Summary of the PhD Thesis

Title: *Efficient analysis and design of devices in Substrate Integrated Waveguide (SIW) technology*

PhD candidate: Elena Díaz Caballero

The substrate integrated waveguide (SIW) is a low cost realization of the traditional waveguide synthesized in a dielectric substrate, where the side walls are substituted by two parallel rows of via holes placed so that there is no power leakage. This is a very promising technology that has aroused a growing interest in the scientific community. The main objective of this PhD thesis is the development of tools for the efficient analysis and design of SIW devices with N accesses. Particularly, two different analysis techniques have been developed, and then they have been used for implementing different design strategies.

The first analysis tool implements a hybrid technique using mode matching and the method of moments, and it also has two fast frequency sweep schemes, which further accelerates the analysis process. This tool is also able to consider the potential power leakage through the gaps between the via holes.

The approach of the second analysis technique is totally different, with the objective of trying to develop a tool even more efficient in terms of computational cost than the previous one. In order to do so, the SIW structure has been analyzed as a multiple scattering problem which is finally characterized by a scattering matrix. Then, a hybrid mode matching between cylindrical and guided modes has been performed in the N access ports. The advantage of this method is that all the calculations can be done either analytically or using the fast Fourier transform, without need for using other more inefficient numerical techniques.

Both techniques have been compared with each other and also with other analysis methods and commercial software. Moreover, the results of these analysis have been experimentally validated by fabricating and measuring several prototypes.

Next, these analysis tools have been used in several strategies for designing SIW filters. All of them are based in the concept of equivalent waveguide, so that very efficient tools for rectangular waveguides are used as starting point or coarse model for the design in SIW.

Moreover, with the objective of improving the results present in this thesis, the existing transitions between microstrip and SIW have been studied and a novel topology has been proposed together with empirical equations for its design. In addition, a calibration technique for measuring SIW devices has been presented, as well as a CAD tool for the analysis and design of filters in rectangular waveguide with rounded corners, which has been used in one of the design strategies for SIW filters.

Finally, the conclusions of this work are outlined and some future research lines are pointed out, including the implementation of fast frequency sweep schemes for the second analysis technique, as well as the development of a tool for the segmented analysis of the SIW structure. With these two improvements in the analysis techniques, it would also be possible to implement much more efficient CAD tools.