High Frequency Vector Sensor Design and Testing

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A new antenna design that exploits the simultaneous measurement of the complete electric and magnetic vector fields (vector sensor) has been designed, built, and tested experimentally. The sensor is designed for use in the high-frequency band (3-30MHz). Special consideration for potential operation near the ground/earth is incorporated into the antenna design, yielding a symmetric response amongst the individual field sensing components. The vector sensor consists of three orthogonally oriented electrically short dipoles as well as three electrically small orthogonal loop elements. Appropriate active impedance matching circuits transform the individual field sensors to a nominal 50 ohms for connection to a multichannel receiver system. Experimental measurements indicate that to first order the sensing components are sufficiently decoupled in spite of their relatively close electrical spacing.

Experimental field testing has been conducted that verifies the operation and theoretical sensing capabilities of this new antenna design. Tests were carried out using a 3 element vector sensor array (18 total receive channels). The results demonstrated the angle-of-arrival and polarization estimation capability of the vector sensor antenna in a real world environment using both known and unknown ionospherically propagated signals. Observations of temporal and spatial ionospheric dynamics have been observed as manifested through time-varying angle-of-arrival estimates during multimode propagation conditions.

Proper calibration of the vector sensor is required to achieve the designed sensing capability. Implementation of high resolution angle estimation can only be accomplished with sufficiently accurate antenna manifold models or measurements. Several techniques using both near-field and far-field sources were investigated and utilized during experimental testing. The utility and precision of these techniques is examined.

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