Project Overview

This project will be divided into several sections indicated below.

1. The development of an Iridium Satellite Antenna to be used in submerged buoys for ocean research. The antennas will be fabricated using DLM Antenna technology.
2. The second part of the project will entail the investigation of several types of high frequency (2 to 30 MHz) antenna arrays. These arrays will be vertically polarized and initially in the form of wire antennas but will later be implemented using DLM Antenna technology.
3. A third phase of the project will be implementation of DLM Antenna technology in the area of parasitic horizontal antenna arrays for use in the 2- to 30 MHz frequency range to reduce their rotation diameter.

Students will be required to familiarize themselves with electromagnetic radiation principles as applied to antenna design and will be required to use such antenna tools as NEC antenna modeling software. Students will trained in the use of field intensity meters, patent measurements and other forms of antenna measurements such as SWR, forward gain and front to back gain and azimuth and elevation radiation angles. In addition they will be trained in the use many hand tools and machinery used in the fabrication of antenna elements as well as becoming proficient with instruments as used in antenna evaluation and measurement techniques.

Iridium Satellite Antenna:

Phase 1.

The College of Oceanography is currently using an Iridium satellite antenna made in England. The antenna is a combination GPS antenna and an Iridium satellite antenna thought they are separate antennas housed in one housing attached to a buoy deployed for making ocean measurements. The purpose of the antenna is to contact mother to tell a research vessel in the area "here I am come and get me"

It also allows some data to be uploaded to the satellite and down loaded to data collection sites around the world. The Iridium satellite operates at 1620 MHz and is a slow data rate system seldom used because of the low data rate. It was initially deployed by the U. S. Navy for communication with submarines and other naval applications. Today more sophisticated satellites are used and the Iridium satellite has been renagated to use only by research institutions.

The antenna proposed would be a balanced dipole antenna as opposed to the current antenna, which is a two-element spiral helix monopole. This antenna has proved to be difficult to tune and keep tuned and as a result has been unreliable. This is an undesirable trait considering its application. In addition the proposed DLM antenna will incorporate two antennas stacked a quarter wavelength to provide more antenna gain over the current device. The bandwidth should also be considerably increased which will improve tuning.

To fabricate such an antenna thin film fabrication techniques will be required as the antenna is very small for 1620 MHz being only about 1.5 inches overall length. DLM antenna technology allows the shrinking of antenna size while retaining bandwidth and antenna gain as compared to a full size counterpart. The ratio of antenna size reduction is about 3 to 1.

To come up with a viable design the antenna will have to developed at 1/10 the frequency or approximately 162 MHz. This means that the antenna can be fabricated using printer wiring board techniques and evaluated at this frequency.

Once a satisfactory prototype has been developed it can then be scaled to 1620 MHz and thin film fabricated. However this may require as many as three to four iterations before a satisfactory prototype can be made. The reasons for this are several fold. The antenna in thin film will be fabricated on an Alumina substrate, which has different characteristics that the 1/10 frequency model fabricated on printed wiring board. Now you are probably thinking why not just jump the step and go directly to thin film. The answer is simply cost. A thin film fabrication cost tens of thousands of dollars as compared to a PWB fabrications, which are only several hundreds of dollars if that. The final antenna has to be developed using thin film fabrication because the upper frequency limit of PWB DLM antennas is a few hundred MHz at best. The upper frequency limit of thin film fabrication of DLM antennas by Vishay is approximately 10 GHz.

High Frequency Antenna Arrays:

Phase 2.

Antenna Arrays are combinations of antenna elements of some defined wavelength or fraction of a wavelength and spaced some wavelength or fractions of a wavelength apart. This arrangement of antenna elements changes the antenna pattern such that in some directions there is no gain or very little gain and in other directions there can be a considerable amount of gain. This depends on the length and number of elements and their spacing.

The arrays which will be studied will consist of in one case simple three element wire arrays using quarter and half wave length elements spaced a half wavelength apart. Antennas of this type when using ½ wavelength spacing of quarter wave elements are called broadside arrays. If the elements are made ½ wavelength in length and spaced ½ wavelength they become end fire arrays and maximum radiation is along the line of elements. Initial experiments of these simple arrays have indicated very high gain with deep nulls perpendicular or broadside to the array of elements.

However, at frequencies of 1.8 to 7 MHz these antennas are working with elements lengths of 66 to 130 feet, which are very high when one considers the required pole height to erect them.

Initial measurements will be conducted at 28 MHz when pole heights of only 16 feet will be required to support the arrays. Since antennas can be scaled with little variation in their operational performance it will be possible to make measurements on antennas operating at 28 MHz which can with reasonable expectations to perform as well as their larger and lower frequency counterparts.

In addition to making individual arrays students will be working with arrays or arrays or several antenna arrays operating together and various back planes will also be erected and evaluated.

Once a substantial amount of data becomes available the students will then create duplicate arrays but using elements fabricated using DLM antenna technology, which will shrink the height of the arrays by a factor of 3-1 and verify any variations in performance as compared to the full size counterparts.

Phase 3.

In phase 2 antennas evaluated were vertically polarized arrays of antenna elements. Horizontally polarized antenna elements can also be combined into arrays but unlike the arrays of phase 2 which utilized phased elements, the antenna of phase 3 will utilize parasitic elements within an array of elements. The difference is that in phase 2 the elements were excited directly and in phase 3 they are excited indirectly or "parasitically excited" which means they are close to the same frequency but can be a little higher or a little lower. This causes the antenna element to appear capacitive or inductive with a corresponding change in antenna radiation from one direction to another. This effect also changes the gain and narrows the beam width, which in some cases is desirable or undesirable.

The problem with lower high frequency antenna arrays is that at frequencies of 1.8 to 7 MHz the arrays become very large. And to realize any worthwhile performance they have to be quite high above ground. These heights have to be in increments of ¼ to ½ wavelength.

With antennas this large, antenna-turning diameters can be from 66 feet to 240 feet with 66 feet pertaining to a 7 MHz antenna array.

In this phase we will look at the feasibility of reducing the antenna turning diameter considerably, using again, principles of DLM antenna technology.

Because of the height requirements and erecting difficulties of 7 MHz and lower frequencies, all the antennas will be scaled to higher frequencies. This will allow much lower antenna heights above ground. The results measured should be close enough to determine if proper antenna performance can be achieved using DLM antenna technology as compared to their full size counterparts.