Design and Analysis of EBG Based Integrated Waveguide Structures for Microwave and MM-Wave Feed Networks

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The design of RF feed networks to connect antenna elements to Transmit/Receive Modules is a critical aspect of integrated antenna design where the use of EBGs is very promising. There are two design issues of particular interest: firstly the losses at higher frequencies with state of the art planar guiding structures are very high; secondly transferring the signal from lower to higher feeding planes in a multilayered structure in both an efficient and cost effective way is not straight forward.

An emerging technological solution that promises to be useful in tackling both problems is the use of integrated waveguides. These are structures that are formed by two parallel metallic planes laterally bounded by periodically spaced vertical pins. The pins can be either metallic (microwave applications (J. Hirokawa and M. Ando, IEEE Trans. A&P, pp. 625-630, May 1998)) or dielectric (optical applications (I. El-Kady, M. Sigalas, R. Biswas and K. Ho, J. Lightwave Tech., pp. 2042-2049, Nov. 1999)). These configurations are often referred to as electromagnetic/photonic band gap (EBG/PBG) structures which alludes to the scattering characteristics arising from the periodicities. This contribution first compares their characteristics and then explores the possibilities of adopting dielectric integrated waveguides in the microwave and millimeter wave ranges.

To simulate both the metallic and non metallic structures, an ad hoc spectral domain Method of Moments solution of the pertinent integral equations has been implemented. While the dispersion properties of metallic pin waveguides, at least for small spacing, are very close to the properties of equivalent solid wall waveguides, similar equivalences cannot be derived for the dielectric waveguides. Accordingly, this study initially considers existing guiding structures scaled from optical frequencies and then evolves into the design of new structures capable of working in the microwave and mm wave regimes. This is the first part of a more extensive work whose scope is the identification of guiding structures that are characterized by very low losses and low dispersion. Our work is premised on the fact that EBG walls can, in principle, establish a perfect magnetic wall condition capable of supporting in the guiding structure a TEM like propagating mode.