Ultra-Wide-Band Slot Antenna with Stepped Index Superstrate with Equivalent Dielectric Constant of Periodic Media

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Ultra-wide-band (UWB) antennas have become one of the hottest topics in the last decade in wireless communications and radars. Many topologies and configurations have been studied and reported in designing UWB antennas. These topologies correspond to radiation pattern, polarization, and band of operation. Most of UWB antennas are not easy to integrate with the backend electronics. In addition, in low frequencies, such as in VHF and UHF bands, the sizes of these antennas become a major factor that must be taken into consideration. It is desirable to design antennas with dimensions comparable to a fraction of the wavelength in low frequencies.

Slot antennas constitute one of the most popular planar low-profile antennas which are easy to fabricate, have high radiation efficiencies, are easy to integrate with the RF frontend, and are low-cost. Their radiation pattern and bandwidth are similar to dipole antennas and thus number of modifications are required to achieve ultra-wideband performance and for radar applications to make the antenna radiation pattern directional.

In this paper, a new technique in designing a slot antenna with 60% fractional bandwidth and directional radiation pattern is presented. In order to further improve the bandwidth, reduce the size, and achieve directional radiation pattern, the use of a stepped index superstrates with tapered dielectric constants, from dense to sparse, is proposed. The electromagnetic waves behavior can be controlled by adding different materials with different permittivities which allows better matching of the waves in the superstrate to the surrounding medium. Adding superstrate with equivalent dielectric constant of periodic media create a dielectric resonance mode near to the other resonance of the slot antenna itself. Proper feeding can also create a fictitious short along the slot antenna that is shown in (N. Behdad and K. Sarabandi, "A Wide-band slot antenna design employing a fictitious short circuit concept," IEEE Trans. AP, vol. 53, no. 1, pp. 475-482, Jan 2005). The superstrate has the effect of reducing the slot dimension for given resonance and therefore, the slot radiates effectively toward the superstrate and reduces the backward radiation. The stepped index allows a better matching to free-space. The width and length of the slot antenna and the thicknesses of each periodic layer of the superstrate are optimized to achieve the required operating bandwidth. The simulated and measured results will be presented during the symposium.