Near-Field Characterizations of a Miniaturized Low-VHF Omni-directional Antenna Using an Electro-Optical System

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Near-field measurement technique has been widely used as an alternative to the standard far-field pattern measurement method for characterization of antennas with large electrical and/or physical dimensions. The advantages of the near-field method for such antennas include relatively small area for the measurement that does not need to fulfill the far-field range requirement and achieving a 3D pattern in one complete scan. Also, issues related to antenna positioning that can be antenna specific can be avoided. Similar advantages exist when even for electrically small antennas at HF and VHF bands far-field measurements in anechoic chambers are not possible. In order to precisely characterize the antennas with low gain or omni-directional pattern, however, spherical near-field scanning technique with complicated computational procedure which in turn leads to increasing processing time is required. Although planar near- to far-field transformation has the virtue of mathematical simplicity, the scanned area is confined to a relatively small area around the antenna boresight. Thus, the finite size of scanning surface results in the truncation error.

To lessen the effect of such truncation error from the planar near-field technique as well as reduce the size of the measurement system, a novel planar very-near-field measurement method that is performed in the reactive region of the near field is developed. Unlike conventional near-field scanning systems that utilize metallic probe radiators to measure the fields, a non-metallic probe having an extremely small electro-optic (EO) crystal mounted at the tip of an optical fiber is employed. The non-metallic fiber-optics attached to the probe whose dimension is only a very small fraction of a millimeter allows for the examination of the near-field distributions without causing any measureable perturbation to the signal around the antenna under test. In addition to the EO probe, specialized equipment including electro-optical modulators and demodulators and sensitive RF components are assembled in RF field probe systems to measure the simultaneous magnitude and phase of the near-field signal. In order to verify the accurate antenna far-field predictions from this measurement technique, the miniaturized low-VHF folded dipole antenna (Choi, Jihun, and Kamal Sarabandi. "Highly miniaturized low-VHF folded dipole antenna for compact, mobile communication applications." *Radio Science Meeting, 2014 USNC-URSI*. IEEE, 2014) is rigorously characterized. The measurement results from the near- to far-field transformation applying the measured very-near-field data are compared with those obtained from the full-wave EM simulation and direct far-field measurement which is reported in the above reference.