

## **Prototype Advanced Antenna Technologies Available For Challenging Electrical Performance With Difficult Volumetric And Environmental Constraints.**

The design of antennas under size and weight constraints is often a challenge, particularly in the high-VHF band designated for use in a handheld or portable situation. A simple approach to determining the physical limits of the problem can be obtained from the theory of fundamental limits of antennas. For a minimum enclosing radius of an antenna of  $a$ , we can evaluate the ideal relationship between the frequency and bandwidth, with the typical bandwidth less than half the estimate. For a band of 240-270 MHz, we have a frequency to bandwidth denoted approximately by a  $Q$  of 8.5. For an idealized  $Q$  of 4.25, we have a minimum radius of minimum radius of  $a = \lambda/2\pi * Q^{1/3} = 11.6 \text{ cm} = 4.6 \text{ in}$ . This size is within the limit of the 360 cubic inches. Trying to load with dielectrics or tuning simply reduces the bandwidth and does not generally improve performance, though often suggested by researchers. By pushing the fundamental limit closer to the ideal, it may be possible to create a smaller antenna and improve performance in the presence of loss materials (like the human body).

The challenges are in terms of meeting the other specifications. The gain suggests using the largest footprint as possible, though contradictory to the expected weight and size desired for typical applications, particularly for handheld use. As the 4.6 in size is approached, it would be expected that the gain would approach that of the dipole or loop at about 2 dB maximum, but typically reduced by system efficiency. The VSWR with a reasonably large band suggests the use of a tapered feed region to eliminate the matching networks that further reduce the bandwidth and efficiency. The need for circular polarization suggests the use of antennas such as a slot spiral, crossed slot, Four-Square, or crossed loop. The latter is probably the lightest alternative, but all should be considered for use. The spiral and crossed slots have the potential of being built into the materials used for clothing, leading to the potential of flexible body-worn antennas. Body-worn antennas offer a covert potential, but should be expected to have a substantial efficiency issue.

Proposed research would include the following: 1. Classify a set of specifications and related scenario or application to focus the research; 2. For each specification, select potential candidate elements to address the specifications in a best sense; 3. Simulate the selected proposed antennas for size, frequency, weight, and performance both in free space and in the presence of a ground plane or human body; 4. Down select the designs to 1 or 2, construct, and test the antenna for pattern, bandwidth, and other specification items.

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