Theory of Size Reduction of DRA Resonators

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Dielectric resonator antennas have found increase interest because of their many advantages as efficient radiators. In the X-band and higher the antenna size is very small, but at low frequencies the antennas size may not be suitable and one has to use very high dielectric constant in order to reduce the size, but the bandwidth decreases dramatically because of the high quality factor. Since for mobile personal communications, the radiation patterns are not very critical. Another method to reduce the antenna size with wide bandwidth is desired. Here we propose a method of size reduction that was used successfully with microstrip patches [1]. The method depends on the nature of the mode excited within the full size resonator. It is well known that a perfect electric conductor (PEC) passing by a plane with zero tangential electric fields or only orthogonal electric field can be replaced with a PEC plate without disturbing the original field distribution and thus reducing the space by half and keeping the same resonant frequency of the antenna. This is corresponding to reducing the antenna size to half. This is actually what is used with the DRA antennas above a PEC. If the mode has a plane of symmetry with respect to the geometry and excitation and parallel to the E-plane of the antenna, the electric fields on this plane will be laying along the plane and the magnetic fields will be orthogonal to this plane. This plane could be replaced by a perfect magnetic conductor (PMC) without disturbing the field distribution and thus keeping the same resonant frequency and reducing the antenna size to half. However, there is no natural PMC to be used. Therefore, the reduction of the size using this plane needs to be considered carefully. Although, artificial magnetic conductors can be realized, this will not serve the purpose of size reduction because these materials to be useful its size might be larger than the size of the antenna itself.

The fields inside the dielectric resonator of the high dielectric materials see the dielectric surface as nearly magnetic conductor. Such an assumption is by itself is a useful argument that makes us believed that this plane exits naturally if the dielectric materials of one half are removed. Of course, such an assumption becomes better as the dielectric constant increases.

Demonstration of this argument will be presented by several DRA designs that keep the bandwidth of the full size DRA even after the size reduction that could be more than 75% of the full size DRA.

REFERENCES

1. Kishk, A. A., et. al., *IEEE Transactions on Antennas and Propagation*, Vol. 52, No. 1, January 2004.