An Electrically Small Quasi-Isotropic Dualband Antenna Using Folded Split Ring Resonator and Parasitic Resonance

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In wireless communication systems, an isotropic antenna is desired in a number of applications such as radio frequency identification (RFID), wireless access points (APs) and ambient electromagnetic (EM) energy harvesting as it provides full spatial coverage so that maintains stable connection of communication links. However, an isotropic antenna which uniformly radiates electric fields in all direction does not exist (H.F. Mathis, Proc. I.R.E. 39, 970 ,1951). Alternatively, a common way to design a quasi-isotropic antenna is implementing a number of orthogonal electric or magnetic dipoles which show omnidirectional radiation patterns. On the other hand, such a quasi-isotropic antenna becomes electrically large due to implementation of multiple electric or magnetic dipole structures, though antennas for wireless communication systems are supposed to be electrically small. Also multiband operation is desired for the antennas of wireless communications. In this paper, an electrically small quasi-isotropic antenna with dualband operation is presented using folded split ring resonator (FSRR) structures.

One of the techniques to miniaturize the electrical size of a resonator is using a split ring resonator (SRR) structure. Additionally, SRR shows quasi-isotropic radiation pattern as it excites an electric dipole and orthogonal magnetic dipole simultaneously. The poor radiation characteristics of SRR can be improved by applying folded dipole structure which uses magnetic coupling of two SRRs (Harrison, C., Jr, King, R.W.P., *IRE Trans. Antennas Propagat*., AP-9, No 2, March, pp171-187, 1961). The interdigital capacitors (IDC) at the gap of SRR are implemented to make the electrical size of FSRR more compact.

A common method for dual band operation is using parasitic elements near the antenna structures. Specifically, the parasitic sleeve structure close to a dipole can excite double resonances due to electromagnetic couplings. Based on the sleeve dipole structure, parasitic SRRs shorter than the FSRR are implemented on top and bottom plane of the FSRR to make second resonance. As a result, the FSRR has double resonance at 880 MHz cellular band and 2.4 GHz Wi-Fi band. The electrical size of the antenna is ka=0.42 and the gain deviation is about 3 at lower resonance.