DESIGN AND TESTING OF HELICAL ANTENNAS FOR A RF TEST FACILITY

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ABSTRACT

RF facilities are necessary to accurately and systematically test multiple types of electronic devices in an electromagnetically quiet environment. Typical RF facilities consist of an anechoic chamber, a room that shields anything inside from external electromagnetic radiation and prevents internal reflections of propagating electromagnetic waves, as well as all necessary transmitting and receiving equipment needed for RF testing.

Requirements for this specific project called for electromagnetic testing from 500MHz-4GHz. Helical antennas were selected as the primary radiating element because of their circular polarization. An additional benefit of helical antennas is that their high gain minimizes the amount of input power required to achieve a given field strength level at a specific distance. In order to span this frequency range with high gain coverage, 5 classes of helical antennas were fabricated around commercial PVC piping. Due to PVC's high dielectric constant, the traveling electromagnetic wave propagates with a slower velocity through the PVC than it would through air. The increased relative permittivity of the PVC changes the instantaneous charge distribution along the length of the helix, which reduces the operational frequency of the antenna as lower order modes will occur.

This paper analyzes the effect that dielectric loading has on helical antennas and presents an innovative design change that compensates for the loading. Traditional design

techniques will be compared to the University of Missouri-Columbia's new optimization methods. Increasing the bandwidth of the antennas is accomplished through impedance matching techniques. In order to view two-dimensional polar plots of the antenna's far-field pattern, an all composite turntable was constructed and controlled by a custom LabVIEW program. The LabVIEW program simplifies testing of the antennas by automatically controlling the turntable, real-time spectrum analyzer, and signal generator based on the user's input settings. The LabVIEW program then automatically calculates and plots the antenna's gain by processing the received signal strength through a MATLAB program, both of which were written in house. Two different types of antennas were constructed: a traditional air-core helix and a dielectric-loaded helix wound using the new optimization method. Both the traditional antenna and the optimized antenna dielectrically loaded with a piece of PVC were sent away for commercial validation. These test results are then compared against the University of Missouri's test results using the newly constructed RF facility.

It was shown that MU's optimized method effective in compensating for the dielectric loading in the helix antennas compared to traditional design techniques, and that the results from its in-house testing methods match up well with both commercially provided measurements and CST simulations.