A novel Hemispherical Dielectric Resonator Antenna with Swastika shaped DGS for high gain applications

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This paper investigates the effect of loading a Swastika shaped Defected Ground Structure (DGS) on a Hemispherical DRA. The HDRA of ε_r=9.2, radius r=2.54 cm (1") resonates at 1.816 GHz with a gain of 6 dBi. The bandwidth of operation (S_{11}<-10 dB) of the HDRA is 10% at the resonant frequency. The optimized dimensions, calculated through rigorous parametric sweeps, of the swastika DGS are a=0.54, b=0.59 and c=0.08 cms, as shown in Fig. 1.

The effect of loading the DGS improves the bandwidth to 11.5 % at 1.82 GHz due to the fact that the effective path length for the current distribution on the ground plane is increased. Also, the gain of the HDRA improves significantly to 8 dBi at 1.8 GHz. This is attributed to the fact that, each DGS is also a resonator which resonates for some band of frequencies. The DGS exhibits the band stop property for certain band of frequencies. Due to this functionality, the gain of the antenna is increased because the power incoming to the antenna port is now being distributed to the fundamental resonant frequency only.

The front to back lobe ratio is low i.e. 8 dB at 1.8 GHz. The back lobe is observed, since Swastika DGS also act as a slot antenna. Further, the effect of swastika DGS results in a directional beam pattern at 1.8 GHz though it excites the TE_{111} mode (fundamental mode) which has a broadside nature. All simulations have been done on CST Microwave Studio (CST MWS) transient solver with 25 tetrahedral meshes per unit wavelength, so as to achieve maximum accuracy. To the best of the literature survey carried out so far, such geometry has not been investigated. Some relevant figures including the proposed structure configuration is as shown below:-

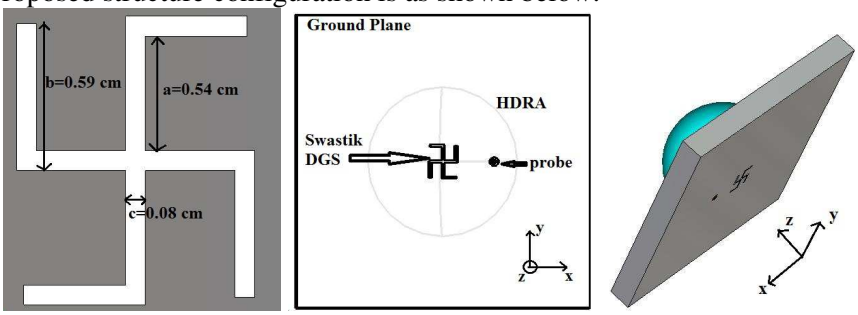

Fig. 1 The dimensions of the swastika DGS, the top view of the geometry and the isometric view.

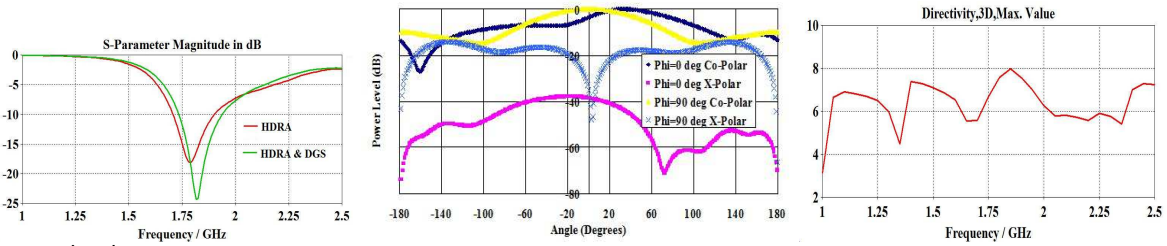

Fig. 2 $|S_{11}|$ plot of HDRA and with DGS, radiation pattern at 1.8 GHz, directivity plot.

References:

1. B. Mukherjee, et. al., "A Novel Hemispherical Dielectric Resonator Antenna with rectangular slot and Defected Ground Structure for low cross polar and wideband applications", IEEE Indicon, 2013.
2. D. Guha, Y. M. M. Antar, "New half hemispherical dielectric resonator antenna for broadband monopole type radiation", IEEE Transactions on Antennas and Propagation.