Antenna Workshop

The Windom antenna was so popular in the early days of radio and it seemed to have almost mythical properties. So, Martti Nissinen OH4NV set out to find out more about it, read on to share his findings!

The Windom - Myth Or Magic Antenna?

After reading the interesting article The Windom Antenna – is it any good? by **John Share G3OKA** (*Practical Wireless,* February 2003), I went and researched through my old radio papers trying to find some original design facts about this antenna. I found no new work on the antenna so, there's almost no new information. But from the articles and papers that I found, the original Windom antenna design is always based on a l/2 horizontal wire fed by single wire feeder tapped at the one-third point of the horizontal antenna wire.

The asymmetrically tapped single-wire feeder is the 'heart' of the Windom antenna and with just that, perhaps, the antenna rose and fell to become a myth later on. So, I reasoned, let's see what modern day tests can reveal about the antenna, then we can judge if there's anything other than the myth still left to explain.

For my experiments, I constructed a Windom antenna by following the old directions for 14.05MHz. The velocity factor is 0.974 for the wire's diameter of 2.2mm . The horizontal antenna wire itself has a length of 10.4m (λ/2 at 14.05MHz) and the feeder is also the same half-wave long. As described in the 'recipe' the feeder is tapped at 3.46m from one end of the antenna, **Fig. 1**.

The height of my test Windom antenna is 12m and it's erected between two trees so that the feeder comes down into shack at an angle. There are some other antennas and a beam on a tower nearby, but not too near. Of course I wanted to know as many of the tested details as possible about this mythical radiator, which seems to have lost its earlier glory.

The set-up for the Windom feed-point's relative impedance

Marrti and his bridge. The signal source and bridge were used to investigate the ins and outs of the Windom antenna descr bed here.

measurements was complete. The items of equipment I used are: an HP-bridge 803A, an HP-receiver 417A and a Fluke generator 6061A. Measurement results were calculated by a substitution method (see Note 1) at the design frequency of 14.05MHz.

Note: The Windom antenna system includes the radiating feeder, but in this case however, the exact half-wave long feeder repeats the proportional antenna impedance (to be found at the tapping point) on the horizontal section without further transformations.

Because the feed-point impedance is repeated along the length of the feeder, it's easy to show if the antenna impedance is reactive or not. The impedance of the Windom's shack-end impedance (14.05MHz) was measured as 330Ω with a phase angle of 0° (HP-bridge and substitution method), equating to (330±j0)Ω using the more usual j-notation. Also, measurement results were calculated by a substitution method.

For comparison purposes, I measured the Windom-system impedance at the second harmonic of 28.1MHz, where the impedance was measured as 340Ω at a phase angle of +14° (HP-bridge). This value translates as (330+j82)Ω. The results were far better than my low (perhaps even negative) expectations. When using the Windom antenna at the design fundamental frequency, the shack-end impedance is purely resistive. And what a surprise, in the second harmonic band it's nearly resistive while the real part (resistance) magnitude is the same value of 330Ω!

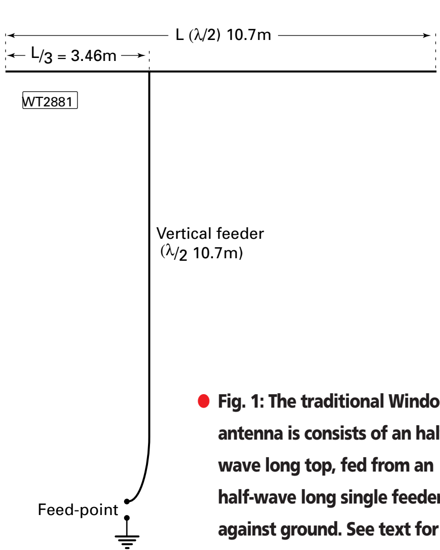

Fig. 1: The traditional Windom antenna is consists of an half-wave long top, fed from an half-wave long single feeder against ground. See text for more detail.

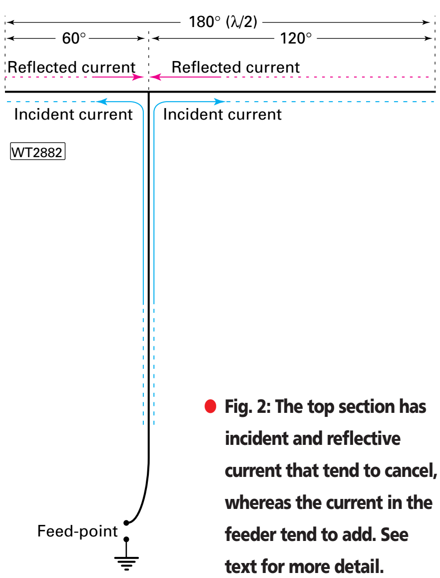

Fig. 2: The top section has incident and reflective current that tend to cancel, whereas the current in the feeder tend to add. See text for more detail.

The Bandwidth

But what about the bandwidth? To my surprise it was very wide giving an s.w.r. of 1.2:1 at the edges of the band, but as with any antenna design, does the thing work? Well to answer that, there was a European pile-up going on, trying to work **VK3EGN** so I called him once. He immediately came back with a report of '559' - wonderful! So, the antenna system works, and I was only running 40 Watts!

As a receiving antenna, the Windom works very well. All the weaker exotic signals were found on the band. After a short test-period it became clear that the original Windom type is a different antenna. The bandwidth, for example, is so wide that only a lossy circuit behaves similarly. But there's little or no extra lossy resistance in the Windom design. The whole construction is so simple that I cannot find very lossy parts in the design.

Some readers may suggest that the grounding of the antenna (Note 2) as the source of the wide bandwidth. It's a good argument, but if it were dependent mainly on the ground, then weak sky-wave DX-signals should be very attenuated - but they aren't! On the contrary they sound the same as when I'm using my beam. Even, after this relative short test-time I find that my own signals from the Windom are heard quite well at DX.

Positive Difference

So, we have to find other reasons to explain the positive difference of the Windom. We understand and we agree (as it is said many times) that the normal resonant half-wave antenna wire is resistive at any point along its length. This means that we are able to measure and use quite a large range of resistive impedances for matching. But can we access into and use those resistance with the single wire feeder?

The answer to the above question is no. The single wire feeder feeds the resistive nature of the resonant length as a parallel (voltage) drive. If we want to 'get' inside the resistive feed-point with a current drive, then we would have to cut the antenna wire and connect a two-wire line in series. But such a connection cannot be made in the original Windom antenna, because, the antenna is no longer a Windom. A funny thing, isn't it?

So, we have a perplexing question to answer! It seems that the single wire feeder can't meet the requirements of the resonance mode of the Windom element (except via the cut ends). If this is so, what mode does it utilise? Look at the **Fig. 2**, noting the directions of the currents.

If we start by looking at the top loading mode consideration. Then the single wire off-centre feeder alters the feed-principle completely. When the feeder is joined with the un-cut Windom wire, it will 'see' two unequal length (60° and 120° at the design frequency) horizontal extensions, or top loads against ground, and starts to feed them with in phase opposite currents. These currents will reflect back and all summarise (as vectors) at tap-point.

Generally, the horizontal current-vectors tend to cancel and vertical currents (feeder) tend to add. If the horizontal section forms a complete 180°, as with Windom, there is resonance against ground. In fact the horizontal element, with ground, form parallel open-ended wide spaced lines (Note 3). The final result is the feeder's shack-end impedance what was just measured. The wide-band flatness and constant resistivity (330Ω±0°) of this impedance (also on the harmonic) generates suspicions, naturally, but in my opinion it's true!

Generally, antenna top loading offers an advantage often forgotten. It tends to shift the maximum current point to the upper parts of the antenna and feeder. This has often been all antenna designers' goal since the early days. Imagine a vertical having highest current at the top! In my view the top-loading mode can be well applied to Windom.

As an extra feature we can see that at the same time the Windom antenna still maintains a horizontal polarisation mode. Therefore the Windom is a mixed polarisation antenna. With its mixed mode and with occasional problems feeding the Windom antenna, it has often been put aside. But this very fact has also moved it into the group of antennas that have become myths.

But is there anything that can bring the Windom antenna back from the place of myths? The measurement and experiments that I've made, on the Windom, reinforce the top-loading mode for the Windom.

Some may say that the story above is unbelievable. How can we start from the perfect half-wave horizontal Windom and arrive at top-loaded vertical antenna? But who can say which of these modes is better? I can't find an error in my measuring set-up and I don't think anyone else will.

Perhaps it's time to take the Windom from the myth-category and put it back to its well-earned place in the backyard again. To really appreciate how effective this antenna is, you should build your own Windom! It's a most simple low-angle radiator and a simple LC impedance matcher is shown in **Fig. 3**. Remember a good quality r.f. ground connection must be to the chassis side of the matcher.

I've found that the best place for this small tuner is on the wall near or above your shack's window. It doesn't even have to have continuous tuning, the antennas bandwidth is so good!

A Warning

The original Windom antenna belongs to the group of directly-fed antennas or the grounded antennas. A disadvantage of all these antennas is that part of the antenna is often within the shack and gives some r.f.-radiation inside the shack. So, the best place for the matching unit is as far as possible from the operator, near or above the exit-point of the shack. Even with this limitation, only a relative low power is recommended.

A better idea still, is to mount the matching unit outside the shack and use a separate coaxial feeder for the Windom. The correct tuning setting is easily obtained and doesn't need re-tuning on changing frequency. This design gives the possibility of running a higher power with Windom and this design is mostly recommended.

Have fun with your Windom. This 'magic' antenna takes you back to early times and the early feelings of radio! **PW**

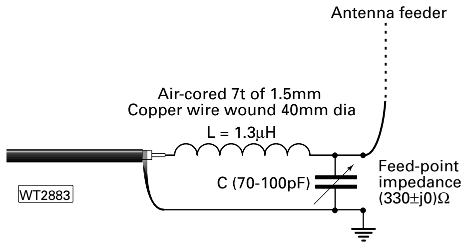

Fig. 3 (above): As the feed-point impedance of the single feeder is around 330Ω a matching unit will be needed for most installations.

Fig. 4 (left): An experimental LC tuner for the Windom antenna, the meter indicates r.f. current flowing in the vertical feeder.

Notes

- In the substitution method the antenna is removed and substituted with tunable lumped components. Then, by adjusting the components, the equal antenna matching is reached (s.w.r. of 1:1). Now, by measuring the values of the lumped components, one can calculate the antenna's complex impedance.
- We shouldn't underestimate the ground-effect. Especially with small antennas, fed by a coaxial cable the ground resistance intrudes easily into the antenna circuits. Such lossy antenna has excellent s.w.r. and wide bandwidth response. But they are often quiet antennas due to high losses. The Windom, as described, doesn't belong to this group. It often competes successfully with my beam.
- For the more complete analysis one can form two parallel open-end feedlines (60° and 120° electrical length) and then calculate the existing reactance trigonometrically. This proves the additional loading resonance.