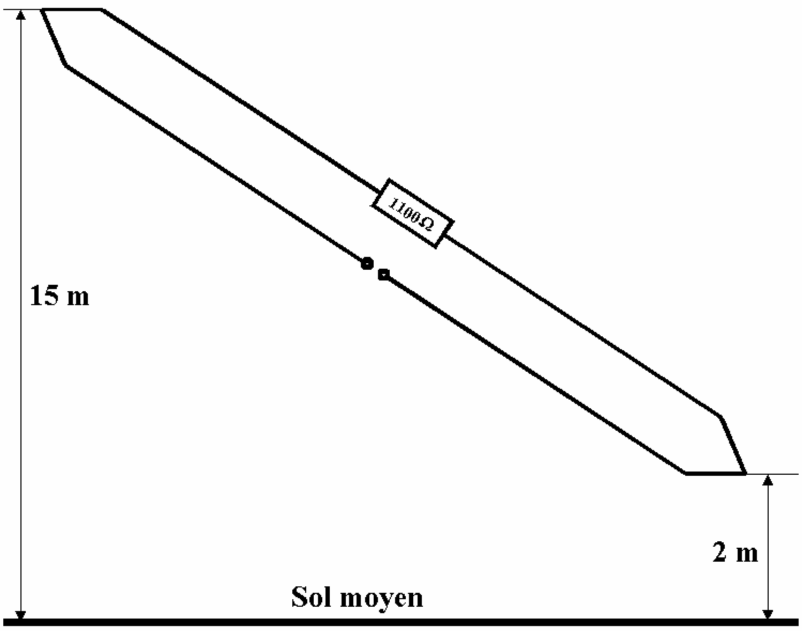

figure 2

The simulator has the advantage of being an impartial judge when used within its limits. See the results in Figure 3 which shows the ROS from 3 to 30 MHz. Indeed, it remains less than 3. The simulation shows no noticeable difference, whether the dipole is horizontal or oblique.

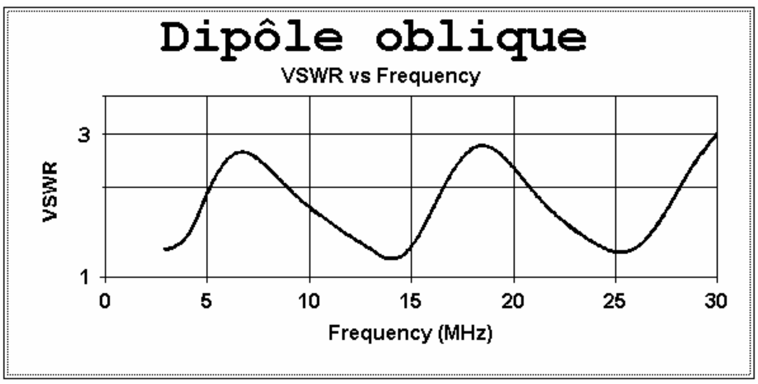

figure 3

In Figure 4, we have the impedance from 3 to 30 MHz plotted on the Smith chart. We have three resonances, at 3.5 MHz, 14.3 MHz and 25.4 MHz where the SWR is close to 1, and two antiresonances, at 6.5 MHz and 18.6 MHz, where the SWR is close to 3. The curve is not perfectly centered around ROS 1 and the average impedance is a little higher than 600 Ohms. It should be noted that compared to an unfolded doublet of the same span, the types of resonances are reversed.

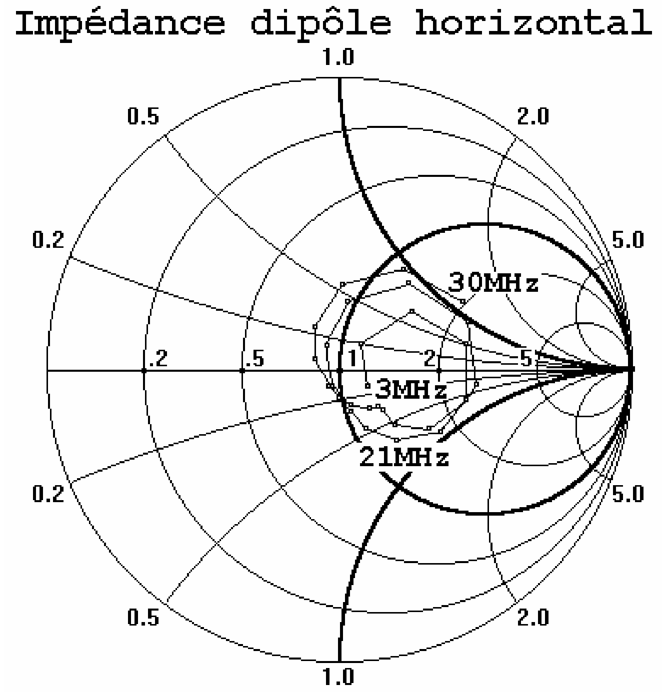

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figure 4

In figure 5, we have the distributions of the currents in the antenna for all the resonance frequencies.

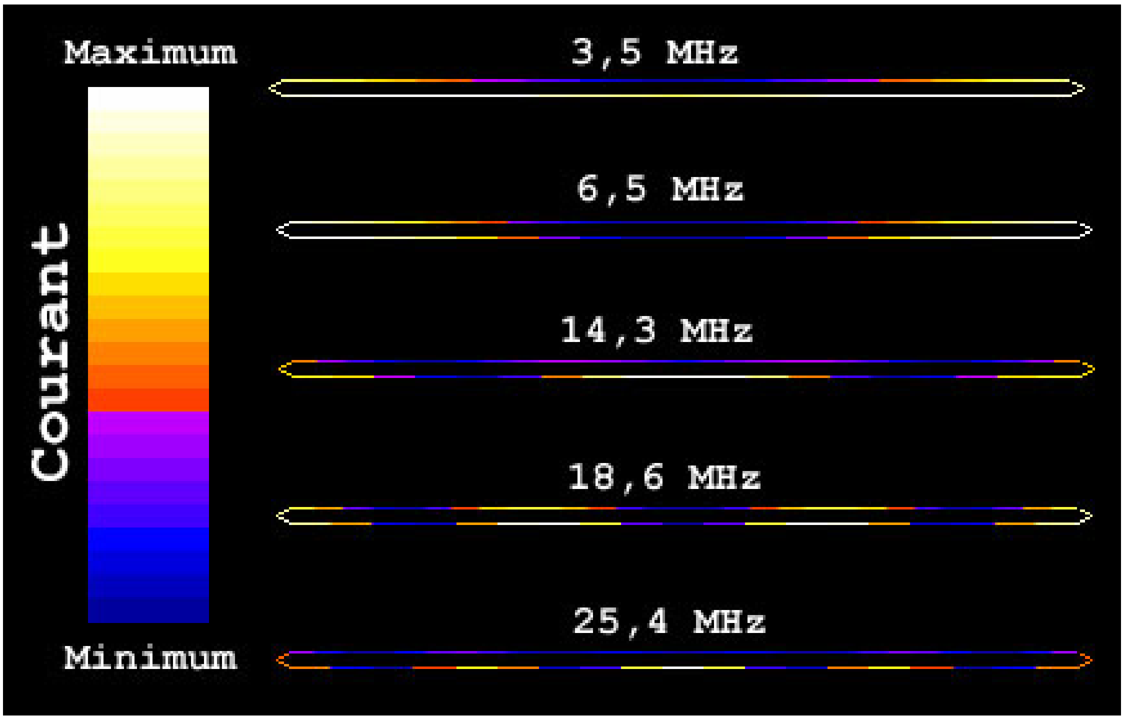
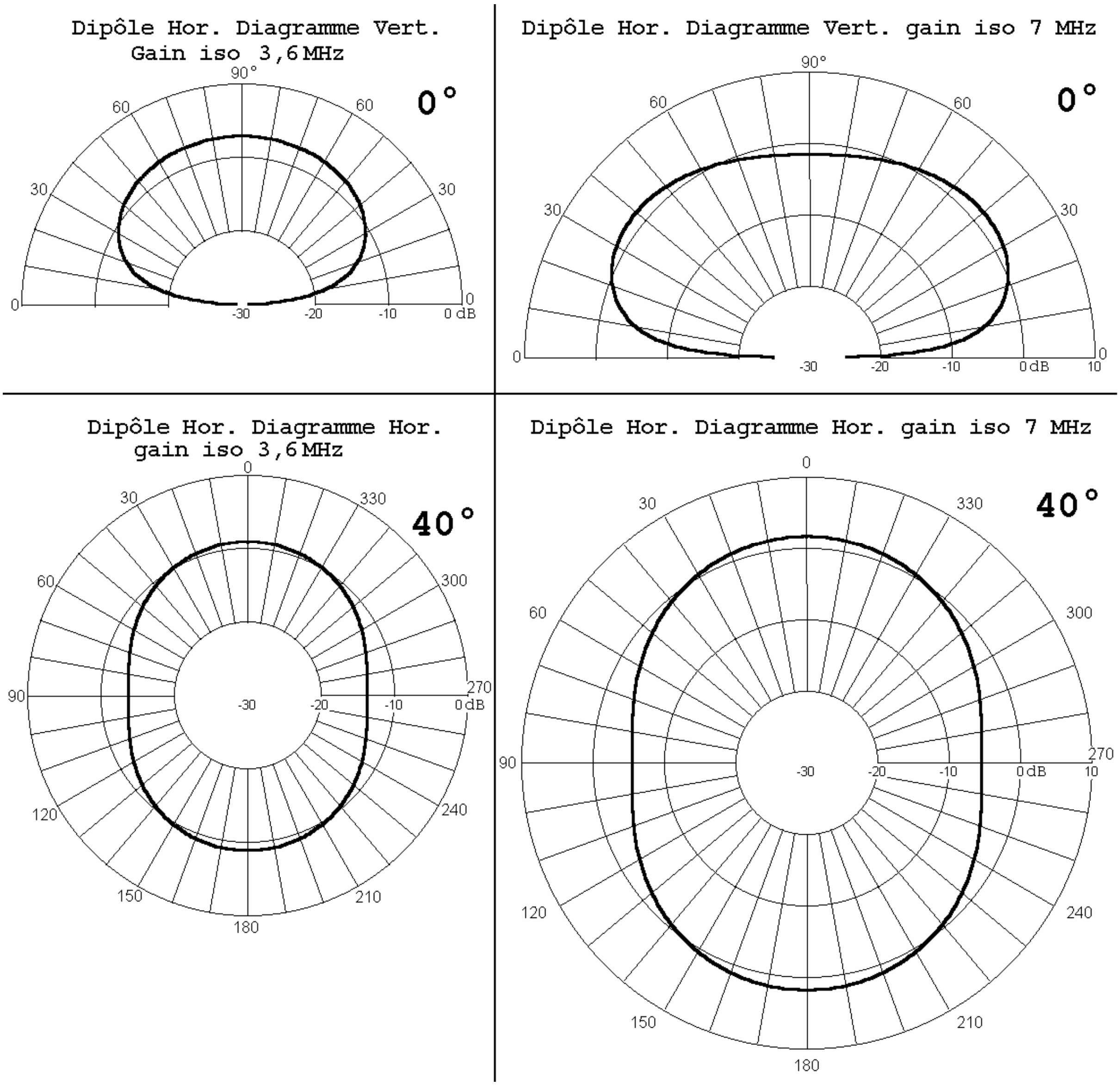


figure 5

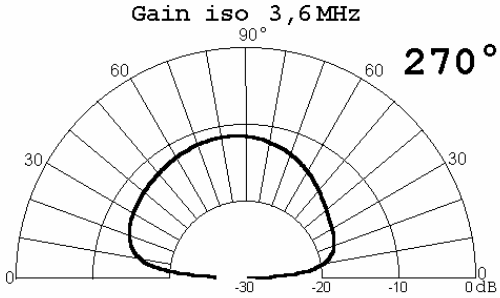
We find that the current is never high in the load resistor, which means performance remains acceptable. These distributions call into question certain simplifying arguments.

Note that figures 4 and 5 change very little when the antenna is placed obliquely.

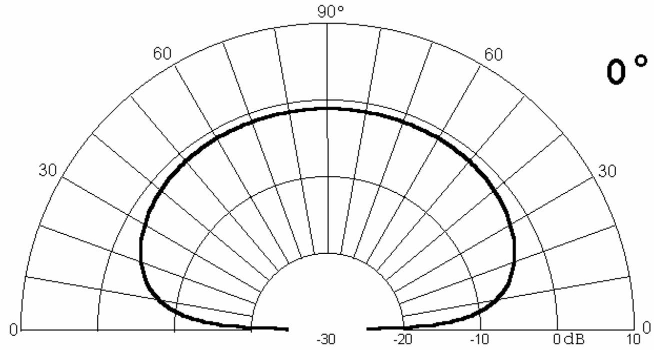
In figure 6, we have the radiation diagrams for the two assemblies, that is horizontal or oblique and for the five main HF bands. Vertical diagrams correspond to an azimuth of greater gain and the horizontal diagrams to the elevation of greatest gain, the closer to the ground.



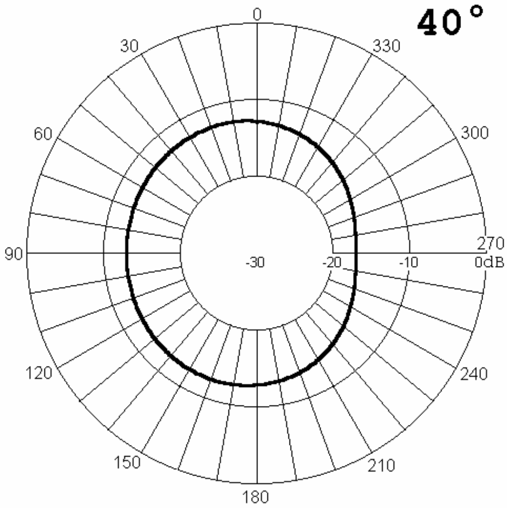
Dipôle oblique Diagramme Vert.
Gain iso 3,6 MHz



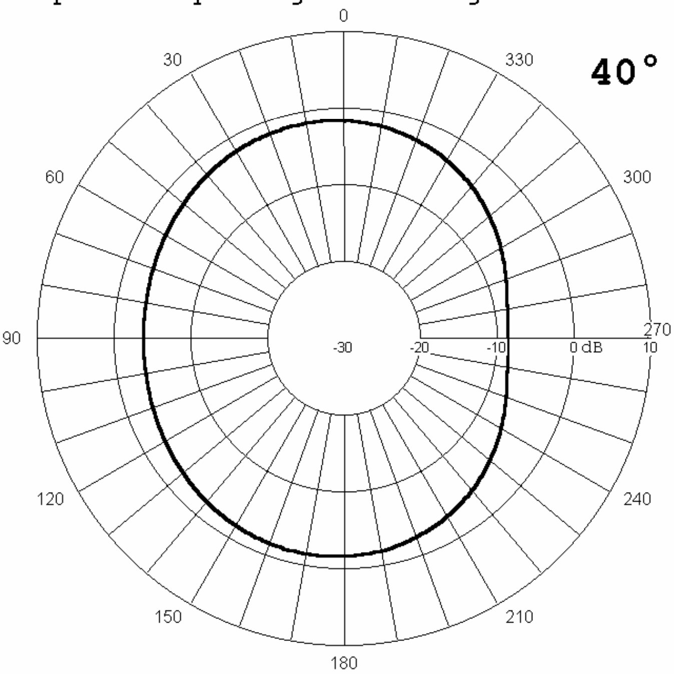
Dipôle oblique Diagramme Vert. gain iso 7 MHz



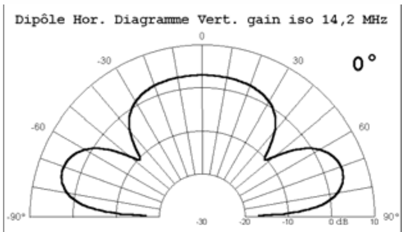
Dipôle oblique Diagramme Hor.
gain iso 3,6 MHz



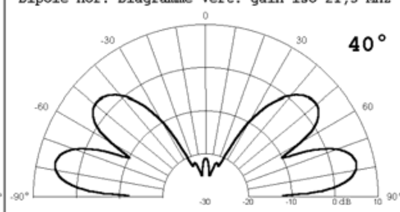
Dipôle oblique Diagramme Hor. gain iso 7 MHz



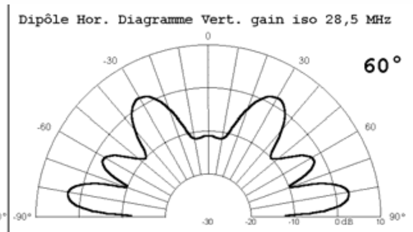
Dipôle Hor. Diagramme Vert. gain iso 14,2 MHz



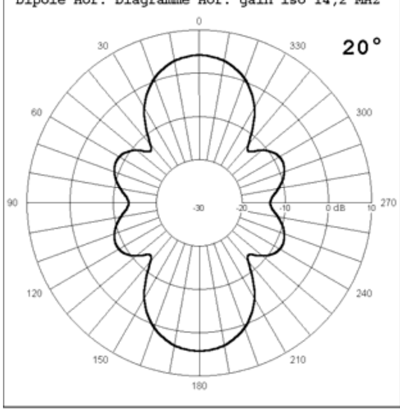
Dipôle Hor. Diagramme Vert. gain iso 21,3 MHz



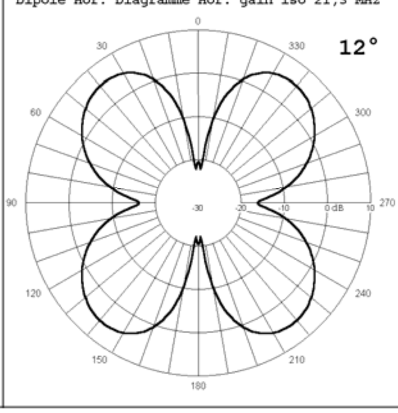
Dipôle Hor. Diagramme Vert. gain iso 28,5 MHz



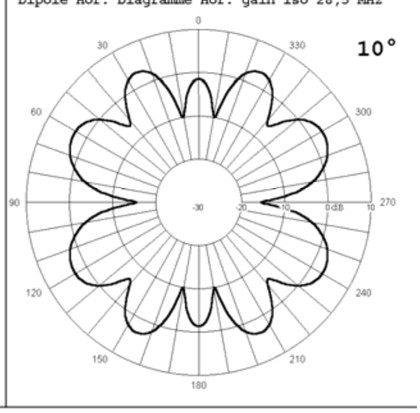
Dipôle Hor. Diagramme Hor. gain iso 14,2 MHz



Dipôle Hor. Diagramme Hor. gain iso 21,3 MHz



Dipôle Hor. Diagramme Hor. gain iso 28,5 MHz



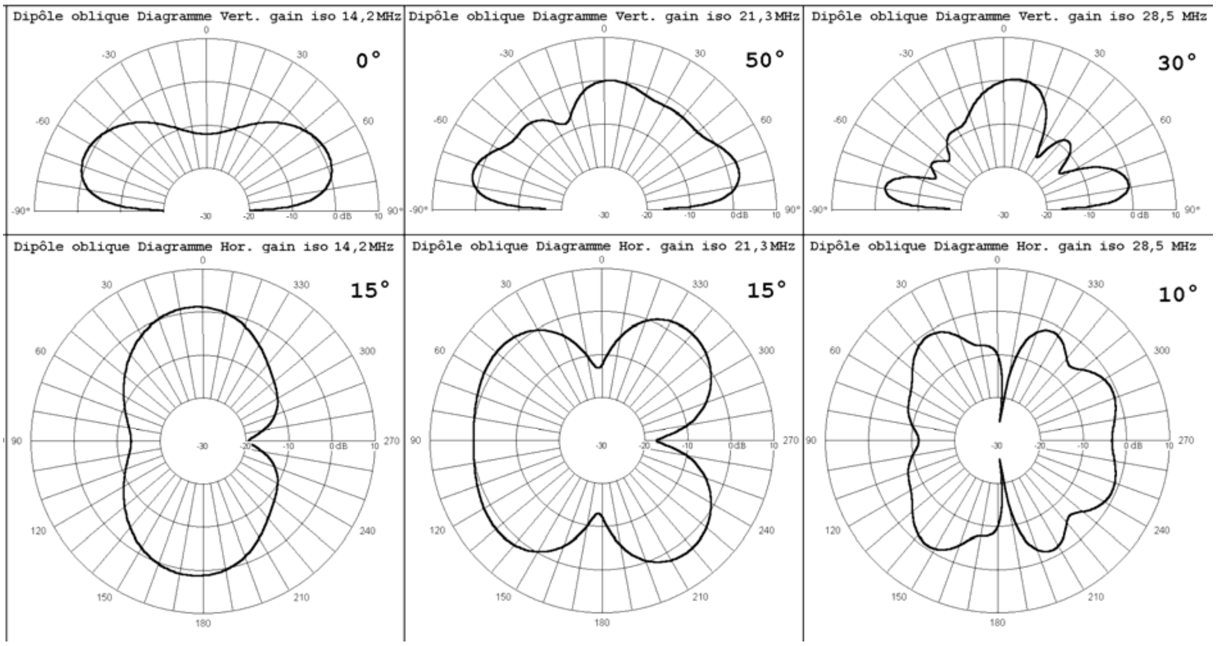


figure 6

Note that overall, the oblique arrangement loses directivity, and therefore a bit of maximum gain, which was expected. Furthermore, the radiation patterns differ little from those of a standard trombone.

Considering the horizontal mounting, we notice:

- For the 80m, the losses are significant. It is worse than a W3DZZ. Note that the H diagram is made at 40° elevation (the maximum is at the zenith).
- For the 40m, it's better, but still worse than the W3DZZ.
- For 20m, it becomes more directive than a half-wave doublet, with a little less maximum lobe gain.
- For the 15m, we have a four-leaf clover diagram. The maximum gain is similar to a half-wave doublet.
- For the 10m, it leafs through seriously and the gain tends to drop.

N-B: For the WARC bands, it's going well too, the diagrams are intermediate.

In all cases, the vertical diagram is a function of height above ground, as for all dipoles.

My findings:

The W3HH is not a bad antenna. It has its pros and cons like any antenna. It is up to everyone to choose their aerials, according to their personal parameters, place, clearance, QSJ, etc… For my part, I think it can be compared with a vertical trapdoor antenna which has only one tuned radian per band, but on condition of the mount wisely.

For example, we can see to arrange the two halves in a somewhat closed angle, say, 120°, and in inverted V (find the best compromise in the simulator). In this case, we should obtain an average gain of the order of –6dB (1 point S) compared to a half-doublet rotating wave. Which is barely worse than a vertical half-wave doublet on a ground medium which has a gain of –5dB, but here, with the advantage of being perfectly omnidirectional in the H plane.

N-B: These gain differences come from the ground and the polarization. Naturally, the two doublets have the same gain in free space.

The manufacture of this antenna is easy, apart from the coaxial cable adaptation transformer power supply. For powers below 200W, this is still easy, and it can be connect directly to the “floating” antenna. For higher powers, the transformer is too heavy and must be placed on a central mast, or on the ground with a connection to the floating antenna by a bifilar line (frog ladder).
The ideal is to use either a transformer of ratio 3 (9 in impedance), with a coaxial of 75 Ω, or a transformer of ratio 4 (16 in impedance) with a coaxial of 50 Ω. In both cases, he is preferable to insert between the transformer and the coaxial power cable, a balun (balun). A load resistor of 1000 Ω (non-inductive) should be suitable. Its value is not critical. On the other hand, it must be able to dissipate approximately half of the output power of issuer to maintain an acceptable headroom.
The average efficiency of this antenna appears all the better as the value of the resistance load is high for bands above λ/2 (a few dB between 400 Ω and 1100 Ω), but it is the opposite for the 80m band. With 400 Ω also, we no longer stay in the limits of ROS-3. It seems that YAESU has found the right compromise with a resistor 1100 Ω and an adaptation to 600 Ω, favoring the DX bands a little to the detriment of the low bands.

Finally, a few tips:
To make the matching transformer, use coaxial cable that is sufficiently insulated and the smallest possible (Teflon). For the ratio 3 transformer, wind on a torus of dimensions and sufficient specific inductance, the maximum number of turns, with three coaxial cables in parallel. For the ratio 4 transformer, the same, but with four coaxial cables in parallel.
Normally, one should use a coaxial of impedance equal to root of (Z1×Z2), but in HF we can take low impedance coaxial, simply to have a section core (some shielded Teflon audio wires may be suitable). This, so much that its length does not exceed λ/10.
For the symmetrizer (balun), take another torus and wind on it the maximum number of turns of coaxial cable, but here, imperatively of equal impedance to the connecting line to the transmitter. The performance of this balun is not critical. In fact, it brings almost no losses. At worst, if it is poorly done, it does not mirror.
For these types of transformers, the total length of the coiled cable must not exceed 1/10th of lambda for the highest frequency and the choke must be at least equal to 10 times the impedance for the lowest frequency (5 times is sufficient for the balun).
See on figure 7, the diagram and the connection of the transformers.

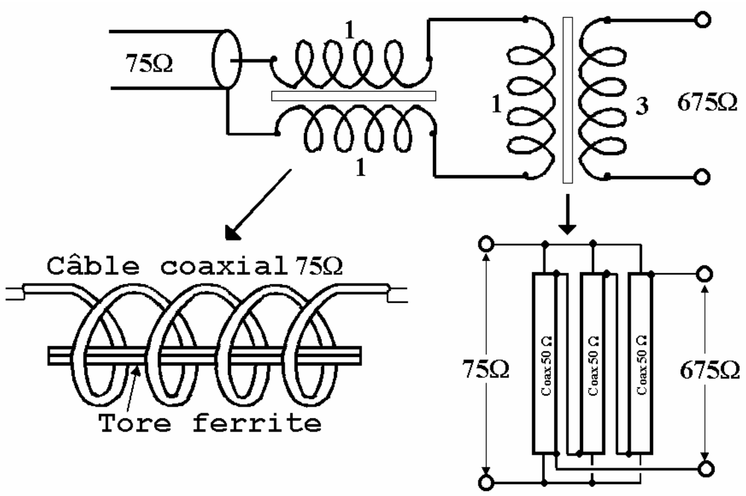


figure 7

N-B: The detailed explanations for the manufacture of these transformers and the resistance would ask for a specific article, and that was not the purpose of this one. For resistance, we can refer to the method described by F5HUP, but it is not the only one. I am more reserved for its transformer, difficult to achieve to obtain a band of 3 to 30 MHz.
F5NB.