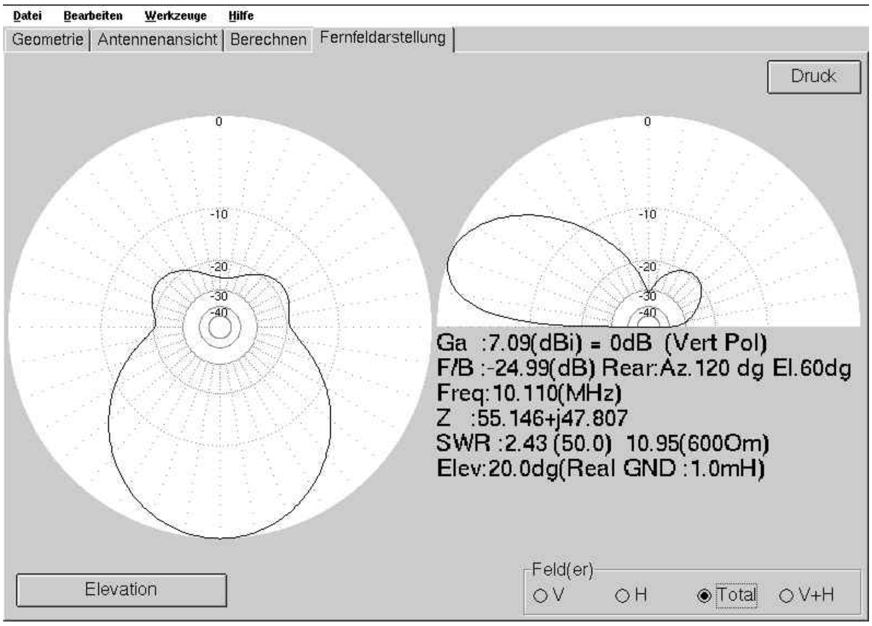
The HSQB --- A half-square beam

Spurred by the good performance from my omni-directional verticals and specially the bidirectional half-square I could not stop pondering on a beam version of the latter. The half-square had proven to be a very nice companion. One should not look down on bidirectional antennas but in some instances it is practically necessary to cut down noise from behind. So the idea of a beam version of the HSQ began to take form in my head.
I accidentally found the same idea at Mr Cebiks antenna site, cebik.com. So while I cannot claim this idea to be mine I have found it at no other place and that perhaps proves the idea to be at least "odd":)

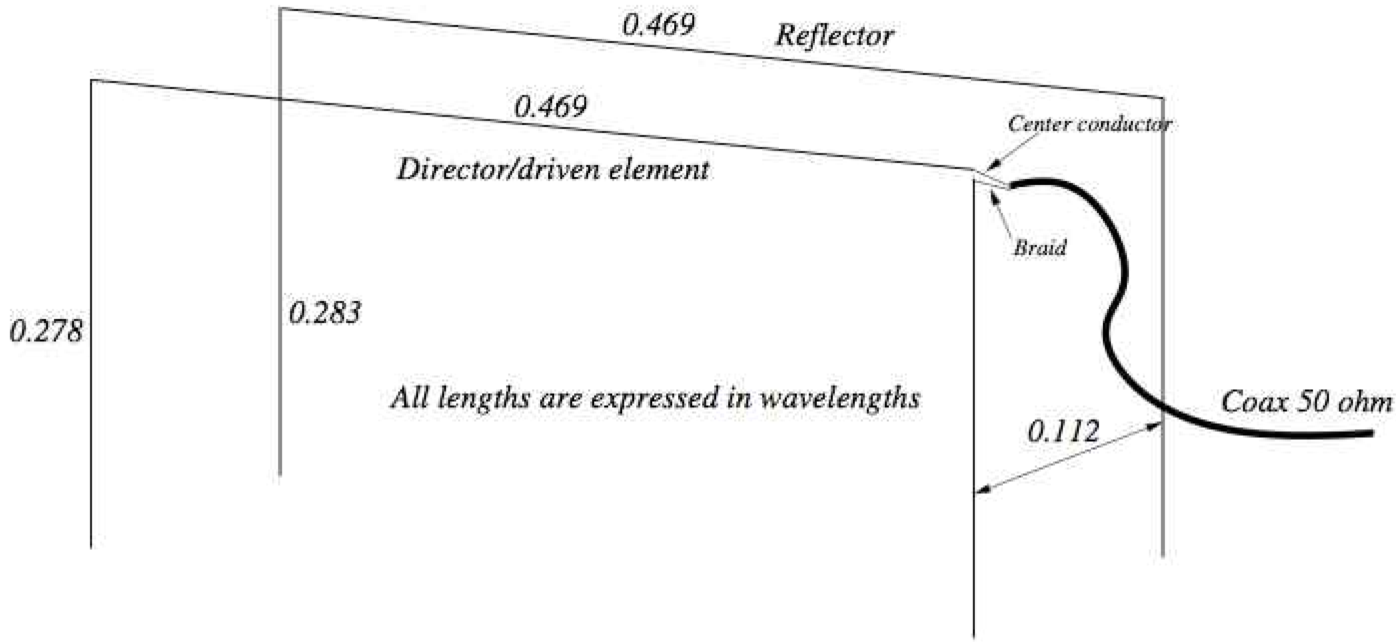
Using the MMANA antenna simulator I have gotten a feel for what makes different parts of antennas perform. I have put that experience into practice in my other experiments with verticals, which can be found elsewhere on this site. So equipping the HSQ with a reflector is a logical next step: At a distance of about 0.15λ one puts a slightly larger HSQ. Larger, since its action as a reflector mandates a lower resonance frequency. And at 0.15λ since we want the gain to be as much as possible.

The optimized resulting radiation pattern is impressive or what do you say of 7 dBi gain and a F/B-ration in excess of 20 dB?



With a simple addition to the HSQ, a beam with impressive performance can be achieved. The additon is a reflector element that is slightly larger than the fed HSQ. While the dimensions of the HSQ is fairly uncritical, the HSQB practically must be trimmed on site for this kind of performance. Once cut it can be mounted at another site with no discernable reduction in performance.

When dimensioning this antenna I started off with the previously optimized dimensions for the pure half-square. Hours of simulations later I settled for the dimensions in the figure below:



Physical dimensions for the HSQB, expressed in wavelengths. These dimensions hold for plain uninsulated wire. With proper trimming a SWR of 1:1 and thus simple coax feed can be used. While gain can be (marginally) increased with greater spacing between the driven element and reflector I ruled that small size was more important.

As pointed out earlier, this antenna needs to be trimmed for optimum performance. The process is luckily a simple one:

1. Trim the reflector legs for best F/B-ratio
2. Trim the director legs for a SWR of 1:1

After erecting the antenna in place make sure the lower ends are about 1 meter off ground. This is not a crucial distance but the ends will couple to ground if they are much lower. Mine were between 0.6 and 1 meter above ground level.

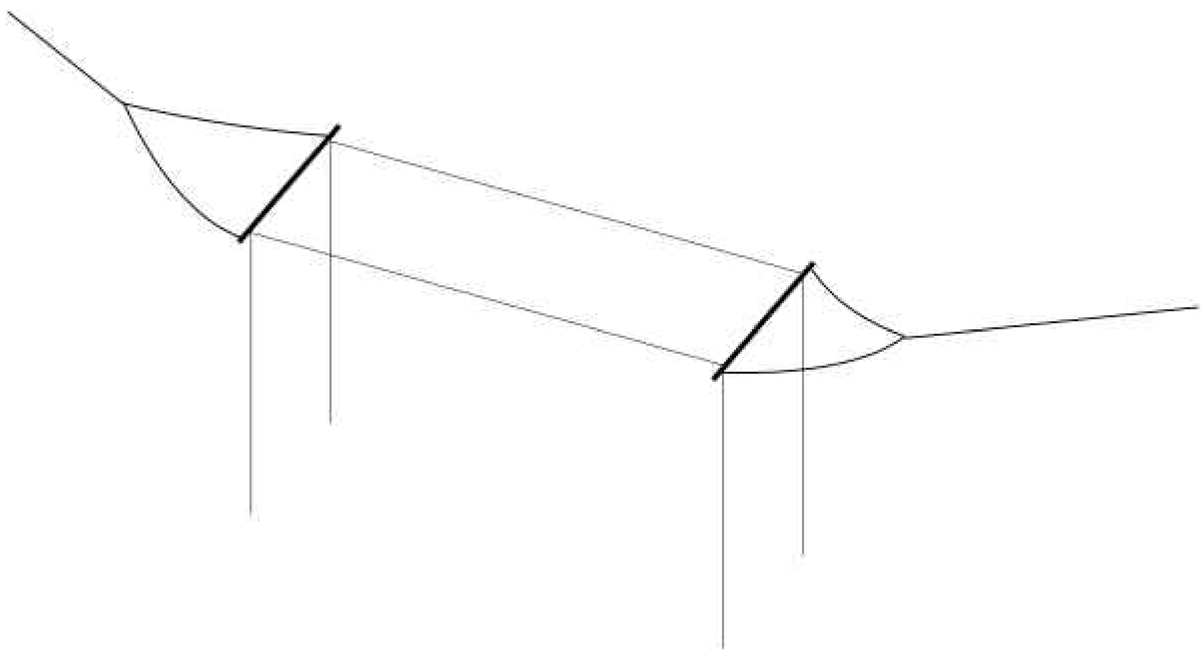
Next, place a small beacon (or perhaps a "radio controlled ham", I used a MFJ-207 SWR-bridge with a short whip, not many mW:s out but that is exactly what we want here) behind the antenna. Make sure the beacon is not too close, we must ensure a good plane wave front to excite the antenna in order to be able to trim it for best performance. I used a distance of about 25 wavelengths. (In laziness I first put up the beacon just outside the garden but that proved to be much too close, I found a dip in F/B of perhaps 3 dB! Hardly noticeable. I was dismayed by the results and rechecked the dimensions against the simulator, but could not find any clue there. Some days passed until I realised that the distance might have been to little. Don't repeat this mistake...)

Now note the signal strength on the receiver S-meter. Start cutting short lengths (2cm pieces) off the reflector legs, one at a time. Make continuous notes of the S-meter readings. At one point or another the readings will start to drop quite rapidly. We are expecting a drop of more than 20 dB so it is very likely the signal will disappear completely. If that happens lengthen the beacon's antenna. We want a signal to read, however weak. Continue to cut until the signal just starts to get stronger again, then stop immediately! It is easy to think "just one more and the F/B will be even better", chances are that you will be ruining the F/B though, by cutting too much.

Also make sure you leave the antenna by several meters between the cuts or your body will load the reflector and give erroneous results. When properly trimmed the signal will reappear slightly when you come close to one of the vertical reflector wires and be *very* loud when you touch them.

One last measure needs to be taken --- trimming the SWR down to 1:1. This is only necessary if you really care about the SWR, as it may be low enough already. Else trim the driven elements successively as you just did with the reflector but now only to get the SWR down to 1:1. I did this measurement through a coax half a wavelength long (electrical wavelength that is, my coax was of the 0.66 velocity type so the length used was 0.66*0.5*λ), as that ensured I watched the same SWR at my end as in the other end, the end which is connected to the antenna in the air.

I made my antenna as per the sketch below. This was practical as I could easily flip the entire assembly, thus reversing the antenna's direction. Actual lengths, as measured with a tape measure with the antenna on ground, were: Driven: vertical 556 cm, horisontal 941 cm and Reflector: vertical 580 cm, horisontal 943 cm. Distance between elements were 241 cm at both ends.



A quick, easy and practical way to build this antenna is with wires and flag lines. I used bamboo sticks to separate the two half-squares. It catches very little wind and was up, and survived, the 2005 hurricane, the most violent since 1969 and which fell over one year's of timber during one single night over the southern Sweden! Unfortunately the 48 hour power outage incurred by the hurricane prevented me from using it then. Which was a pity since t the noise level was *so low*, as I found out by listening with my KX-1.

To conclude: As vertically polarized antennas go, this is an impressive one. The 7 dBi gain means 1-2 S-units more gain than the plain vertical, but what really makes this one stick out is the >20 dB F/B-ratio. Aiming it northeast from my QTH in northern Europe it practically cuts off the strong European stations in the south and gives me very big ears towards Australia, Japan and Oceania.