# **Low Profile LF and MF antennas**

Proposed Research and Experimentation

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Most radio amateurs assume that verticals are the only practical antennas for long distance communication at low frequencies. Simulations of antenna performance in the proposed 135.7 – 137.8kHz and 472 – 479kHz Amateur Radio Bands show that resonant horizontal dipole antennas located very close to the ground (but with no ground system at all) have significant vertical E-field radiation and can potentially perform nearly as well as a 15 meter (50 ft) top loaded vertical with a ground system. This is especially true in locations with poor ground conductivity where vertical antennas tend to perform poorly. The dipoles are directional, with maximum vertical radiation off the ends. In one simulation, a resonant dipole at 475kHz positioned 2 meters (6.5 ft) above the ground with ground conductivity of .002 S/m created a vertical Electric field off it's ends only about 3dB less than the 15 meter vertical mentioned above. Even a dipole 2 inches above the ground radiates significant energy in simulation. The Dipoles are also broadband. The 475kHz dipole 2 meters off the ground has 30kHz bandwidth at the 2:1 SWR points, far wider than the proposed band.

Resonant dipoles close to the ground are much shorter than in free space, ~220 meters (715 ft)for the dipole 2" above ground vs ~315 meters (1033 ft) in free space. They can be shortened further by adding capacitive loading to the ends, loading coils, or with a matching network at the center. For very short antennas, the ends can be grounded, but this can add considerable loss especially where ground conductivity is poor.

I think that if these LF and MF bands become reality, these simple low profile antennas could allow many hams (who have some space) to experiment with LF or MF that otherwise would not attempt it because of the hassles and expense of a tower, ground radial system, top-hat, and tuner. These antennas can be run along the top of a fence or attached to trees while standing on the ground. Cheap Aluminum electric fence wire and insulators can be used. I have the space to conduct some experiments.

I propose to attempt the following:

- Simulate several more antenna configurations, heights, and ground conductivities for each band using the NEC4 method of moments program.
- Measure the actual conductivity of the ground where the antennas will be erected to better estimate expected performance.
- Erect a limited number of antennas (one at a time in the same location), tune them, and measure and record lengths, bandwidths, etc. All antennas will be "in the woods" well below the existing tree canopy.
- Transmit a carrier of known power from each antenna and measure the vertical field strength off the ends and sides in the far field several km away, using a shielded Fairchild calibrated loop antenna and a Rycom portable Selective Voltmeter with a preamp. Based on the simulations, the initial transmit power will be adjusted for an expected EIRP of ~1 Watt or less.
- Compare measured to simulated performance and select the best designs.
- If possible, use existing signal "grabbers" linked to the internet, or direct contact with other experimental stations to demonstrate long distance communication. Possible modes are CW, PSK31, and the narrow band weak signal FM digital modes created by K1JT, especially WSPR and his new JT9-1 mode designed especially for LF/MF communication.

I have the following equipment on hand now:

- Materials to erect the antennas.
- A homebuilt 25 Watt Class E amplifier for 472-479 kHz.
- A Hafler P3000 300 Watt linear audio amplifier suitable for 135.7-137.8kHz.
- An HP3586C Selective Level Meter as a receiver, with an RF output suitable to drive the amplifiers for the field strength testing.
- A homebuild active loop antenna to receive these bands to select clear channels.
- A Trimble GPS frequency standard to lock the 3586C frequency to a fraction of a Hz accuracy.
- A Fairchild calibrated loop antenna for the field strength measurements.
- A battery operated Rycom 3121B Selective Level Meter with preamp for field strength.
- Equipment to assemble an RF impedance bridge for tuning/measuring the antennas.
- An Advantest R3361A Spectrum Analyzer for measuring harmonic output of the amplifiers, etc.
- An IC-703 as a low level (SSB) signal source for the digital modes.
- A laptop computer with software to send and receive the digital modes.

I will need to fabricate a ~100 Watt amplifier for 472-479 kHz, with adjustable power level, and a forward/reverse RF power meter that covers both bands. I will need to assemble and calibrate the RF impedance bridge.