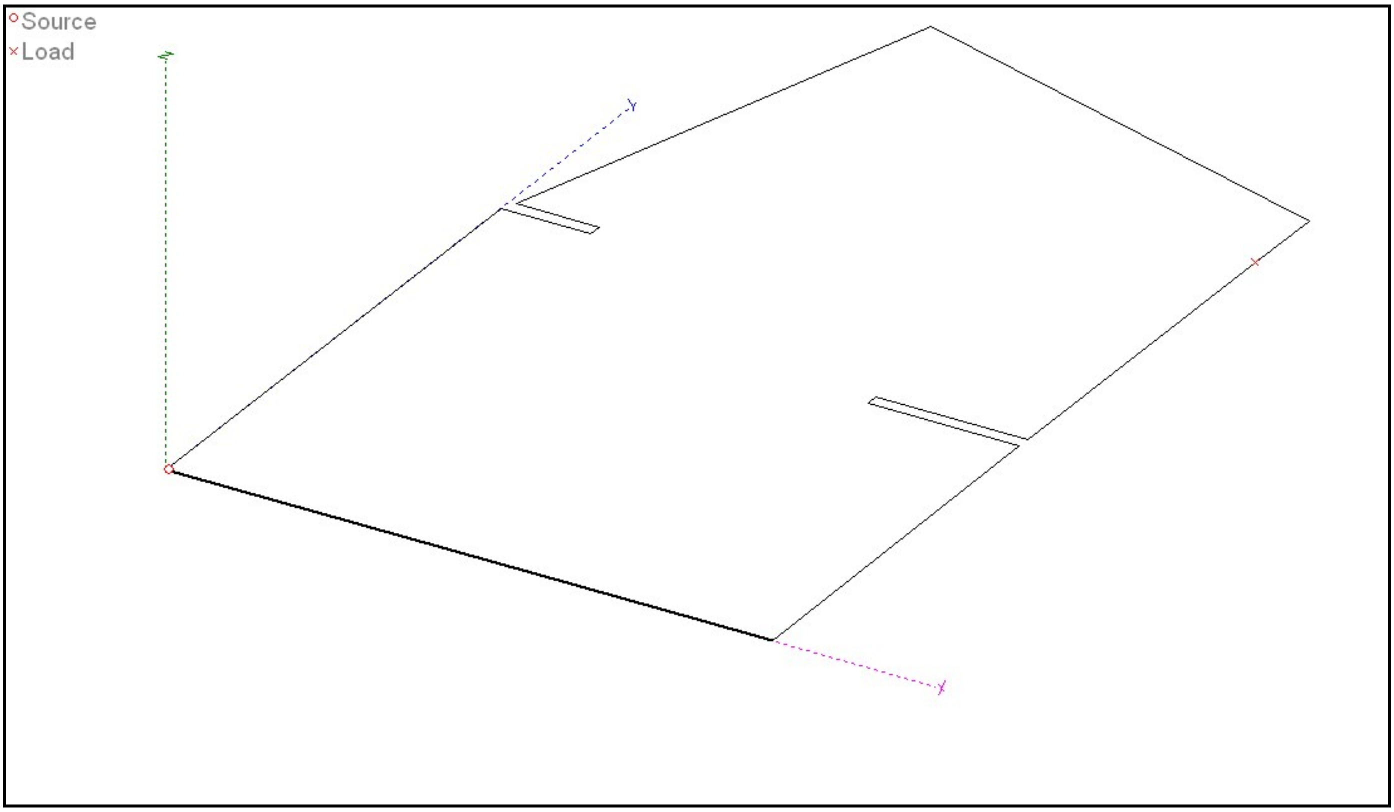
Aperiodic antenna for 160m-10m

Since I live in a small apartment in a crowded town, there isn't much space to set up complex antennas. Luckily I can call a 2x5m dipole my own, suspended in front of the facade of the building and more or less tolerated by the suspicious neighbors. A second antenna only for WSPR? Out of discussion! So for that purpose it had to be something indoors and of course hidden from the views of the "better half". And it had to be broadband, since I wished to keep the hardware simple (no matching networks, …). In addition I was targeting a minimum gain of 9dBd or so, but that turned out to be a bit unrealistic ☺

To cut that story short, my choice fell on an aperiodic design in the shape of a wire rectangle, running along the walls of my living room and being hidden behind the skirting boards. Aperiodic means that the antenna does not work as a resonator, as is usually the case, but more like a feeder line with its two legs pulled apart. The "feeder line" is connected to the source (transmitter) on one side and terminated by a resistor on the exact opposite side. Because the forward and return path of the "feeder" do not geometrically overlap, EM-fields will not cancel each other out. Hence, such a construct is going to radiate EM-waves. At shorter wavelength (in relation to the dimensions of the antenna) a significant amount of energy will be radiated before it reaches the resistor and ends its live as heat. One prominent member of this species is the T2FD.

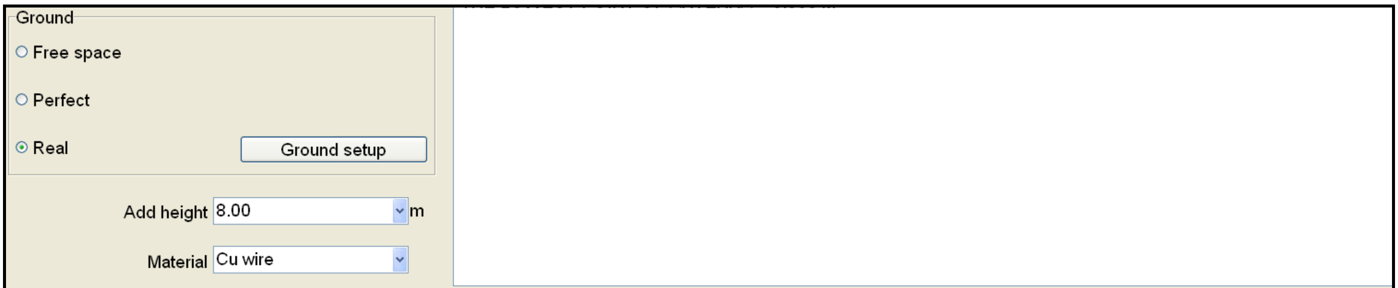


antenna layout / circumference about 30m / source in lower left (matched to 50 Ohm by a 1:22 balun), 1k terminator at the opposite side / the two indentations have no technical meaning but are simply because of walls that I did not want to drill holes into (HI)

As already explained, designing this antenna was a bit like putting the cart before the horse. A given geometry was taken and its suitability for a certain application was tested by simulation. In my case this job got done by MMANA-Gal, a freely available NEC software. After the wires had been laid, the simulation results were checked against reality using a network analyzer and found to be pretty good matching. The following table and graphics show some details of the simulation results. According to general wisdom such designs should be relatively effective for wavelengths up to their total geometrical length, which in this case happens to be 30m. As you can see, data provides quite good support to that radio amateur axiom. From 10m down to 17m the loop is a good match to a full size dipole, taken into account its omnidirectionality. Here also the elevation angle is reasonably flat. For 20m and 30m the design is still close to a dipole, with losses in the range of 3dB…6dB. For 40, 60 and 80 meter I'd call it a compromise and on 160m it's merely a heater. Although looking at what was actually achived on those bands, this isn't fully true either. On 40m and 60 the beacon regularly gets decoded by stations 1000…2000km away, on 80m spanning a distance of 1000km isn't exceptional and even on 160m I got heard by (a few) stations as far as 1000km away from my home.

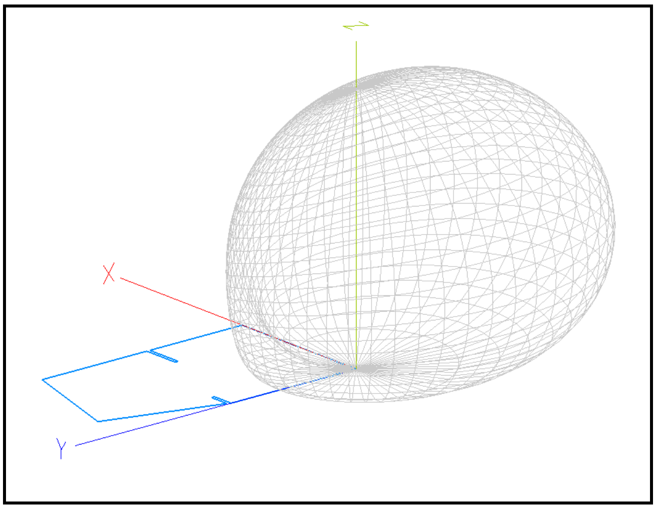
A word of caution with respect to indoor antennas:

During early test phase one of my neighboring hams, running a WSPR receiver and living only 2km away, picked up and decoded my transmissions not only at the actual frequency generated by the DDS but also at +/-50Hz and +/- 100Hz from there. Of course the power of those "ghosts" was in the range of a fraction of a mW, but still powerful enough to get decoded. My first impulse was "a bad power supply or some inductive coupling by a transformer near the beacon", but the oscilloscope didn't reveal anything and it turned out that the signal was clear and the effect gone when running the beacon on my outside antenna. Finally and with significant investigative effort the originator of the crossmodulation was found to be a cheap switching power supply hidden behind a cabinet and at a mere 2cm distance to my also carefully hidden wire. The power brick was resettled and the signal went clean (for now, at 200mW -> to be continued?). The moral of the story: Don't try to hide your problems, they'll always re-emerge.

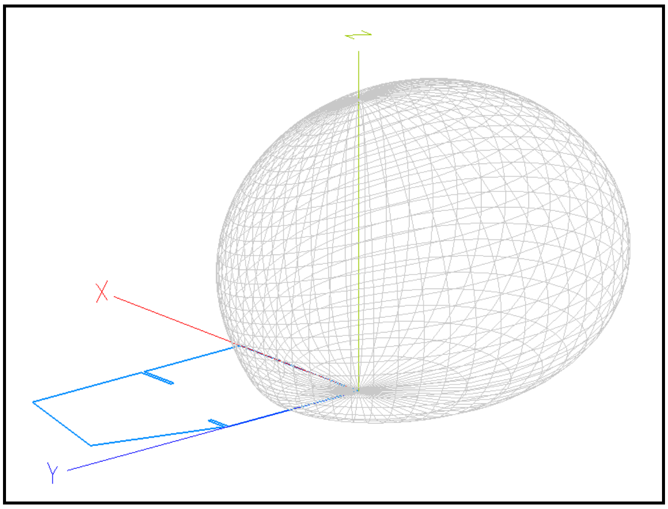


No.	F (MHz)	R (Ohm)	jX (Ohm)	SWR 1100	Gh dBd	Ga dBi	F/B dB	Elev.	Ground	Add H.	Polar.
10	1.825	1080	145.5	1.14	---	-42.02	-5.28	64.0	Real	8.0	hori.
9	3.55	1265	216.6	1.26	---	-26.38	-5.3	63.0	Real	8.0	hori.
8	5.6	1506	56.17	1.37	---	-16.2	-4.98	62.0	Real	8.0	hori.
7	7.05	1516	-174.0	1.42	---	-11.44	-4.9	60.0	Real	8.0	hori.
6	10.12	1200	-360.5	1.38	---	-5.21	-5.02	52.0	Real	8.0	hori.
5	14.05	1096	-78.97	1.07	---	-2.73	-4.48	41.0	Real	8.0	hori.
4	18.08	1220	-167.8	1.19	---	-0.61	-6.75	30.0	Real	8.0	hori.
3	21.05	1168	-338.1	1.35	---	-0.12	-6.56	26.0	Real	8.0	hori.
2	24.9	828.5	-168.4	1.4	---	3.76	-7.13	21.0	Real	8.0	hori.
1	28.2	1075	-111.4	1.11	---	1.3	-1.89	74.0	Real	8.0	hori.

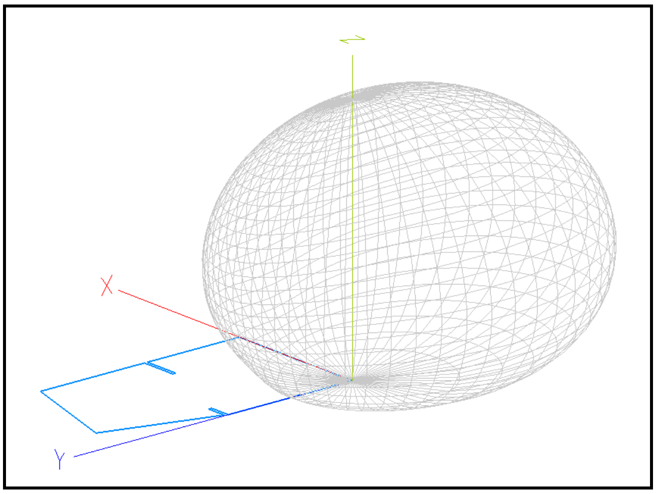
Simulation results from 160m to 10m / copper wire / 8m above ground



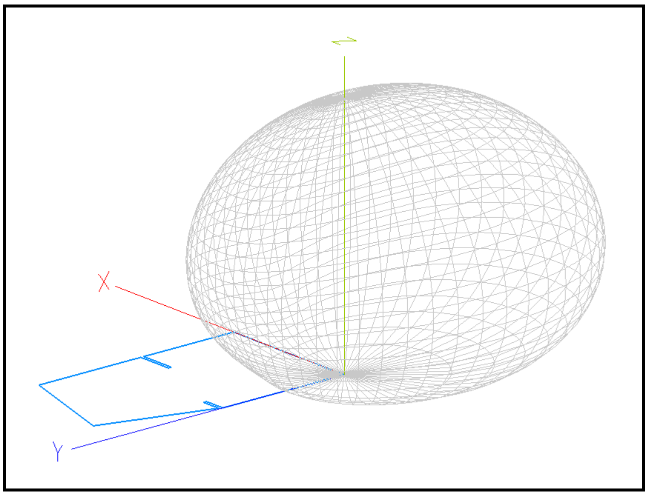
far field plot at 160m



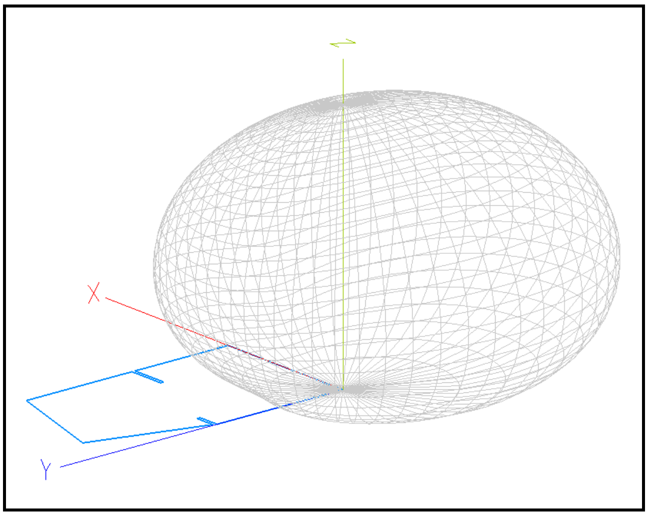
far field plot at 80m



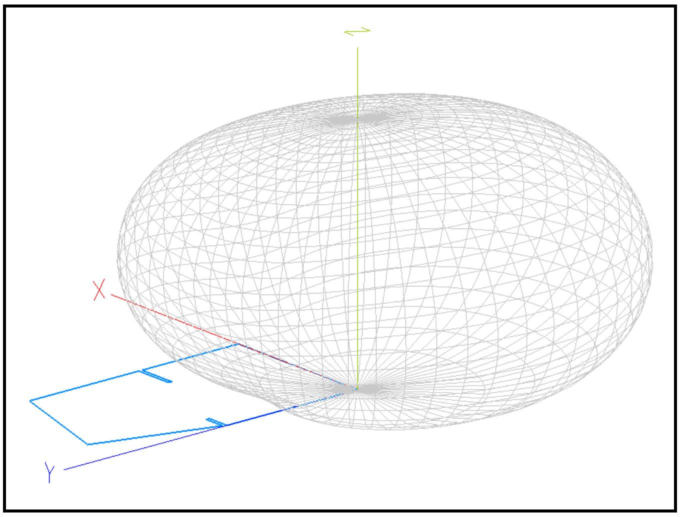
far field plot at 60m



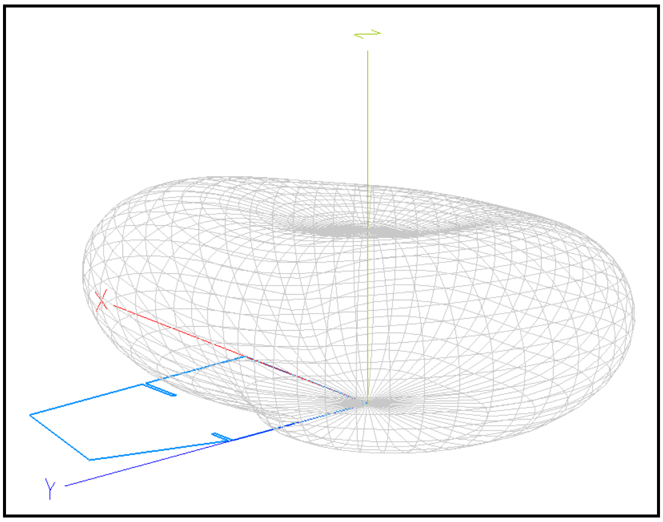
far field plot at 40m



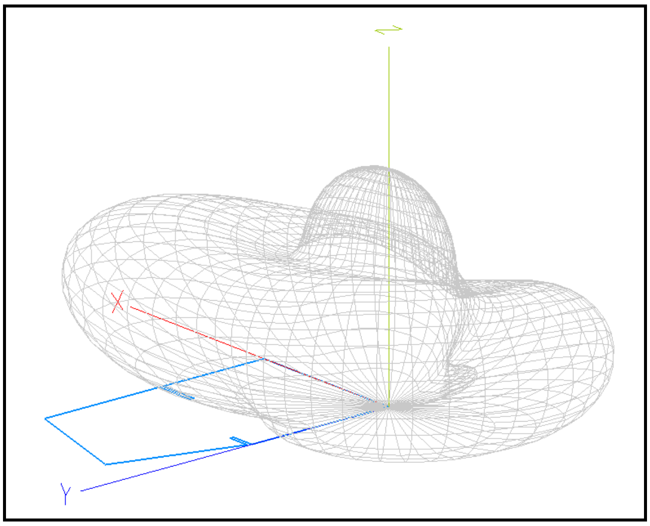
far field plot at 30m



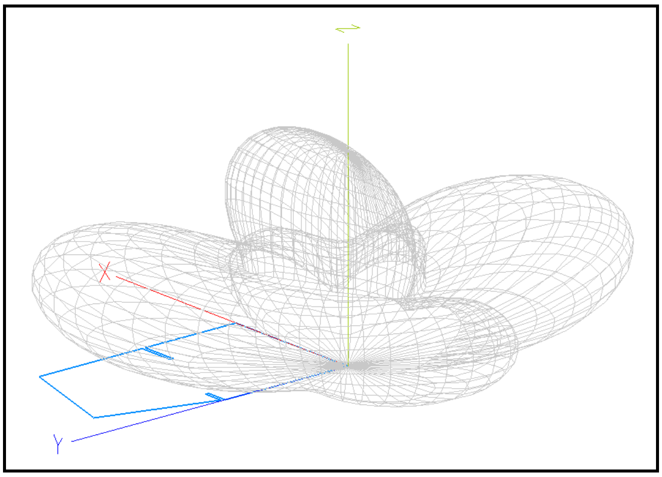
far field plot at 20m



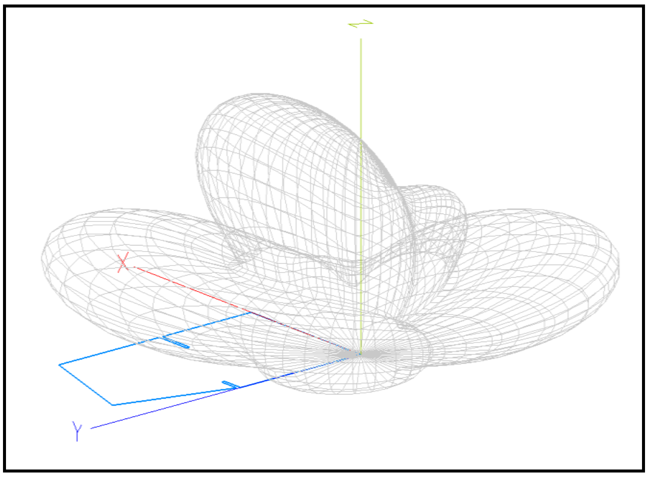
far field plot at 17m



far field plot at 15m



far field plot at 12m



far field plot at 10m